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LANDFILL GAS-TO-ENERGY AS A PROFITABLE FORM OF SUSTAINABLE SOLID WASTE MANAGEMENT: THE COMPARATIVE STUDY OF POLAND AND BELARUS

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ABSTRACT

On the example of Vireo Energy AB – a landfill gas-to-energy (LFGE) company operating in Poland and Belarus – the current research aims at finding reasons behind greater attractiveness of East-European non-EU operational and business environment in comparison to that of the EU-countries of Eastern Europe. As the Solow-Swan model associates business development with technological advancement, the research checks whether more powerful equipment positively distinguishes Belarus from Poland. Additionally, it evaluates whether slowly-liberalizing economy of Belarus offers Vireo greater opportunities since neo-liberal development theory parallels liberalization with greater perspectives for profit-generation and business growth. Finally, as the scientific management theory associates competitive advantage with the pursuit of best practices and waste-minimization, the study evaluates whether Vireo's facilities in Belarus are exploited in a more efficient way than the ones in Poland. The findings support each theory revealing the local legislation to be the key driver for the business to be more profitable in Belarus.

KEYWORDS

Landfill gas-to-energy (LFGTE), energy market liberalization, landfills, Belarus, Poland

INTRODUCTION

Landfills and dumps being one of the oldest forms of waste treatment represent an escalating problem in most countries of the world. In this context Mazzanti and Zoboli [1] attribute increase in their number to the overall population growth and intensified *'consumptionism'* – an inherent feature of globalization. According to the World Bank [2], landfilling is the most popular treatment activity associated with solid rubbish in both developing and developed countries. According to the United States Environmental Protection Agency (USEPA) [3], bacterial decomposition of organic materials in solid rubbish not only leads to a release of carbon dioxide, but also to the production of methane. Thus, a greater number of companies begins to think about utilizing these gases. According to Jaramillo and Matthews [4], utilization through burning it within generators is the most attractive for business due to a number of reasons: First, minor treatment-related costs are incurred because landfill gas is combusted in engines specially designed for fuel with instable quality (heating value, sulphur content etc.). In contrast, for example, scrutinized purification is required for it in order to be upgraded to either pipeline quality or to the quality of a vehicle fuel. The second advantage of this method is strictly related to the first one – i.e. no major transportation costs are faced (neither pipeline-related (e.g. pressurization), nor compression-related) as generating facility located on the landfill itself is directly linked to the electricity grid. In this context, Benett [5] suggests distance problem to be the major hamper for comprehensive appreciation of the thermal potential of landfill gas because of high heat losses incurred in transmission. Finally, according to the World Bank [2], the cost of electricity is often higher than the cost of natural gas (methane) in most countries of the world because of the fact that electricity usually happens to be a secondary product (with the exception of hydro-, nuclear power etc.) generated out of natural gas. As we see, electricity production from landfill gas appears to bring significant benefits in contrast to other forms of treatment,

especially in countries and regions with no significant development of nuclear and hydropower sectors – i.e. the factors usually in charge of lowering electricity prices [6].

In addition to the above-mentioned advantages, current practice has it that renewable energy businesses often either receive support from the government or operate in conditions stimulating their activity. In particular, Cora (2008) mentions quota obligations and feed-in tariffs among those direct mechanisms favouring green energy production over conditional one. According to the author, the first instrument represents specific obligations of energy consumers to obtain a certain percent of their energy generated from sustainable sources, whereas the second one – specific bonuses for each megawatt-hour (MWh) of such green energy bought by these customers. Besides, the majority of developed energy markets possess an additional stimulation mechanism expressed through 'green' or renewable energy certificates (hereinafter – RECs) that, according to Aune, Dalen and Hagem [7], represent special tradable property rights confirming that the energy is generated by sustainable means. In the opinion of Cora [8], the sale of such certificates and governmental support in a form of quotas, tariffs or both may actually create solid basis for profit generation even in landfill gas companies operating within the circumstances of low electricity prices. On the other hand, when electricity prices are reasonably high, such enterprises may have obvious advantages over organizations producing power in a conventional way because of the whole spectrum of versatile gains they have.

In such circumstances, a great number of scholars reasonably suggest developed nations to be on the lead in terms of business advantages that landfill gas-to-energy (LFGTE) projects may provide to energy producers. In particular, in their research covering specific aspects of energy policy of the European Union Aune, Dalen and Hagem [7] highlight common EU initiatives stimulating diversification of energy supplies and overall support of alternative energy sectors of member states as a supranational mainstream additionally encouraging national support mechanisms. That is actually why the authors believe the EU experience to be unique in terms of coverage scope comparing it to similar energy policy initiatives in other developed nations (e.g. Canada and the USA) and suggesting them to be greatly superior to the mechanisms exercised by developing nations. Since green certificates are recognized by Heinzel and Winkler [9] as 'the main mechanism to support the production of electricity from renewable sources' in many countries of the European Union including relatively new members (such as e.g. Poland), this tool could be regarded as the most efficient one in terms of profit generation. In this context it could be reasonably assumed that developing nations that do not possess green certificate trading systems and exploit solely quotas or feed-in tariffs are presumed to be less attractive for business operations than their developed counterparts. According to Oman and Manandhar [10] this happens to be one of the key deterrents for landfill gas companies deciding to invest in developing countries. In this connection, Eastern Europe with a number of its post-Soviet emerging economies presumably does not represent the most attractive target region for investment in renewable energy sources in a form of landfill-gas-to-electricity projects.

Vireo Energy AB (hereinafter – Vireo) is an international company specializing in energy production by means of organic sources and operating in four post-communist countries of Eastern Europe. According to Vireo [11], the firm's energy-producing installations are located or planned to be placed in Belarus, Poland, Romania and Russia with landfill gas (LFG) forming the core of the company's business interest. As a part of the Kinnevik Group – one of the leading Swedish investment organizations – Vireo is extremely determined to generate profit though the application of advanced technology solutions in new markets [11]. That is why the organization is constantly

investing in new projects in Belarus and Russia – i.e. non-EU countries – notwithstanding the fact that Poland and Romania – current EU members – were chosen as the target markets from the very start of the business. According to Marchenko [12], neither of these markets can boast green certificate-trading mechanisms. In addition the author provides evidence that quota schemes already in place in such EU countries as e.g. Poland are not implemented in Belarus and Russia. That is why the investment choice of the company may seem to be paradoxically irrational, unless any feasible explanation could be found. Thus, the *aim* of this research is to find the reasons why LFGTE projects happen to generate greater profits and offer more significant growth advantages in the developing non-EU nations deprived of sophisticated renewable energy certificate (REC) trading markets and exercising only a few forms of governmental support rather than in the developed EU countries with well-functioning RECs' trading and supportive quotas/feed-in tariffs already in place.

The paper analyses the LFGTE projects in Belarus and Poland through the prism of TELOS (technology, economy, law, organization, and scheduling) framework for project management suggested by Hall [13] and reflects the viability of Vireo's business undertakings with the exception of the very last constituent – scheduling. This component is excluded since, according to Gardner [14], the average 'effective methane production' timeframe for most of the landfills lies in between ten and fifteen years. Thus, the *research objectives* could be defined as follows:

To evaluate whether technological conditions for LFGTE projects in Belarus are better than those in Poland.

To evaluate whether economic conditions for LFGTE projects in Belarus are better than those in Poland.

To evaluate whether legal conditions in Belarus are more favourable for LFGTE projects in comparison to those of Poland.

To evaluate whether organizational/managerial conditions for LEFGTE projects in Belarus are better than those of Poland.

As a result of the research the findings should shed light on the prerequisites of the paradox spotted by Vireo in their activities in Belarus and Poland. In addition, conclusions made on the basis of the investigations could potentially be extrapolated to other developing nations with the post-Soviet region being characterized with the greatest applicability level.

LITERATURE REVIEW

Landfill gas utilization and its business dimension: Historical perspectives

Industrial utilization of landfill gas in contrast to its direct burning in flares represents a promising niche not only in the field of anthropogenic methane treatment but also in alternative energy management greatly because of constantly growing number of dumps – the process generally paralleled by Mazzanti and Zoboli [1] with increasing population in most regions of the world. Even though economic perspectives of LFGTE projects have been discussed for almost half a century, according to Gardner [14], replacing flaring with either upgrading landfill gas to pipeline level or controlled incineration in generators or heating facilities was not considered an economically feasible option due to its relatively lower return-on-investment (ROI) when compared to the conventional fossil

fuels. In this connection, the author binds increase in interest towards finding feasible methods of producing energy out of landfill gas to the overall depletion of the deposits of fossil fuels and gradual increase in their price associated with that. At the same time, however, the overall increase in interest towards processes of migrating landfill gas treatment is bound by such authors as Meima, Naranjo and Haarstrick [15] to the awareness of accidental explosion danger first raised in the late 1970s. In such circumstances we could indicate an academic gap of almost twenty years from the first research on controlled accumulation and handling of anthropogenic gas mix to the first studies of LFGTE projects presupposing almost no significant research coverage of the topic by the beginning of the mid-1990s.

In addition to that, even nowadays not all the researchers admit the ubiquitous importance of such undertakings stating that burning is the only viable method of waste treatment in some countries because of their overall level of development. In particular, Holmgren and Alemayehu [16] while commenting on the use of landfill gas for heating purposes indicate high costs of creating accompanying infrastructure and general absence of necessity for many developing countries to do that because of mild climatic conditions. Apart from that, the necessity to invest in sophisticated and usually costly facilities (e.g. landfill gas engines) is assumed by the authors to ward off any thoughts of potential investment initiatives in the developing countries. On the other hand such scholars as Gardner [14] at the dawn of business projects for landfill gas utilization expressed a more profound optimism towards their perspectives associating economic profits with gradual technology transfer and consequent technology cost reduction. Nevertheless, as Goh et al [17] reasonably bind academic interest towards LFGTE businesses to the presence of respective technology in the studied country or region, we could definitely assume significant inequality between the number of research pieces on the topic in the developed and developing nations with the odds being on the side of the former. While the United Nations Development Programme (UNDP) [18] shows most of the developed countries to be located in one of the following regions: Western Europe, North America, South America and Asia Pacific, most studies of LFGTE business implications happen to cover each of the mentioned regions. In their academic papers the authors attribute profitability and growth perspectives of LFGTE projects to some specific factors: technological, economic, legal or organizational (managerial). That is why practice has it that the most significant research pieces covering the studied topic highlight the ultimate importance of a specific driver. For example, Cora [8] provides evidence that within the current circumstances of relatively low prices for natural gas and high prices for electricity LFGTE projects are technologically more profitable since they bear the highest return on investment (ROI). In that sense, according to the author, introduction of more advanced technologies into the business process will give entrepreneurs broader perspectives for profit-generation and operational sprawl. This research has a very important relevance for the current study as it potentially implies that the comparison of technological indicators of Vireo's LFGTE facilities in both countries (Poland and Belarus) and also electricity prices may give answer to the main research question.

As the same time, however, Bennett [5] binds the general attractiveness of landfill gas projects to the overall economic and legal environment in the host country since many governments offer stimulating incentives which can ultimately generate generous profits even with modest energy return on investment (EROI) in comparison to conditional hydrocarbons. Thus, in the opinion of Raboni and Urbini [19], business growth is assumed to take place in pursuit of more favourable economic or legal environment. According to Heinzel and Winkler [9], presence of green certificates per se or feed-in tariffs associated with quotas generally constitutes such conditions. These pieces

of literature are also extremely relevant to the current paper as the comparison of the revenues associated with each system-specific LFGTE-support mechanism (feed-in tariffs vs. RECs) may shed light on the prerequisites of the observed phenomenon.

Finally, such authors as Goh et al [17] bind the process of gaining competitive advantage by LFGTE companies to the number of competitors in the market and overall competency of the managers capable or not capable of spotting business opportunities in the given economic or legal environment etc. In this sense Aguilar-Virgen, Taboada-González and Ojeda-Benítez [20] bind the success of managerial decision to the ability of company leaders to minimize expenditures and waste. Applicably to the current research, these studies potentially highlight the importance of comparing operational efficiency of Vireo's managerial decisions.

Theoretical frameworks

Since technology, economic, legal, organizational/managerial conditions are seen by most researcher to be the driving forces for the success of LFGTE organizations explanation of the phenomenon discovered in this paper could theoretically lie within the scope of the following frameworks: *Solow-Swan exogenous growth model*, *neoliberal development approach* and *scientific management theory* attributing the success of such undertakings to either technology, economic and legal environment or organizational/managerial stimuli, respectively. In this connection, juxtaposing previous academic experience with the mentioned theoretical background may potentially help to identify the prerequisites for the decision of Vireo to focus on producing LFG electricity in Belarus.

Solow-Swan exogenous growth model

Neoclassical growth model elaborated by Solow [21] and Swan [22] illustrates business development and economic growth primarily through the prism of productivity increases spurred by technological progress accompanying labour and capital:

$$Y = F(K, L, E)$$

Here, even though increase in quantity of labour (***L***) and capital (***K***) will definitely result in the overall business progress, the crucial factor of growth lies in technological break-through (***E***) – i.e. advancements multiplying physical efforts and money invested.

That is why Raboni and Urbini [19] and Wolz, Buchenrieder and Markus [23] comment on the crucial importance of having access to technologies in the vicinity of your business providing examples of engines produced by Jenbacher, Perkins and MWM GmbH (Deutz AG) as the catalysts of LFGTE projects in such countries of 'old Europe' as Austria, Great Britain and Germany, respectively. In this respect, technology transfer and its acceleration is assumed by Zappini, Cocca and Rossi [24] to be the key determinant of gaining advantage over competitors, which is quantitatively demonstrated by the authors on the example of Italy where the most successful LFGTE businesses simply acquired more efficient LFG engines.

As we see, the above-mentioned pieces of research eventually relate the Solow-Swan theory to the current study showing its potential to explain the essence of the reviewed phenomenon through the utilization of more advanced

technology by Vireo's Belarusian facilities which were brought there from the neighbouring Poland ultimately causing 'technological overflow' – a term used by Zhou, Cai and Chen [25]. Even though this theory can explain the process of gaining competitive advantage by LFGTE companies, none of the above-mentioned researchers provide evidence that implementation of more efficient technology has the decisive effect on the company's business growth. This is assumed to be done by the neo-liberal development theory.

Neo-liberal development theory

In parallel with the Solow-Swan model, other researchers linking the success of landfill gas-to-energy projects to more general macroeconomic factors such as overall decentralization of key industries as a result of political liberalization etc. actually follow the tenets of neo-liberal development approach to economic progress. In some of the most notable ones Cora [8] and Currier and Sun [26] take the US and UK as the examples of successful deregulation reforms leading to partial privatization of energy industry. In their opinion, alongside with technological progress this led to the abrupt growth of LFGTE businesses in the 1990s. According to Currier and Sun [26] and Blanco and Santalla [27], this experience was taken as example by the Chinese and Argentinean economies. The authors associate this fact with the subsequent development of LFGTE projects in other countries of Asia Pacific and South America.

For example, Menikpura, Sang-Arun and Bengtsson [28] – a group of researchers focusing on identifying the reasons for the development of LFG market in Thailand –attribute their success to the benefits achieved by the companies in the process of green certificate trading. In the opinion of the authors, American and European landfill gas companies moved to the country seeing the new prospects offered by liberalized economy, in general, and RECs, in particular. However, the case of China reviewed by Currier and Sun [26] is a little bit different: domestic LFGTE companies expanded their business in the regions offering less centralized economic environments. Blanco and Santalla [27], in their turn, reviewing landfill gas industry of Argentina imply that the development of waste-to-energy projects in that country owes primarily to economic liberalization undertaken against the US pattern which let many American LFGTE firms into the country. Just as in the example from China represented by Currier and Sun (2014), local entrepreneurs from neighboring countries seeing such advantages of business decentralization built-up their operations.

At the same time, economic freedom per se does not explain much of the profit-gaining rationale of the LFGTE entrepreneurs. According to Raboni and Urbini [19], who comment on the success of LFGTE initiatives in 'old Europe', at least half of the company's profit in the countries executing REC trading (apart from the direct sales of electricity) comes from certificate transactions. Moreover, Verhaegen, Meeus and Belmans [29] while focusing on Belgian landfill gas market rank green certificate trading mechanisms as number one in terms of income-building for such companies. That is why, according to the authors, economic liberalization not only has its general stimulating influence on waste-to-energy activities, but also quite specific affirmative financial effect.

Thus, as we see, the mentioned studies basically associate energy market liberalization with business growth and development which highlights the importance of current study as the one which is able to either prove the affirmative effect of liberalization of Belarusian energy market or set important limitations on neo-liberal development theory. In particular, the comparison of the financial effects (revenues and profits) of the utilization of

each particular stimulation mechanism associated with different economy liberalization levels is assumed to augment the phenomenon's explanation.

Scientific management theory

At the same time, however, some researchers still see managerial will as the crucial driver of any changes that can happen to a company. Applicably to the studied paradox, business expansion and growth of revenue are the result of thorough managerial planning and effective use of resources through waste minimization and efficiency enhancement – the pillars constituting scientific management theory. Exemplifying the tenets of this theory Bennett [5] draws attention to the United States – a country with different business environments in different states. In their studies, the authors show that business growth and accompanying profit-generation was achieved as a result of timely relocation of LFGTE businesses to the states with more favourable conditions, including legislative and technological environment etc. Cora and Golblum [30], in their turn, highlight the importance of prudent utilization of governmental initiatives such as e.g. regulations of the United States Environmental Protection Agency (USEPA) [3] presupposing not only tax stimuli for landfill gas collectors and electricity producers, but also benefits offered to those locally exceeding the limits in affirmative sense. In the opinion of the authors, this tactics not only encourages LFGTE companies, but also allows them conducting technology investments making their operations more efficient.

In the case of Asia Pacific, Woon and Lo [31] provide the example of China where LFGTE projects happen to play a particularly important role in minimization of pollution aftermath while replacing fossil fuels (mainly coal) in the process of electricity generation. Since such businesses in that country are able to benefit from governmental support primarily in a form of feed-in tariffs offered for green electricity producers in densely-populated areas (provinces), Woon and Lo [31] imply that in order to generate maximum profit LFGTE companies in China should relocate activities to the regions with most favourable conditions (i.e. the most populated ones and thus those where provincial feed-in tariffs are the highest). Thus, all the mentioned studies highlighting the necessity of prudent managerial decisions for the success of the company could explain Vireo's success in Belarus through a more skilled management capable of minimizing waste and expenditures. That is why comparing operational efficiency of Vireo's facilities in both countries is crucial.

METHODOLOGY

As the paper contains analysis of both qualitative and quantitative data different gathering methods are applied with each one being specifically tailored for a certain type of information that needs to be received and processed later on. Here, primary data forming the core of the research are supplemented with secondary ones utilized for follow-on in-depth investigation.

Primary data-gathering

When it comes to the *primary data* they are used for identification of the main areas where plausible paradox

causes can be found. There the research participants include the investigator himself and the representatives of the company (Vireo Energy AB) since the study is performed in a form of interviews. Here, the *researcher* plays the *role of interviewer*, whereas the role of *interviewees* is vested upon *four managers* with each of them representing a

specific trade. In spite of the relatively small sample size the reliability of the research does not suffer as it has a specific *quota nature*.

In general, each interviewee embodies a particular group in the landfill gas-to-energy business. In particular, since Vireo [11] appears to be a typical medium-size company operating in that industry, questioning the Chief Executive Officer (CEO), Managing Director (MD), Operations Manager (OM) and Finance Manager (FM) will address senior management (CEO), middle management (MD) and development teams (OM and FM), respectively. The company representatives are located in three different countries with the CEO residing in Sweden, OM – in Poland (but occasionally travelling to Belarus), FM – in Belarus and MD – biweekly travelling from Poland to Belarus being responsible for business in both regions. The interviews were thus conducted in three different countries: Sweden (Stockholm, Vireo's main office), Poland (Kozodrza, Vireo's oldest operating LFGTE facility) and Belarus (Minsk, country office). Apart from the possibility to cover all business levels of the company and industry such sample choice allowed aligning research questions with the reviewed theoretical frameworks:

In particular, interviews with the company's CEO and MD for Belarus and Poland approach answers for *the research question* of *whether organizational and managerial conditions in Belarus (non-EU area) are more favourable for LFGTE businesses in terms of profit generation and organizational growth than those in Poland (EU)*. Since all these aspects to some greater or minor degree lie within the responsibility area of both managers the interviewees are presumably able to compare Vireo's management styles in both countries as well as highlight the key stimuli for profit generation and business growth in each region. This is how *scientific management framework* is testified. Here, the interviewer approaches the issues of investment justification and competitors on the markets of Poland and Belarus.

Similarly, interviews with the FM and MD aim at answering the next row of *research questions* inquiring *whether economic and/or legal environment in Belarus* (non-EU countries of Eastern Europe) *fosters the development of LFGTE projects in a more efficient way than that prevalent in Poland* (i.e. EU members). As both managers apart from pure financial aspects deal with legal background of waste-to-energy management, asking them allows finding the plausible refutation of the *neo-liberal theoretical framework* while checking whether less intense liberalization of post-Soviet energy market in Belarus (and other former USSR countries of Eastern Europe) was more efficient for LFGTE business than liberal reforms in Poland (and other EU nations of Eastern Europe). Here, economic and legal stimuli in both regions are contrasted though the comparison of feed-in tariffs with quota-backed RECs and supporting legal provisions in both countries with each other.

Finally, addressing the OM aims at answering the *research question* of *whether technological conditions in Belarus* (representing non-EU countries of Eastern Europe) *happen to be more favourable for LFGTE business than those of Poland* (an EU-member). This is actually how the researcher approaches *the Solow-Swan theoretical framework* since the OM is responsible for handling technical side of the business (i.e. electricity production). In this connection, the interviewee is assumed to be able to assess the advantages and drawbacks of Vireo's machinery at each particular LFGTE installation which will contribute to finding answer to the related question. As we see, being conducted by means of *interviews with polar and clarifying questions* primary data gathering focuses on *qualitative information* identifying the key landmarks of further investigation and analysis. Each interview was appointed in advance with sample questions delivered to the interviewees by e-mail. The initial conversations lasted about one

hour each which was subject to the working limitations of the company's managers as well as the semi-structured nature of the interviews. This allowed focusing the respondent's recitation on the specific areas: i.e. CEO – on organization and management; MD – on organizational/managerial specifics and legal/economic conditions; OM – on technical aspects of LFGTE business, and FM – on financial and legal issues. Besides, semi-structured conversation allowed preliminary testifying of all the three theoretical frameworks.

After the appropriate consent of the interviewees each meeting was accompanied by *written recording conducted by the interviewer*. Also, *participant information sheets* were delivered to the respondents prior to the conversations which included access and confidentiality statements. These anonymity-related preliminary measures not only made the interviews smoother, but also built confidence which consequently allowed obtaining secondary data of quantitative nature indispensable for the follow-on analysis and evaluation of the theoretical frameworks-to-be-checked (*see 3.2.B. Secondary data-gathering: Participating sites and role of the researcher*). That is why the researcher conducted one interview with each manager except for the MD (two interviews) because of his personal experience and expertise of organizing business activities in both countries/regions as well as authorization of the company's information release to the researcher.

Due to the researcher's previous professional experience in the Finnish-Belarusian Chamber of Commerce associated primarily with evaluation of financial and legal feasibility aspects of new investment projects, the current study possesses a risk of researcher bias expressed through the tendency to pay greater attention towards economic and legal aspects while investigating the reasons for greater profit generation and growth potential of LFGTE projects in Belarus in comparison to Poland. Nevertheless, this peril is eliminated through the introduction of secondary quantitative data analysis focused on technical aspects of business utilization of landfill gas.

Secondary data-gathering

The secondary data utilized in the research could be divided into two major groups with the first one being the information received from the company itself and the second one – information obtained from the official sources of primarily legal content (laws, regulations etc.). The first group of data was gained *from the company's management information system* after the official consent of the CEO and via the MD – the person in charge of all Vireo's business operations in Poland and Belarus. This information is generally of technical nature related to the landfill gas-to-energy production facilities and the gas fields (landfills) themselves.

The other group of secondary data obtained by the researcher is used for the investigation of whether Vireo's business behaviour could be explained through the prism of the *neo-liberal development theory* where RECs being the embodiment of decentralization etc. are supposed to be more progressive that feed-in tariffs common to less liberalized economies. At the same time, however, the findings of the research could equally well refute some tenets of this theory. Since this information is basically open *no confidentiality issues arise.* Apart from legal documents, Vireo's management databases were used to get the information on the company's annual costs incurred in each country which was obtained after the official consent of the MD during the interview and in accordance with the Participant Information Sheet will not be revealed to the public.

At this stage acting independently from the researcher the *study participants do not play any research-specific role* while the role of the *researcher* himself at this point is practically *non-existent* – it is revealed at the stage of quantitative data analysis. That is actually why personal bias cannot affect the study outcomes (in contrast to the primary data collection phase). At the same time, however, the researcher being unable to influence secondary data collection perpetrated by the company's representatives and official bodies (such as e.g. Belenergo [32] – Belarusian state company managing the country's electro-energy sector etc.) may be subject to some plausible measurement mistakes and inaccuracies.

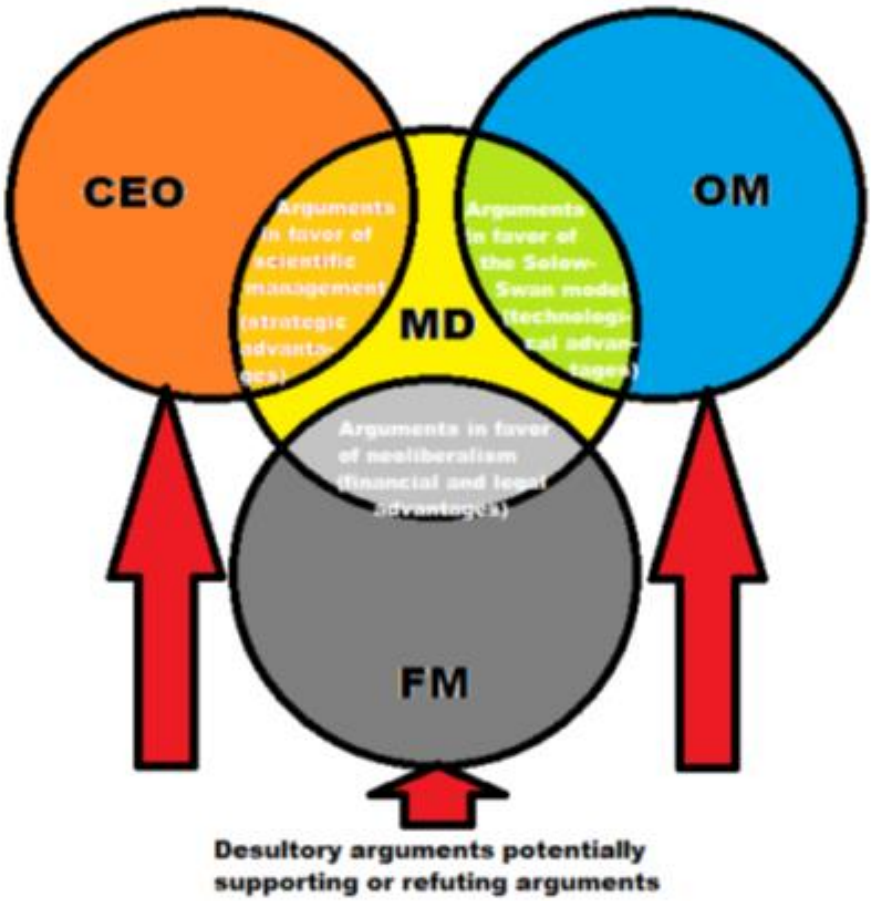
Data analysis

Since the data gathered relate to both qualitative and quantitative domains, each group requires its specific analysis technique. Here, primary data are primarily qualitative whereas secondary – quantitative.

Qualitative data analysis

Qualitative data collected by the researcher represent the results of the interviews with the company's managers. That is why a combination of analysis methods is applied since the researcher strives for understanding the motivation of the company's managers to invest in Belarus instead of Poland which is characterized as a better option. Here, *case-oriented understanding analysis* method is implemented as the basic one. At the same time, however, *qualitative comparative analysis* is applied in order for the investigator to juxtapose different views on the phenomenon so that all its plausible prerequisites could be discovered. Since a snowball sampling method was actively used at the data gathering stage, less structured interviews with similar questions to different company's representatives allowed finding the areas with the highest probability of the phenomenon's causality as well as those with lower causality chance. These overlapping interview questions and discussion topics could be depicted as follows:

Fig. 1: Overlapping interview questions



Here, the MD being the central figure in charge of business operations in both countries is used as a core reference adding to or subtracting importance from the plausible drivers of the phenomenon. In such circumstances if the opinions of two respondents about a specific phenomenon's cause coincide this variable is viewed as one of the most probable paradox's prerequisites. For example, OM's arguments in favour of more advanced machinery installed in Belarus confirmed by MD increase the possibility of this factor to be one of the decisive points for the manager's investment decision, which perfectly coincides with the Solow-Swan model. Similarly, feed-in tariffs agreed to be more efficient for profit-generation in less decentralized economy of Belarus than RECs in a liberalized Poland refute the basic tenets of neo-liberal development framework. Finally, strategic decision to invest in Belarus offering greater profits via maximization of work efficiency due to higher level of biodegradable content in the exploited landfills in comparison to that in Poland argues in favour of the scientific management theory.

The '*traffic light system'* will display all the converging topics raised in the interviews so that 'green' will depict the opinions most strictly coinciding with the verified theories, 'yellow' – those of medium-convergence momentum, and 'red' – with none. All these arguments supporting each of the theories are quantitatively scrutinized using the methods described in the next section as most of them have some feasible expression: e.g. percentage of biodegradable waste in a landfill; yearly electricity production etc. Here, quantitative data obtained by the researcher from legal sources (such as number of competitors in the market, timeframe of feed-in tariffs and multiplying factors)

are assumed to augment desultory arguments of the respondents which, in their turn support/refute respective theoretical frameworks.

Quantitative data analysis

Quantitative data analysis is generally based on the secondary data gathered by the researcher from Vireo's management databases and official documents either related to each landfill site in particular or LFGTE products in the countries of operation in general. This analysis strives for either augmentation or refutation of the relevant theoretical frameworks that could explain the investigated paradox. In this context *regression analysis* plays an important role as it helps to testify whether scientific management theory could potentially explain the decision of Vireo's managers to focus their business operations in Belarus. In particular, according to Gardner [14], dump composition directly correlates with methane generation as it is bound to its organic content. As methane is associated with bacterial activities which, in the opinion of Mahar et al [33], take place solely in biological substances, LFGTE production is assumed to be greatly affected by these processes. Thus, while assuming Belarusian landfills possess greater percent of organics identifying relationship between the percentage of biodegradable waste in a landfill and the overall electricity production will probably explain managerial decision to catalyse business activities in Belarus. This follows the tenets of the *scientific management model* as the decision to transfer business activities to the regions where gas engines work on landfill gas with greater methane percentage means lesser waste of efficient production capacity due to waste minimization as more methane and fewer additives are processed.

At the same time, greater percentage of biodegradable content may not solely be the cause of Vireo's focus on Belarus. Extrapolating the assumption of Bennett [5] to Belarus, more powerful engines used could potentially explain Belarusian technological supremacy leading to greater profit-generation. This actually coincides with the *Solow-Swan neoclassical growth model*. In such circumstances the quantitative data obtained by the researcher will be used for building a linear regression of the following kind:

$$yi = \beta 1 Xi1 + \beta 2 Xi2$$

Here, ***yi*** represents the *dependant variable* of *total electricity production per annum for each installation*, whereas ***Xi1*** and ***Xi2*** – the *explanatory variables* of *engine's electric output (power)* in each site and the *quantity of biodegradable waste* in a landfill, respectively. Here, quantity of the biodegradable waste is calculated as the

$$\text{Quantity of biodegradable waste in a landfill } (Xi2) = \text{Total amount of waste in a landfill} \times \frac{\text{Percentage of biodegradable waste in a landfill}}{100\ \%}$$

organic part (percentage) of the total amount of waste disposed by each landfill in a given year:

Created with the help of SPSS Statistics multiple linear regression allows identifying whether the assumed relationship between the biodegradable content of a landfill and electric output of engines used there from one side and total electricity production from the other side really takes place. Proof of each relationship supports either Solow-Swan or scientific management framework or both.

According to Niskanen and Värri [34], electric output may not always stand for technological supremacy due to the overall characteristics of landfills either undersupplying or oversupplying generators with landfill gas. In such circumstances older LFG generators are predictably less efficient due to the technical problems preventing them from functioning averagely 80 percent of the full-year time. As maintenance not only means additional repair expenditures, but also loss of profit due to underperformance, calculating the actual working time of each generating installation and comparing it to the optimum one may additionally prove both Solow-Swan and scientific management theories if the real working time of generators installed in Belarus is closer to the optimal one assessed for each gas field capacity. Here, narrower gap between the functioning time percentages are assumed to indicate greater reliability of Vireo's engines used in Belarus as well as prudent managerial decision to minimize waste through the installation of more efficient machinery which respectively reflects both theories.

Taking each landfill's electric capacity, electric output of each generator and total yearly production of each installation – i.e. the data obtained from Vireo's managerial databases – we could deduce the following formula for

$$\text{Optimal generator's functioning time in \%} = \frac{\dfrac{\text{Total yearly production of the installation in kWh}}{\text{Gasfield capacity in kWe}} \times 100\ \%}{8760\ \text{h}}$$

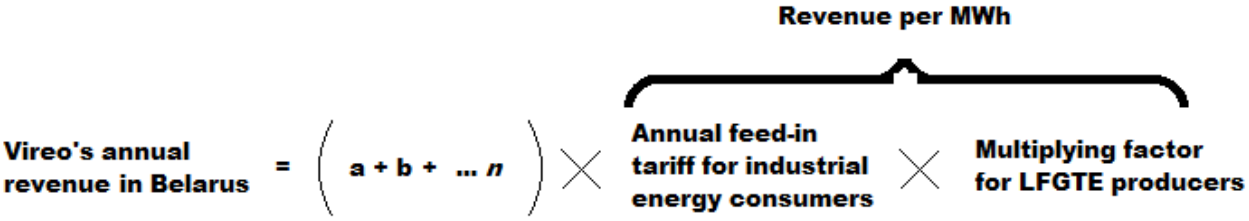
the optimal working time for each installation:

Similarly, the formula of real functioning time for a generator looks as follows:

$$\text{Real generator's functioning time in \%} = \frac{\dfrac{\text{Total yearly production of the installation in kWh}}{\text{Electric output of the engine or total output of the installation in kWe}} \times 100\ \%}{8760\ \text{h}}$$

Here, 8760 stands for the number of hours in a year.

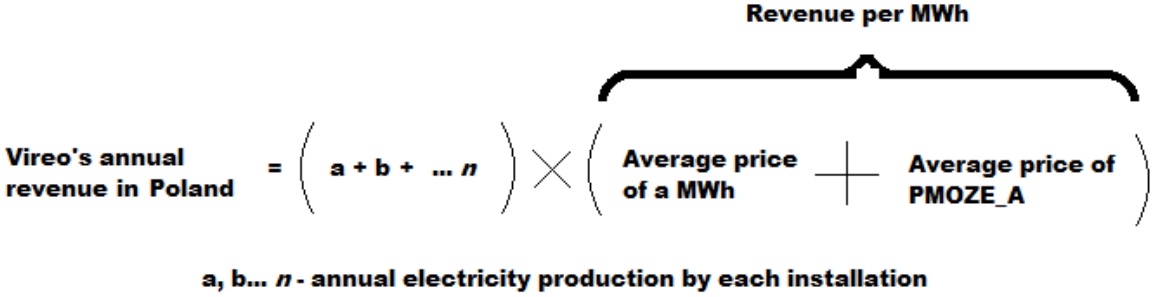
Finally, the capacity of neo-liberal development theory to explain Vireo's business conduct is testified through the comparison of Vireo's profit per megawatt-hour (MWh) in both countries. Since Belarus executes feed-in tariffs whereas Poland – green certificate trading the calculation of these data is different. In particular, in Belarus this sum will simply constitute annually-established feed-in tariff for industrial energy consumers multiplied by the coefficient for LFGTE producers – both imposed by the Ministry of Economy of the Republic of Belarus [35]. The



firm's annual revenue will thus be calculated as follows:

For Poland, however, the calculation is different as LFGTE companies earn money through the direct sale of electricity to the owners of the transportation grid, industrial consumers etc. obliged to buy it by quotas and through the sale of green certificates (PMOZE_A) issued by the Energy Regulatory Office [36] on the Property Rights Market of the Polish Power Exchange. That is actually why, Vireo's revenue per MWh in Poland is deduced as a sum of average electricity price for MWh for industrial electricity consumers and average exchange price of PMOZE_A for each MWh in a given year, which, in their turn, are calculated as the arithmetic mean of all electricity and PMOZE_A's prices in a given year. Similarly to the Belarusian example, the annual revenue of Vireo's facilities in Poland is deduced though the multiplication of total electricity production of all facilities and revenue per MWh:

Having calculated annual revenue in both countries and knowing annual costs incurred by the company in Belarus and Poland (information obtained from the company's management databases) we could calculate profit per MWe



produced in each country:

Since the overall output in both countries differs juxtaposition of annual profits per MWe comparatively highlights the supportive mechanism which is more efficient. The odds on the side of Poland will support *neo-liberalism*, whereas the indication of Belarusian advantages over the Polish ones – will set important limitations to it.

FINDINGS

Qualitative data

Since the interviewees were chosen according to their affiliation with a specific professional and business dimension answers given to the questions posed by the researcher, relate to one of the verified theoretical frameworks: neo-liberalism, scientific management and the Solow-Swan growth model. As each of the mentioned models presupposes some specific factor or a number of factors to be crucial for driving successful business activities, the answers given by the respondents not only allow justification of the theories, but also answering the research questions organized in compliance with the TELO pattern ultimately leading to meeting the research objectives:

Respondents	Theoretical frameworks	Drives of business success	Research questions	Research objectives
OM and MD	Solow-Swan exogenous growth model	Technological progress, innovation and efficiency	Do technological conditions in EU countries happen to be less favorable for the development of LFGTE market when compared to non-EU ones?	To evaluate whether technological conditions for LFGTE projects in Belarus are better than those in Poland
FM and MD	Neo-liberal development model	Industrial decentralization and overall economic liberalization	Do economic conditions in EU countries happen to be less favorable for the development of LFGTE market when compared to non-EU ones?	To evaluate whether economic conditions for LFGTE projects in Belarus are better than those in Poland
MD			Do legal conditions in EU countries happen to be less favorable for the development of LFGTE market when compared to non-EU ones?	To evaluate whether legal conditions in Belarus are more favorable for LFGTE projects in comparison to those of Poland
CEO and MD	Scientific management	Adequate managerial skills capable of spotting and utilizing waste minimization and profit maximization opportunities	Do organizational/ managerial conditions in EU countries happen to be less favorable for the development of LFGTE market when compared to non-EU ones?	To evaluate whether organizational/ managerial conditions for LEFGTE projects in Belarus are better than those of Poland

Table 1: Research questions against the TELO pattern

Since the MD plays the core role in identifying areas with highest number of arguments in favour of each particular theory, the 'traffic light system' will be implemented for displaying the results relevant for each framework with 'green' standing for the highest convergence of probability, 'yellow' – medium-level one, and 'red' – the lowest level of similarity, respectively.

Interviews with the Operations Manager (OM) and the Managing Director (MD): The Solow-Swan exogenous growth model

The interviews with both OM and MD supported the research with the feedback related to the tenets of Solow-Swan model and covering *technical* part of the TELO pattern used by the research. In the traffic-light system, the convergence of answers provided by the respondents could be represented in the following way:

	Questions addressed to the MD	Questions addressed to the OM	Curt answers
Questions identifying differences between the technological conditions of LFG production in Vireo's businesses in Poland and Belarus	Are there any significant differences in technological conditions in LFG production that Vireo faces in Belarus and Poland?	Is LFG-extraction technology in Belarus different from the one used by Vireo in Poland?	No
	Is there any difference in LFG output in Poland and Belarus?	Is LFG yield in Belarus greater than LFG yield in Poland?	Yes
Questions identifying differences between the technological conditions of LFG production in Vireo's businesses in Poland and Belarus	Are there any significant differences in technological conditions of consecutive electricity generation that Vireo faces in Belarus and Poland?	Are there any differences in consecutively-implemented electricity-production technologies?	No significant differences
		Are the LFG engines used in Belarus more powerful than those in Poland? (Is the average engine output in Belarus greater than that in Poland?)	Not all of them, but Belarusian installations outnumber the Polish ones by the quantity of powerful generators
	Is there any difference in Vireo's electricity production in Poland and Belarus?	Is Vireo's average electricity production in Belarus bigger than that in Poland?	Yes
Questions identifying physical differences that may influence LFG and electricity production of Vireo	Does landfill content happens to significantly influence LFG extraction and electricity generation indicators of Vireo in each of the countries?	Does the content of landfills in Belarus differ from the content of landfills in Poland?	Yes
		Is the content of landfills in Belarus more favorable for LFG production and consecutive electricity generation that the content of landfills in Poland?	Yes
	Is there any difference in trash volume utilized by Vireo in Poland and Belarus?	Does the average volume of a landfill (i.e. the amount of trash) influence the ultimate LFG output and follow-on electricity production?	Yes
		If yes, is there any significant difference in the total amount of waste exploited in Poland and in Belarus?	Yes

Table 2: Questions addressed to the OM and MD

As we see in the 'red' areas there are no major differences in terms of technological environment of Vireo's operations in Belarus and Poland, but the 'green' ones signify that there are significant discrepancies in output/production indicators when it comes to both LFG and electricity. In this context, 'yellow' areas of medium

divergence identifying greater number of high-output engines, more favourable biological content in the landfills and greater overall volume of trash should draw our particular attention. Only the first of all these variables (i.e. the output of the engines) directly relates to the Solow-Swan model whereas the remaining two – biodegradable content of the landfills and the overall volume of trash utilized – may have their implicit influence on the technology implemented. That is why, these potential paradox's drivers are verified for the probability of their causality further on by quantitative means. Here, particular attention is given to the generators' output because of the answers' maximum convergence.

Interview with the Financial Manager (FM) and Managing Director (MD): Neo-liberal development model

The results of the interviews with FM and MD reveal quite a similar picture where both FM and MD mention the same financial and legislative stimuli which could be displayed in the following way:

	Questions addressed to the MD	Questions addressed to the FM	Answers
Questions identifying the key stimuli for Vireo to launch LFGTE operations in Belarus	What are the main drivers of Vireo's success in Belarus?	In your opinion, what are the key stimuli for the development of LFGTE projects in Belarus?	*State support and absence of competitors*
		Which of these stimuli are the key drivers of profit-generation?	*Feed-in tariffs and multiplying factors (for each MWhr of electricity produced from sustainable energy sources)*
		Which of these stimuli are the main reasons for organizational growth?	*Lack of competitors*
Questions identifying the key stimuli for Vireo to launch LFGTE operations in Poland	What are the main drivers of Vireo's success in Poland?	What are the main factors helping Vireo generate profit in Poland?	*Tradable green certificates and quotas*
		What are the perspectives of organizational growth in Poland?	*No growth perspectives*
Questions comparing stimulation mechanisms in Poland and Belarus	Why do you think Vireo moved from greatly liberalized LFGTE market of Poland to a less liberalized one of Belarus	Why do you think the company launched its operations in Belarus – a country with neither quotas nor RECs?	*Because feed-in tariffs and multiplying factors help to generate sufficient profit level in Belarus*
	Do you believe feed-in tariffs and multiplying factors are more efficient than RECs and quotas?	Do you think quotas and tradable green certificates would be a better alternative to feed-in tariffs and multiplying factors?	*No, because in Belarus there are neither competitors nor well-functioning property rights' market*
		In your opinion, what stimulation mechanisms are more efficient: those in Poland or those in Belarus?	*Hard to say, because the conditions Vireo faces in Poland would not bring profit in Belarus and vice versa*

Table 3: Questions addressed to the FM and MD

Questions comparing challenges for Vireo's LFGTE projects in Poland and Belarus	Where strategic growth perspectives are greater, in your opinion?	Where do you think the perspectives of upgrading landfill gas to the level of vehicle fuel and using landfill gas for heating purposes are more promising?	*In Belarus because of the expected state support and no competitors*
	What are the key challenges for the development of Vireo Energy AB in Belarus?	Are the procedures to connect installation to the grid more complicated and expensive in Belarus or in Poland?	*The average costs of connection to the grid are relatively similar. However, the whole process is more complicated in Belarus because of the bureaucratic procedures*
	Are there any significant differences in legal environment?	In your opinion, where do you think the legal environment is more favorable for driving LFGTE business: in Poland or in Belarus?	*Legal environment in Belarus presupposes obligatory state support for LFGTE projects that guarantees profit generation. In Poland, however, RECs forming the greatest part of the profit are only supposed to be daily traded on a stock exchange meaning revenue's volatility etc.*
	What are the key challenges or the development of Vireo Energy AB in Poland?	What are the main barriers for the successful development of Vireo's LFGTE projects in Poland?	*Strict waste-treatment legislation, great number of competitors and limited number of landfills*

Here the situation happens to be quite similar to the previous set of interviews displaying both respondents basically expressing similar opinions on all the questions relating to the same topic. This case, in particular, shows us what rare convergence with neo-liberal tenets depicted in 'green' is overwhelmed by strong divergence responses of the interviewees ('red'). Namely, contrary to the opinions of most scholars presuming liberalized economies to be more favorable for business development, economic and legal environments of Belarus with its feed-in tariffs, multiplying factors and less strict waste-treatment regulations in the absence of competitors are implied to safeguard Vireo greater revenues and growth perspectives than it encounters in Poland. On the other hand, bureaucracy being the main drawback of centralized energy systems generally supports neo-liberal tenets. Hence, the 'yellow' areas of relative convergence put a very significant question on whether supportive mechanisms that Vireo faces in Belarus are more efficient than those in Poland which, if affirmatively proved, imposes significant limitations on the neo-liberal framework.

Interview with the Chief Executive Officer (CEO) and Managing Director (MD): Scientific management theory

Just as in the previous cases, the answers to the interview questions addressed to the CEO and MD generally coinciding in their connotation supported the research with a ranging level of convergence with the tenets of the scientific management theory. In the 'traffic light system' this picture could be displayed as follows:

Table 4: Questions addressed to the CEO and MD

	Questions addressed to the MD	Questions addressed to the CEO	Answers
Questions identifying the key advantages of relocating Vireo's operations to Belarus	What are the main prerequisites of Vireo's business success in Belarus?	Why did you decide to invest in LFGTE projects in Belarus?	*Belarus offers greater profit generation and growth perspectives*
		Are there any specific aspects making that market more attractive for such companies as Vireo when compared to the conditions you faced in Poland?	*Technical, financial and legislative incentives*
	Why do you think Vireo moved from greatly liberalized LFGTE market of Poland to a less liberalized one of Belarus	What specific financial stimuli for LFGTE business were discovered by Vireo in Belarusian market?	*Feed-in tariffs and multiplying factors*
		Why did you decide to expand business to Belarus in the absence of a sound system of quotas and tradable green certificates?	*Because tariffs and coefficients offer greater revenue level*
Questions identifying prerequisites for more effective waste-minimization and profit-maximization in Belarus	Are there any differences in managerial and organizational practices that Vireo exercises in each country?	Are there any specific differences between managerial practices applied in Poland and those applied in Belarus?	*No, waste-minimization and profit-maximization principles are the same for Vireo's branches in both countries*
	What stimuli and hindrance for the adherence to waste-minimization and profit-maximization management principles in Belarus could you mention?	What are the main legislative benefits of business operations in Belarus in comparison to such operations in Poland?	*Less strict waste-treatment legislation allowing greater LFG extraction etc.*
		What are the main technical benefits of running business in Belarus in comparison to those associated with Business in Poland?	*Higher percentage of biodegradable content in landfills*
		Are there any other country-specific benefits that tipped the balance in favor of the decision to invest in Belarus?	*Yes, absence of competitors*
		What are the major barriers (if any?) for business development in that country/region?	*Bureaucracy*

Here we can see almost complete convergence of the answers with the scientific management theory ('green') as Belarus offers greater profit-generation and growth perspectives while possessing only one minor hamper – i.e. bureaucracy ('red'). In particular, waste-minimization practices find their reflection in utilization of less strict waste-treatment legislation provisions and thus securing optimal load of LFG engines through greater percentage of biodegradable content in the landfills themselves. Besides, greater governmental support for LFGTE projects and absence of competitors deprive the company of additional expenses on production promotion etc. At the same time, however, no significant differences in managerial practices are spotted.

Quantitative data

Qualitative data analysis based on the secondary data obtained from the company itself and the official waste management plans (in Poland) and ordinances of the local councils of deputies (in Belarus) is used both in regression analysis and the follow-on calculations conducted by the researcher.

Regression analysis: Solow-Swan exogenous growth model and scientific management theory

Multiple regression viewing electricity production as the dependant variable and generators' output and biodegradable content of landfills – as respective explanatory ones shows us the following results:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.880[a]	.774	.755	.1163

a. Predictors: (Constant), Content, Output

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-4.147	1.534		-.792	.436
	Output	3.961	.663	.696	5.974	.000
	Content	.001	.000	.285	2.449	.022

a. Dependent Variable: Electricity

Here, the equation describing the relationship between the engines' output and landfills' biodegradable content on the one hand and electricity production on the other could be represented as follows:

Electricity = (3.961) Engine output + (0.001) Biodegradable content – 4.147

At the same time, however, using only biodegradable content as an independent variable for predicting electricity

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.651[a]	.424	.400	.1819

a. Predictors: (Constant), Content

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.994	1.544		3.660	.001
	Content	.002	.000	.651	4.205	.000

a. Dependent Variable: Electricity

production would give us the following result:

Here the equation describing the relationship between the independent variable of biodegradable content and the electricity production is as follows:

Electricity = (0.002) Biodegradable content + 1.994

Now if we compare the R squares of the two the R square of the multiple linear regression (the first equation) is greater than the R square of the simple linear one with the explanatory of biodegradable content:

0.774 > 0.424

On the other hand, the standard error of the estimate is actually slightly less significant:

0.1163< 0.1819

A similar picture could be displayed if we create a simple linear regression with the engine output as a sole

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.846[a]	.715	.704	.1279

a. Predictors: (Constant), Output

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-3.962	1.586		-.675	.506
	Output	4.815	.620	.846	7.769	.000

a. Dependent Variable: Electricity

explanatory influencing electricity production:

Here, the equation could be depicted as follows:

Electricity = (4.815) Engine output – 3.962

As we see again, the R square of multiple linear regression is greater that the R square of the newly-constructed one:

0.774 > 0.715

Besides, the standard error of the estimate is also less:

0.1163< 0.1279

At the same time, however, since the LFGTE production in Belarus and Poland started in quite different circumstances (with the Belarusian landfills possessing more biodegradable waste etc.) the explanatory variables on a joint graph depicting interdependence between the waste content and electricity production are more scattered than in the graphs specifically dedicated to Vireo's activities in each of the countries, respectively:

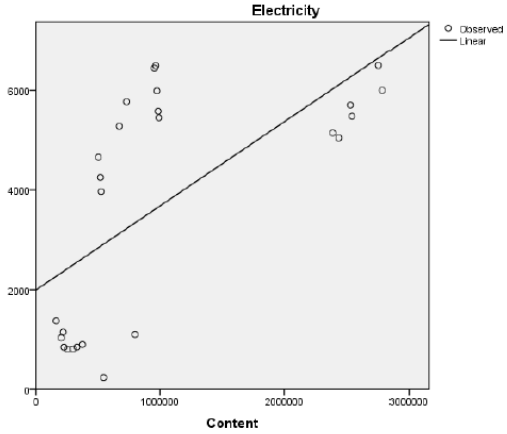


Fig. 2. Biodegradable content determining electricity production in Poland and Belarus

Here, we see that the dots are scattered quite far away from the main direction line. This effect is mitigated when electricity production is pictured for Poland and Belarus in a separate way:

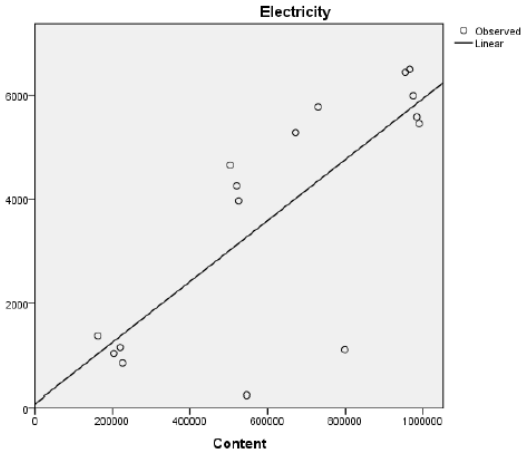


Fig. 3. Biodegradable content determining electricity production in Poland

Predictability in Belarus is even greater than in Poland:

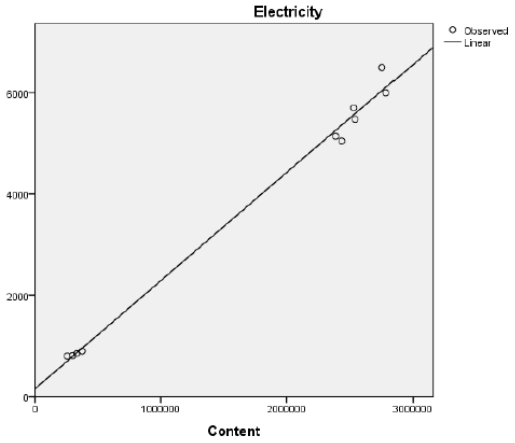


Fig. 4. Biodegradable content determining electricity production in Belarus

If we graphically describe the relationship between the engines' output and electricity production in all installations, the picture looks as follows:

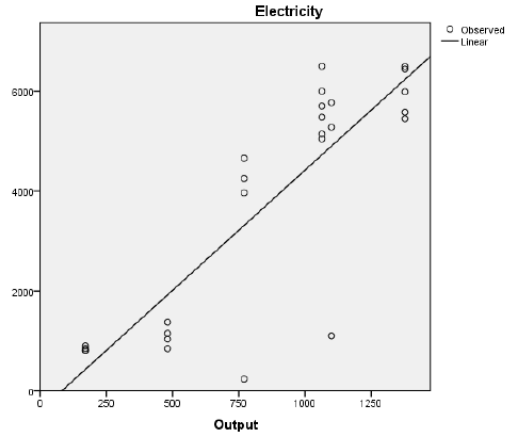
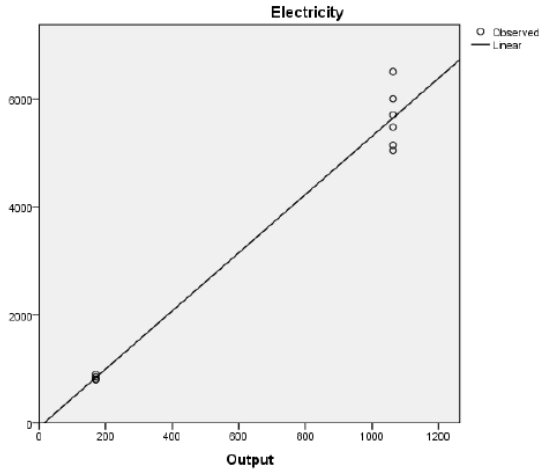


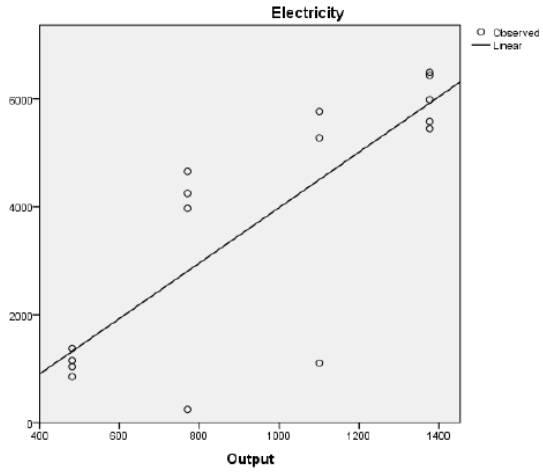
Fig. 5. Engine output determining electricity production in Poland and Belarus

As we see, the dots are very much scattered round the line. This result does not change when we picture dependence for Belarus and for Poland separately:

Fig. 6. Engine output determining electricity production



Belarus



Poland

Thus, as we see, two variables jointly determine electricity production more precisely than each of them in a separately, whereas graphically the dots depicting biodegradable content are less scattered than the ones standing for the output.

Optimal working time vs. real working time: Scientific management theory

Comparatively, the results of the calculations of optimal generators' working time and the real time of their functioning could be represented in a joint table as follows:

Table 5: Optimal functioning time vs real time

Country	Installation	Optimal generators' functioning time vs. real generators' functioning time (in %)									
		2011		2012		2013		2014		2015	
Poland	Kozodrza	69.1	45.2	70.8	46.3	76	49.6	82.4	53.8	81.7	53.4
	Zabrze	–		38.7	20	52.5	27	47.2	24.5	62.7	32.5
	Rusko	–		4	3.5	64.8	58.8	69	63	75.9	69
	Lubin	–		–		14.8	11.3	77.5	59.9	70.9	54.8
Belarus	Gomel	–		–		43	36.4	84.8	71.8	82.4	69.8
	Orsha	–		4.4	3.6	47.2	38.7	72	59	73.4	60
	Vitebsk	–		–		70.5	53	90.9	68.4	85.6	64.4

Here the 'traffic light system' is used again to demonstrate compliance with the scientific management theory in the following way: 'green' – the cases of maximum compliance (i.e. when the deviation of real time from the optimal one does not go further than 5 percent), 'yellow' – the cases of medium compliance (i.e. when the deviation of real

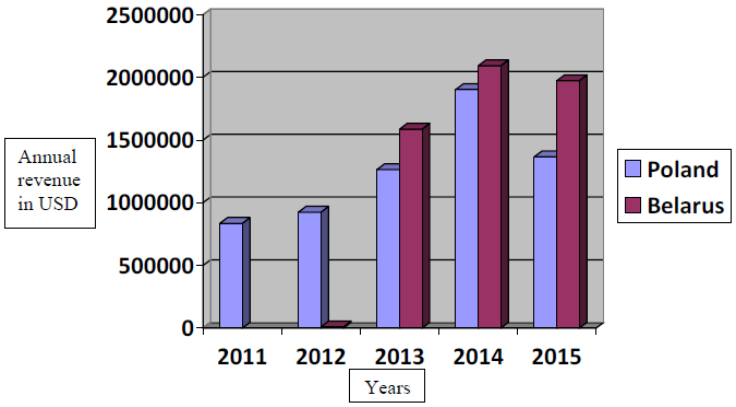
time is between 5 and 15 percent), 'red' – the cases of minimum compliance (i.e. when the deviation is greater than 15 percent).

Even though the installations in Vitebsk have shown neither medium nor maximum compliance, the calculations demonstrate that in comparison to Poland operations in Belarusian facilities show better adherence to the principles of waste-minimization etc. In particular, in seven out of ten cases the real engines' working time is very close to the optimal one ('green' and 'yellow' areas). In contrast, Polish facilities demonstrate total incompliance with the scientific management theory in eleven out of sixteen cases ('red') sticking to waste-minimization only in five cases.

Comparative profit per MWh: Neo-liberal development theory

Neo-liberal model testified via comparison of Vireo's profits per MWh in each country could have been verified through a simple comparison of the annual revenues gained by the company in each country, respectively as the discrepancy appears to be quite vivid:

Fig. 7: Vireo's annual revenues from LFGTE activities in Poland and Belarus



Here we see that the annual revenue gained by Vireo in Belarus is greater than the one gained by the company in Poland even though the number of installations in the latter country is greater (four) than in the former (three). Besides, Belarusian operations were launched later (only at the end of 2012) than the Polish ones. However, the first full-time production year (2013) shows us that Belarusian installations generate greater revenue against all odds.

At the same time, however, only profit per MWh can support us with the most accurate information regarding the efficiency of profit-generating mechanisms in both countries. Hence, the calculation of Vireo's profit per MWe in each country for each year of production will give us the following results:

Years	Profit per MWe (in USD)	
	Belarus	Poland
2011	—	-29.97
2012	-20182.77	-176.17
2013	-79.95	21.71
2014	110.72	79.92
2015 (estimated)	111.49	46.02

Table 6: Vireo's profit per MWe in Belarus and Poland

As we see, the first two years of electricity production in both countries were characterized with negative profit per MWe with Belarusian facilities scoring lower than the Polish counterparts. At the same time, however, consecutive years of LFGTE operations show greater profits per MWe spotted in Belarus when compared to Poland:

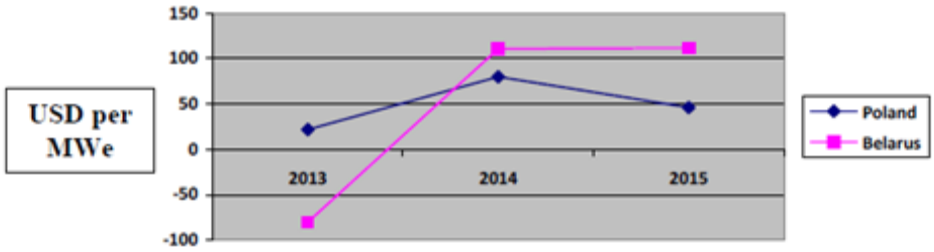


Fig. 8: Vireo's profits per MWe in Poland and Belarus

In particular, as we see from the chart estimated indicators for 2015 are almost two times higher in Belarus than in Poland. In general, when observed from 2013 – the first year all the installations in both countries were in action – Belarusian facilities made a giant leap from negative profit per each MWe produced to the profits almost doubling those of Poland. As we see, Belarus vividly offers better conditions not only for the build-up of revenues, but also shows better prerequisites for profit-generation.

DATA ANALYSIS

Qualitative data

Based on the answers of Vireo's personnel displayed in a form of joint table and organized in compliance with the 'traffic light system' the qualitative data analysis represents the interpretation of the information that potentially explains managerial decision to relocate LFGTE operation to Belarus and focus on them.

Interviews with the Operations Manager (OM) and the Managing Director (MD): The Solow-Swan model

As we see from the table in the previous chapter, there are no significant differences in terms of technology used for LFGTE production in Poland and Belarus ('red' areas). At the same time, however, substantial differences in electricity production are observed in Vireo's installations with the odds being on Belarusian side. According to the

MD and OM, this could be explained by more favourable content of the waste polygons in Belarus and greater amount of trash placed there. These two factors happen to be interdependent with both LFG yield and consequent electricity generation highlighting Belarus as a more perspective venue for the company's operations since it potentially offers greater profit-generation. Apart from that, only one Polish installation possesses LFG engine with the output over 1000 kWe, whereas two of the Belarusian sites have such machinery:

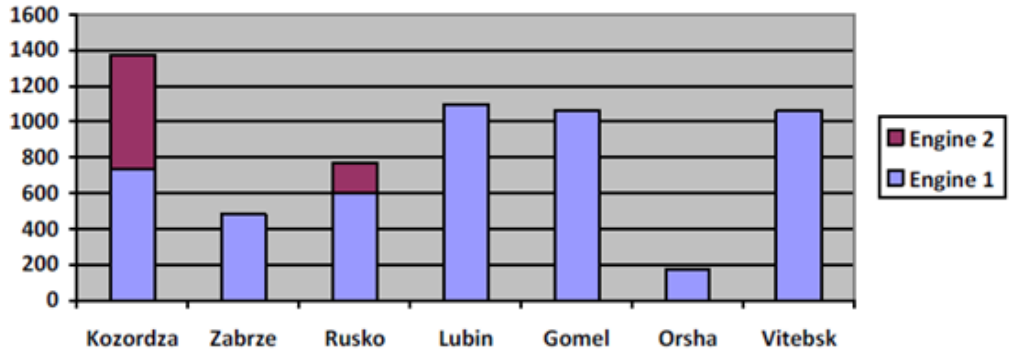


Fig. 9: Output of engines installed (in kWe)

Greater total power in Poland is achieved through the installation of additional generators augmenting the total output so that two of the four installations operating there possess two LFG engines. In contrast to that, each Belarusian installation disposes one single generator for electricity production. Following waste-minimization and functionality principles, this could potentially be interpreted as follows. Except for the site in Orsha (the oldest of all the landfills), Belarusian LFGTE facilities are designed for steadily high LFG yield and thus high output of electricity so that they utilize more powerful machinery installed there from the very start of operations. In contrast to that, the facilities in Poland are designed in such a way that they can switch from intensified electricity generation to a less significant one depending on the volatility of LFG production. The feasibility of this interpretation is checked by quantitative means through the implementation of multiple linear regression.

Interview with the Financial Manager (FM) and Managing Director (MD): Neo-liberal development model

As we see from the table displayed in the previous chapter, most of the answers appear to show extreme divergence from the tenets of neo-liberal development theory. In particular, judging by the revenues accumulated in Belarus, mechanisms of income-generation utilized in Belarus offer greater prospects than those used in Poland. As most of these mechanisms happen to be typical for the economies with strong centralization and lower level of economic liberalization the discrepancy between the company's real performance and the one expected by the proponents of neo-liberalism, appear to indicate important limitation of the framework. In particular, Belarusian economy being currently in a state of transition does not dispose a developed property rights' market, which presupposes that no efficient system of tradable green certificates can be in place. In these conditions, the 'red' areas, which are almost pervasive in the table represented in the previous chapter, confirm the following tenet.

For Belarus – a country in a state of transition – traditional mechanisms of profit-generation typical for centralized economy appear to be more efficient than the ones associated with liberalized one. In this connection, the case of Vireo represents an important constraint for the neo-liberal development morel as the company's performance in a

state-controlled energy market (Belarus) demonstrates greater success than the one observed in the conditions of deregulation and reduced governmental spending on support of the energy business (Poland). At the same time, however, these observations may be of temporary nature due to the general strive for liberalization and such drawbacks of the state-controlled system as bureaucracy ('green' areas in the table) so that with the development of property rights' market Belarus may potentially follow the Polish path.

Interview with the Chief Executive Officer (CEO) and Managing Director (MD): Scientific management theory

As both respondents engaged in the third round of interviews confirmed absence of any significant differences between the managerial practices exercised in Poland and Belarus waste-minimization and profit-maximization intentions happen to be the most important ones determining Vireo's managerial decisions to launch business activities in Belarus. In such circumstances both MD and CEO confirm better operational opportunities for Vireo spotted in Belarus due to the governmental support expressed through the feed-in tariffs and multiplying coefficients. Besides, less strict waste-treatment legislation pre-determines greater percentage of biodegradable waste in a landfill and thus greater LFG yield and more intense electricity production. Finally, absence of competitors defines the greatest strategic advantage of Belarus as an operational hub a point for the company's further expansion. This advantage mentioned last is the only one that cannot be analysed by quantitative means. At the same time, however, this is the one that distinguishes Vireo's operations in Belarus from the ones in Poland in the long-term perspective, as the latter do not possess that future-oriented strategic advantage.

The only drawback that might potentially prevent Vireo from building-up its operations in Belarus is bureaucracy-associated procrastination ('red' area in the table) which not only has negative effect on planning, but also potentially pulls additional funds and theoretically undermines the company's strategic advantage. On the other hand, however, as the overwhelmingly 'green' and 'yellow' areas show financial and strategic benefits of relocating business to Belarus tip the balance in favour of the new venue. Thus, the decision of Vireo's managers goes in line with the principles of scientific management theory highlighting rationality and waste-elimination.

0.424<0.774>0.715

As R square lies in between -1 and 1 this value actually signifies the magnitude of the dependency identifying it as quite a strong one (almost 80 percent) in comparison to the one built solely by engine output and biodegradable content determinants. Applicably to Vireo's LFGTE business activities this means that the company's profit directly bound to the electricity production is determined by both trash structure and engine power.

In such conditions knowing that Belarusian landfills are characterized with greater percentage of biodegradable content which is maintained at relatively stable level whereas the Polish ones lose its biodegradable constituents year by year we could explain managerial decision to launch operations in Belarus and focus on them. This

goes in line with tenets of the scientific management theory confirming profit-maximization and waste-minimization rationale. Graphically, this could be seen through separate estimation curves (lines) for LFGTE production in Poland and Belarus: there Belarusian facilities demonstrate significantly lower dot-dispersion level when compared to the Polish ones:

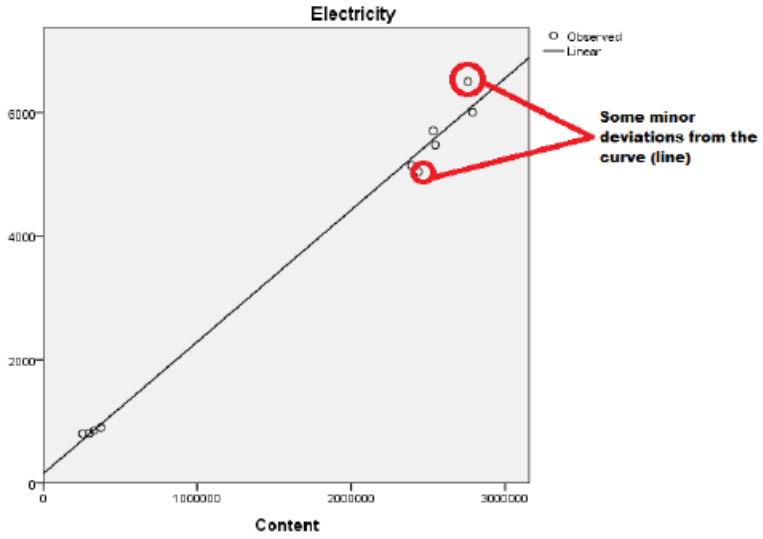


Fig. 10: Landfill content determining energy output in Belarus

Here, Belarusian LFGTE activities show only slight deviation from the ideal compliance whereas the picture of Polish activities is a little bit different:

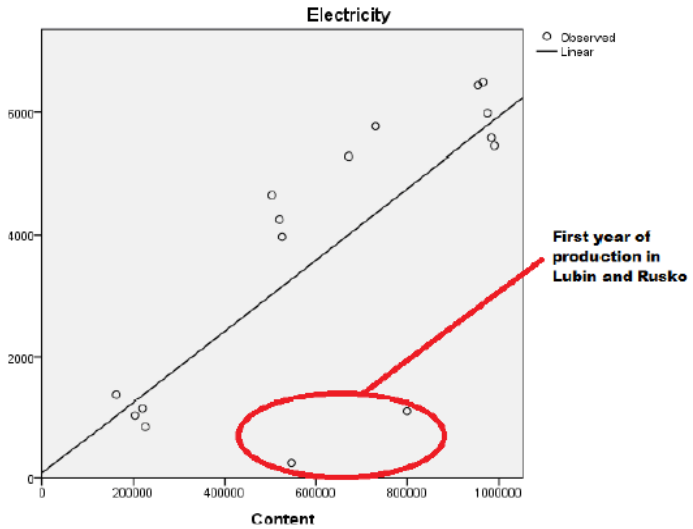


Fig. 11: Landfill content determining energy output in Poland

Here, as we see, the most deviating dots from the middle line happen to be the ones standing for the first year of production in Lubin and Rusko, respectively. As the production in those gas fields did not start in January and thus the facilities were not able to gain their full magnitude by the end of the first production year, the general relationship between waste content and electricity production lies close to the curve (line). Nevertheless, the general picture of LFGTE production in Poland still happens to be more deviating than in Belarus, which could also explain the reasons behind Vireo's managerial decision to launch activities in Belarus as those offering more stable revenues from LFGTE activities because of more favourable waste content conditions.

When it comes to the Solow-Swan model the relationship between the output of the engines installed and the electricity produced is characterized with quite a firm R square coefficient – that of 0.715 (very close to the one observed with two explanatory variables of output and biodegradable content: 0.774). This actually means that apart from biodegradable content of the landfills output of the engines is a significant determinant of the company's electricity production and thus profit. At the same time, however, this variable exercises its greatest effect when combined with the waste content one rather than without it. That actually goes in line with the results of the interviews confirming that the output of electricity generators installed in all the landfills utilized by Vireo matches the output of the landfills themselves. That is why Belarusian landfills possessing greater capacities in general outnumber the Polish waste polygons in terms of powerful LFG engines. This confirms the tenets of the Solow-Swan theory binding business progress to technological advancements in the following way. Vireo maximizes profits through relocating business to Belarus where more powerful generators are installed because of greater LFG yield. This tenet is confirmed graphically if we separately compare the pictures illustrating dependency of electricity production on engines' output in each country:

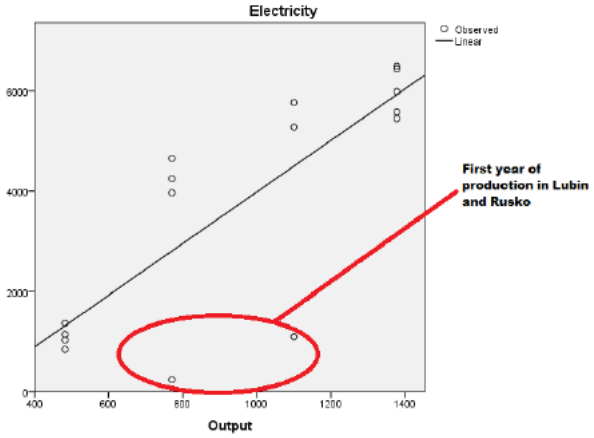


Fig. 12: Engine output and electricity production in Poland

Here, the Polish facilities show greater dispersion of dots and thus higher level of deviation from the main curve (line). Even though the most distant points illustrate first-year production results of installations in Lubin and Rusko, the dots are still more scattered than on the graph illustrating Vireo's activities in Belarus:

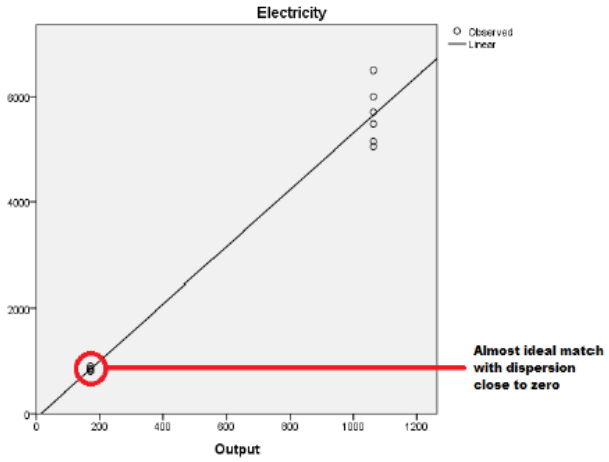


Fig. 13: Engine output and electricity production in Belarus

This actually means that Belarusian facilities utilize technology that better matches electricity production pattern than

their Polish counterparts – i.e. more powerful engines offer greater electricity yield which basically confirms the Solow-Swan model. This gives another argument in favour of Vireo's managerial decision to focus business activities on Belarus as it allows the company to exercise profit-maximization.

Optimal working time vs. real working time: Scientific management theory

When it comes to the comparison of real working time of LFG engines with the optimal working time the 'traffic light system' applied in Chapter 4 shows us greater compliance of Vireo's operational activities with waste-minimization principles in the company's facilities in Belarus ('green' and 'yellow') in contrast to almost total incompliance observed in Poland ('red'). This means that the generators in Belarus tend to spend more time producing electricity when compared to the generators in Poland. In that sense less spare time for engines in Belarus means waste minimization and thus profit-maximization through the use of best practices in a new operational environment (Belarus) in contrast to the old one (Poland). In such conditions, LFGTE production in that country happens to be more rational and thus more profitable than in the neighbouring one. Apart from greater percentage of biodegradable content in Belarusian landfills (described in the previous part) this happens to be additional argument in favour of the rationality of managerial decision to focus business activities in Belarus, which also goes in line with the tenets of the scientific management theory.

Even though the real functioning time of the LFG generator in Vitebsk does not match the optimal one the arithmetic mean of real indicators for all the years of production compared to the optimal ones in all sites reveal the following picture:

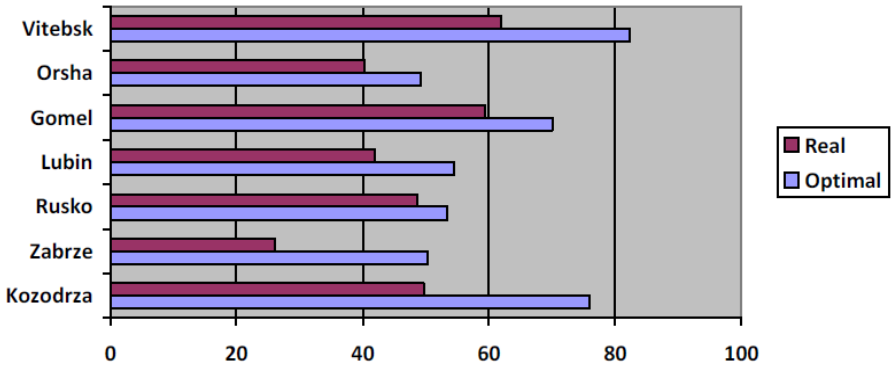


Fig. 14: Real and optimal functioning time

This picture shows us that the average real working time of the LFG generator in Vitebsk is still greater than that at any other site of Vireo's operations, which presupposes greater electricity production and broader perspectives for profit-making for that installation, in particular, and Belarus, in general.

Comparative profit per MWh: Neo-liberal development theory

As we see from the diagrams displayed in the previous chapter installations in Belarus started their operations later than their Polish counterparts. This resulted in a specific lag of revenue-generation and consecutive build-up of profit. On the other hand, however, starting from 2013 – the first year when electricity was produced by all the LFGTE facilities (i.e. 3 engines in 3 sites in Belarus and 6 engines in 4 sites in Poland) we can see significant preponderance of Belarusian electricity production over the Polish one being reflected by the revenues of the former surpassing the revenues of the latter by almost one third in 2015.

At the same time, however, the first years of production in Belarus is characterized with negative profit per MWe: in particular, 2012 holds a record for adverse profit indicators. Nevertheless, this result should be interpreted as follows: The first year of production bears the greatest capital costs (since the installation of a single LFG engine cost about 1 000 000 USD) and if the production starts at the end of the year, the site does not manage to break even by the end of the year. The velocity of negative indicators spotted in the first year could potentially be explained by the fact that the commissioning of new LFGTE facilities in Belarus happened in 2012 (one generator) and 2013 (two generators) and the electricity production in the first year started in autumn. The consecutive years of operations show significant supremacy of Belarusian facilities.

Thus, such graphically clear differences displaying odds on the side of Belarusian facilities generally support the scientific management theory and draw rationale behind Vireo's managerial decisions to launch business operations in Belarus and focus main activities in that country. Besides, slowly decreasing revenues and profits per MWe in addition to the total absence of perspectives to expand for Vireo's Polish facilities undermine the growth prospects in Poland and highlight them in Belarus. In such conditions business activities in Belarus could be regarded as best practice being characterized with minimum waste and maximum result.

CONCLUSIONS AND RECOMMENDATIONS

General prognosis

As Belarus represents a typical East-European post-Soviet economy that did not join the EU and Poland stands for an EU member from the same region the results of the research can be extrapolated to the nations with similar development level and legacy. For example, Štreimikienė and Makarenko [37] comment on similar evolution patterns of the energy sectors in Lithuania and Ukraine. In particular, state support in a form of feed-in tariffs and slowly developing waste-treatment legislation make Ukraine closer to Belarus while progressive property rights' market and strict EU trash-handling regulations put Lithuania in the same line with Poland. In such circumstances, we can predict greater profit-generation perspectives for the countries with lower development level of waste-treatment legislation and higher centralization (i.e. greater state support) of their energy sectors and lesser accumulation of revenue for the countries with stricter rubbish-handling rules and greater liberalization of their power industries:

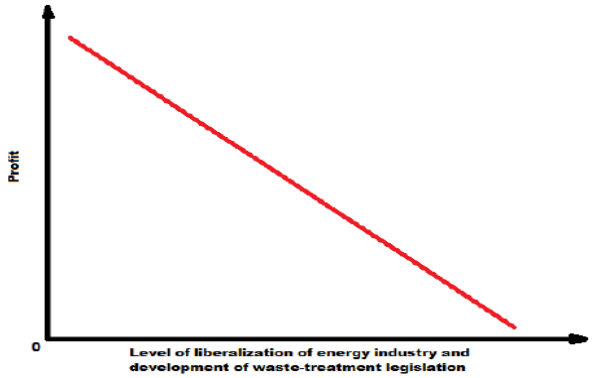


Fig. 15: Level of industry's liberalization/development of waste-treatment legislation and LFGTE companies' profit

In general, the study was able to reach the main *aim* of finding the reasons for LFGTE projects to generate greater profits and offer more significant growth advantages in the developing non-EU nations not possessing the system of tradable green certificates rather than in the developed EU countries with elaborated REC's trading systems. This was achieved through finding the answer for the research questions that reflected the research objectives going against the TELO pattern:

Research objectives	Research questions	Answers
To evaluate whether technological conditions for LFGTE projects in Belarus are better than those in Poland	Do technological conditions in EU countries happen to be less favorable for the development of LFGTE market when compared to non-EU ones?	No, technological conditions for driving LFGTE projects in both countries are the same. However, due to greater percentage of biodegradable content Belarusian facilities outnumber the Polish ones in terms of more powerful LFG engines
To evaluate whether economic conditions for LFGTE projects in Belarus are better than those in Poland	Do economic conditions in EU countries happen to be less favorable for the development of LFGTE market when compared to non-EU ones?	Yes, less-liberalized energy sectors of non-EU nations happen to be more favorable for profit-generation through their state support when compared to the liberalized EU ones
To evaluate whether legal conditions in Belarus are more favorable for LFGTE projects in comparison to those of Poland	Do legal conditions in EU countries happen to be less favorable for the development of LFGTE market when compared to non-EU ones?	Yes, in contrast to the non-EU nations strict waste-treatment legislation of EU countries deprive LFGTE businesses of their profit-generation means leading to less biodegradable waste being disposed and thus less LFG and electricity produced
To evaluate whether organizational/ managerial conditions for LEFGTE projects in Belarus are better than those of Poland	Do organizational/managerial conditions in EU countries happen to be less favorable for the development of LFGTE market when compared to non-EU ones?	No, organizational and managerial conditions in both countries are generally the same. Besides, bureaucracy makes Belarusian environment less favorable for driving LFGTE projects

Table 7: Answers to the research questions and meeting the research objectives

As we see, not all the answers were affirmative which meant that some of the theoretical frameworks potentially capable of explaining the rationale behind Vireo's managerial decision to launch LFGTE business in Belarus were not able to do so. In particular, neo-liberal development model presupposing decentralized markets to be more effective in terms of profit-generation through the system of tradable green certificates happened to be refuted in practice as state-support in a form of feed-in tariffs and multiplying coefficients created greater revenues. Even though this fact does not prove inconsistency of the neo-liberal theory per se mainly because of the medium level of the dissertation's external validity, it reveals significant limitations of the neo-liberalist approach adding important remarks to the general body of knowledge. In this connection, the implications of neo-liberal tenets for the developing nations, in general, and East-European transitional economies, in particular, should be viewed with greatest concern, as the reality may not always reflect the previously agreed postulates.

Similarly, the Solow-Swan exogenous growth model attributing business development to technological advancements was only partially proved as more powerful LFG engines in Belarus offering greater electricity production and thus profits were installed because of the need to comply with constantly high LFG yield. Thus, technological advancement of Belarusian electricity-production sites was determined by greater comparative LFG yield of the respective gas fields. On the other hand, this argument adds to the one of more prudent engine utilization determining greater efficiency in use of Belarusian electricity generators, which goes in line with the scientific management theory highlighting waste-minimization and arguing in favour of applying best practice. That is why the research findings suggest viewing two theories in complex: the Solow-Swan model with the scientific management framework as the elements of the former happen to be augmented by the latter. In addition to that, the scientific management theory was qualitatively proved by the interviewees highlighting absence of the competitors as one of the crucial elements in Vireo's business growth. That is why in the case of current dissertation this theoretical model happened to be the only one proved to function efficiently without major limitations and augmentations.

In addition to that, the scientific management theory was qualitatively proved by the interviewees highlighting absence of the competitors as one of the crucial elements in Vireo's business growth. That is why in the case of current dissertation this theoretical model happened to be the only one proved to function efficiently without major limitations and augmentations. In sum, the research demonstrated empirical evidence strongly supporting at least one theoretical framework (scientific management theory), partially supporting another one (the Solow-Swan framework), and defining important limitations for the third one (neo-liberal development model).

Recommendations

At the same time, however, apart from the factors discovered in the research the success of LFGTE projects is subject to a number of other variables that are not mentioned by the Solow-Swan model, neo-liberal growth framework and the scientific management theory as important drivers. Apart from host country's access to alternative means of electricity generation described in the previous section volatility of governmental policy regulating activities of sustainable power producers, in general, and LFGTE companies, in particular, quite vividly have significant impact on the development and growth of such companies.

In this connection, the assessment of LFGTE business perspectives in Eastern Europe should be conducted with respect to these multiple factors. According to the UNDP (2014), the following nations are included into this geographic region: Bulgaria, the Czech Republic, Hungary, Moldova, Romania, Russia, Slovakia and Ukraine. While using the 'traffic light system' where 'red' stands for the minimum success chances for LFGTE projects, 'yellow' – for the medium ones and 'green' – for the maximum prospects we can draw the picture for the rest of Eastern Europe in the following way:

Countries	**Development level of LFGTE market (high vs. low number of competitors)** (according to Nilsson, Pallemaerts and von Homeyer (2009))	**Waste-treatment (ecologic legislation)** (according to Nilsson, Pallemaerts and von Homeyer (2009))	**Profit-generating mechanisms of LFGTE companies** (according to Brick and Visser (2011))	**Alternative sources of electricity-generation** (according to Engoian (2005))	**Volatility of governmental policy regulating LFGTE business** (according to Nilsson, Pallemaerts and von Homeyer (2009))
Bulgaria	Medium development level – average number of competitors	Strict EU regulations obliging to minimize the biodegradable content of waste	Feed-in tariffs and multiplying coefficients	Developed nuclear and coal-mining sectors	Medium level of volatility with the plans to safeguard Russian gas supplies
Czech Republic	Big number of competitors – i.e. well-developed market	Strict EU regulations obliging to minimize the biodegradable content of waste	Feed-in tariffs and multiplying coefficients	Own nuclear industry and coal mining, but imported coal because of technologic and ecologic restrictions	Medium volatility with periodically-emanating plans to modernize coal industry
Hungary	Big number of competitors – i.e. well-developed market	Strict EU regulations obliging to minimize the biodegradable content of waste	Feed-in tariffs and multiplying coefficients	Elaborated nuclear industry and minor and insufficient oil and coal deposits	Minor volatility
Moldova	Underdeveloped LFGTE industry – almost no competitors	No or minor limitations for the content of disposed waste	Feed-in tariffs and multiplying coefficients	Absence of significant domestic energy sources	No volatility because of the absence of funds to develop any energy industry

Table 8: Success chances of LFGTE projects

Romania	Average level of competitors with the developing LFGTE industry	Strict EU regulations obliging to minimize the biodegradable content of waste	Quota-based tradable green certificates	Well-developed hydro, nuclear, coal and oil industries	Medium volatility with governmental stimulations of domestic hydrocarbon-related industry
Russia	Almost no competitors because of the not actively developing LFGTE sector	No or minor limitations for the content of disposed waste	Feed-in tariffs and multiplying coefficients	Well-developed nuclear and hydrocarbon sector	Minor volatility and lack of governmental interest to stimulate alternative energy sources
Slovakia	Medium level of industry development with average number of competitors	Strict EU regulations obliging to minimize the biodegradable content of waste	Feed-in tariffs and multiplying coefficients	Developed nuclear and hydroelectric sectors	Medium volatility with main subsidies going to the nuclear and hydropower sectors
Ukraine	Medium level of competitors because of the intensified industry development	No or minor limitations for the content of disposed waste	Feed-in tariffs and multiplying coefficients	Developed nuclear sector and coal mining	Currently high volatility because of the crisis and armed conflict

As we see, almost all countries of Eastern Europe represent promising markets for LFGTE investors with Moldova apparently being the with greatest perspectives and Romania – that providing minor for success (this actually confirms the decision of Vireo's managers to invest in biogas installations instead of LFGTE projects in that country. Each of the remaining nations, in its turn, demonstrates a set of its own benefits and drawbacks with the affirmative correlation being on the side of Russia and Ukraine rather than on the side of Bulgaria, the Czech Republic, Hungary and Slovakia. Thus, as we see the developing non-EU countries of Eastern Europe generally represent greater prospects for profit-generation, operational growth and LFGTE business development. This generally goes in line with the dissertation's main tenet. At the same time, however, each particular country possesses its specifics and (as we see from the current instability in Ukraine) the situation may abruptly change which definitely means that further research would be advantageous.

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APPENDIX I

Characteristics of landfills and installations

Country	Installation	Gas field capacity (in kWe)	Type of engine installed	Engine output (in kWe)	Total output of installations (in kWe)
Poland	Kozodrza	900	Jenbacher JMS 316	740	1377
			Jenbacher JMS 312	637	
	Zabrze	250	Perkins 630 C	482	482
	Rusko	700	Jenbacher JMS 312	600	770
			MWM Deutz TCG 2015 V6	170	
	Lubin	850	Caterpillar G3516 LE	1100	1100
Belarus	Gomel	900	Jenbacher J316	1063	1063
	Orsha	140	MWM Deutz TGC 215V	171	171
	Vitebsk	800	Jenbacher J316	1063	1063

APPENDIX II

Electricity production by installations

Country	Installation	Total electricity production (in MWh)				
		2011	2012	2013	2014	2015
Poland	Kozodrza	5450	5580	5989	6494	6443
	Zabrze	–	847	1149	1034	1373
	Rusko	–	239	3969	4252	4655
	Lubin	–	–	1102	5771	5281
Belarus	Gomel	–	–	3390	6682	6500
	Orsha	–	54	579	884	900
	Vitebsk	–	–	4941	6367	6000

APPENDIX III

Total amount of waste in landfills

Country	Installation	Estimated total amount of waste (in tons)				
		2011	2012	2013	2014	2015
Poland	Kozodrza	1560000	1620000	1680000	1740000	1800000
	Zabrze	–	790368	860368	930768	1000368
	Rusko	–	680000	770000	860000	950000
	Lubin	–	–	930000	990000	1050000
Belarus	Gomel	–	–	2568000	2784000	3000000
	Orsha	–	341000	394000	447000	500000
	Vitebsk	–	–	2600000	2800000	3000000

APPENDIX IV

Estimated percentage of biodegradable content in landfills

Country	Installation	Estimated percentage of biodegradable content in landfills (in %)*				
		2011	2012	2013	2014	2015
Poland	Kozodrza	64	61	58	54	53
	Zabrze	–	29	26	22	16
	Rusko	–	80	68	61	53
	Lubin	–	–	86	74	64
Belarus	Gomel	–	–	95	91	92
	Orsha	–	75	76	74	75
	Vitebsk	–	–	92	91	93

***- information sources: [38], [39].**

APPENDIX V

Annual costs

Years	Annual costs (in USD)	
	Belarus	Poland
2011	—	1000000
2012	1100000	2100000
2013	2300000	1000000
2014	550000	500000
2015 (estimated)	480000	550000