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STRATEGIC OPTIONS OF ECONOMIC AGENTS IN THE FIELD OF RENEWABLE ENERGY AND THE INFLUENCE OF PROJECT MANAGEMENT ON TGC SCHEMES

The aim of this paper is to provide a detailed analysis on the main strategic options of economic agents in the field of renewable energy, given their involvement in tradable green certificates (TGC) markets. The paper encompasses a causal analysis of the main variables influencing the TGC market, a short description of the causal links between the variables by using a causal loop diagram, the development of a set of strategic options for economic agents, starting from the relations within the diagram, and last, but not least, some considerations on how project management features could enhance the competitiveness of energy industry companies at the TGC markets. Also, the paper mentions the case of TGC Romanian market, for providing relevant examples of strategic behaviour at emergent TGC markets.

Keywords: *tradable green certificates, project management, strategic options, market mechanisms, renewable energy.*

JEL Classification: *L29, O22, Q41.*

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СТРАТЕГІЧНІ ВАРІАНТИ СУБ'ЄКТІВ ЕКОНОМІЧНОЇ ДІЯЛЬНОСТІ В ГАЛУЗІ ПОНОВЛЮВАНИХ ДЖЕРЕЛ ЕНЕРГІЇ І ВПЛИВ ПРОЕКТНОГО УПРАВЛІННЯ НА ТОРГІВЛЮ "ЗЕЛЕНИМИ СЕРТИФІКАТАМИ"

У статті проведено детальний аналіз основних стратегічних варіантів для суб'єктів економічної діяльності в галузі відновлюваних джерел енергії з урахуванням їх участі на ринку "зелених сертифікатів". Проведено причинний аналіз основних змінних, які впливають на цей ринок, описано причинно-наслідкові зв'язки між змінними за допомогою циклічної схеми. Розроблено комплекс стратегічних варіантів для суб'єктів економічної діяльності, виходячи зі змодельованих залежностей, та приведено міркування про те, як проектний менеджмент міг би підвищити конкурентоспроможність енергетичних компаній на ринку "зелених сертифікатів". Розглянуто приклад румунського ринку як джерела даних і прикладів стратегічної поведінки на ринках, що розвиваються.

Ключові слова: *торгівля "зеленими сертифікатами", проектний менеджмент, стратегічні варіанти, ринкові механізми, відновлювані джерела енергії.*

Рис. 2. Таб. 1. Літ. 20.

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СТРАТЕГИЧЕСКИЕ ВАРИАНТЫ СУБЪЕКТОВ ЭКОНОМИЧЕСКОЙ ДЕЯТЕЛЬНОСТИ В ОБЛАСТИ ВОЗОБНОВЛЯЕМЫХ ИСТОЧНИКОВ ЭНЕРГИИ И ВЛИЯНИЕ ПРОЕКТНОГО УПРАВЛЕНИЯ НА ТОРГОВЛЮ "ЗЕЛЕНЫМИ СЕРТИФИКАТАМИ"

В статье проведен детальный анализ основных стратегических вариантов для субъектов экономической деятельности в области возобновляемых источников энергии с учетом их участия на рынке "зеленых сертификатов". Проведен причинный анализ

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основных переменных, влияющих на этот рынок, описаны причинно-следственные связи между переменными с помощью циклической схемы. Разработан комплекс стратегических вариантов для субъектов экономической деятельности, исходя из смоделированных зависимостей, и приведены соображения о том, как проектный менеджмент мог бы повысить конкурентоспособность энергетических компаний на рынке "зеленых сертификатов". Рассмотрен пример румынского рынка как источника данных и примеров стратегического поведения на развивающихся рынках.

Ключевые слова: *торговля "зелеными сертификатами", проектный менеджмент, стратегические варианты, рыночные механизмы, возобновляемые источники энергии.*

1. Introduction. In many European countries, including Romania, the non-renewable energy industry produces over 61% of the total amount of greenhouse gas emissions (Wustenhagen et al., 2007). In the last decade, policy makers have set mandatory annual quota for greenhouse gas emissions (GHG) for each European country, while national governments have developed market-based incentives for economic agents in order to support investments in developing renewable energy production capacities, which are susceptible both to reduce GHG emissions and to cause a shift in energy production and consumption.

One of the most already common incentives are tradable green certificates (TGCs), which are widespread market-based instruments (Hass et al., 2011) used for promoting the generation of electricity from renewable energy sources and developing the renewable energy market. TGC markets are complex systems, with certain particularities, which make them resemble close dynamic systems, which can be best described by causal loop diagrams.

Under these circumstances, we state that economic agents are supposed to face the challenge of competing at TGC markets, process which involves the development of strategic options for achieving competitive advantages at these markets.

Further, the analysis will be focused on identifying the main variables influencing the TGC market, on describing the causal links between the variables by using a causal loop diagram, on analyzing a set of strategic options for economic agents starting from the relations within the diagram, and last, but not least on using project management features for enhancing the competitiveness of energy industry companies at the TGC markets.

2. Literature review. According to Bergek & Jacobsson (2010), in European energy policy debate, TGC schemes were suggested to be a superior regulatory framework for promoting the diffusion of renewable energy technologies, as their main purpose is to improve the ratio between renewable energy and non-renewable energy at minimum costs.

The strategic dimension of TGC markets is given by economic implications of trading green certificates onto these markets for obliged parties (electric production, distribution and transmissions operators), which are requested either to buy certificates for a certain quota of their total electricity sales (Marchenko, 2008) — the demand side, or to provide such certificates — the supply side.

Apparently, TGC markets are being governed by classical supply-demand rules, but when analyzing the constraints at this market, achieving competitive advantage is no longer a matter of pure economics (Fristrup, 2003), but a mix of strategic man-

agement, project management, and system dynamics. The 2 most important issues which provide the market a strong specificity are:

- the existence of many alternatives for the holders of certificates, which can choose to sell the certificates immediately, to bank the certificates and sell them later, or to use the certificates within a borrowing scheme (Nilesen & Jeppesen, 2003);
- the existence of a upper price limit (buy-out price) at the TGC market, as a fine for quota non-fulfilment by a retailer (Tamas et al., 2010);

These constraints, as well as many other variables, make the TGC markets suitable for being described by causal loop diagrams, which are usually used both to clarify the causal relationships involved in a model and to help disclose certain patterns of behaviour the system might have (Pehnt, 2006).

Assuming that the analysis carried out with regard to the relationships between the variables of a causal loop diagram might be a strategic management core issue, as previously Maruyama (1992) and DeMarco (1999) stated, its results could be assimilated to certain strategic options among which both economic agents and investors in the field of renewable energy are requested to choose, in order to achieve a sustainable competitive advantage.

Under these circumstances, and taking into account that the recent economic literature promotes more than ever the hypothesis that economic entities which choose not to organize their strategic activities as projects are exposed to major business risks (Zeng et al., 2007), which can range from losses of market share (Danilovic and Borwning, 2007), to recurrent failures in running the business efficiently (Aubry et al., 2008), we provide evidence of how project management features may be used for identifying suitable strategic options at the TGC markets, as well as for enhancing economic agents' competitiveness at these markets.

The role of project management is essential, as the classical assumption that net present value and internal rate of return are being regarded as the most powerful tools to assess an investment project, in terms of profitability and financial analysis (Yescombe, 2002) is no longer valid either at financial markets, or in the system dynamics theory.

3. Assumptions. The main assumptions we use in our analysis are based both on previous research, as well as on the empirical research carried out on emergent TGC markets, such as Romanian or Polish markets.

Therefore, we assume the following statements, before describing the general mechanism of TGC market:

- TGC markets are emerging, centralized markets, where the price is not usually set as a consequence of supply-demand mechanisms (Ford et al., 2007);
- higher prices of TGCs will lead to massive investments in renewable capacity, which will gradually lead to the overproduction of renewable energy and subsequently to a collapse of prices in a few years;
- TGC markets can be best described by causal loop diagrams, which makes them more similar to dynamic systems than to classical markets;
- project management issues are necessary for monitoring and assessing the economic agents' behaviour at TGC markets, as well as for supporting the implementation of the chosen strategic options.

4 assumptions stated above will be taken into account within all the stages of the current research, being integrated in the research methodology presented further.

4. Methodology. We use the causal loop diagrams to develop strategic options for economic agents in the field of renewable energy. The logical flow of the causal loop diagram is based on system dynamics approach, pioneered by Forrester (1961), and updated by recent studies of Ford (1999) and Vogstad (2004). By capturing interactions and consequently the feedback loops, a causal loop diagram reveals the structure of a system. Understanding the structure of a system, it is possible to ascertain a system's behaviour over a certain time period (Meadows et al., 1982). However, the paper is not focused on system dynamics models, which are comprised of a set of nonlinear differential equations, solved through a numerical integrator, an approach which is applied to a wide range on environmental and economic systems (Ford et al., 2007), but on the strategic and managerial dimension of economic agents' decisions regarding their behaviour at TGC markets.

We describe the influence of project management on TGC schemes using the descriptive techniques. We also use scenarios technique for analyzing the strategic options and their impact on economic agents operating in energy industry.

5. Factor analysis of the variables influencing the TGC market. The variables which describe the TGC market dynamics could be summarized in 3 representative categories, as follows:

- level variables — (LV) — describe certain accumulations within the market;
- rate variables — (RV) — describe certain running processes, which are permanently in progress;
- result variables (RsV) — describe possible results of the interaction between the level variables and the rate variables.

Therefore, in Table 1 we present the primary variables influencing the TGC market.

Table 1. **Primary variables influencing TGC market dynamics**

Primary variable	Description
Overall non-renewable energy consumption **(α_1)**	*Constant* - reflects the total amount of non-renewable energy, generated and used by consumers in a definite period of time
Overall electricity consumption **(α_2)**	*Constant* - reflects the total amount of electricity, generated and used by consumers in a definite period of time, regardless its renewable or non-renewable origin.
Estimated optimal share of renewable energy **(F_1)**	*RV* - reflects the trend of renewable energy in total amount of energy, depending on the overall electricity consumption **(α_2)** and the overall non-renewable energy consumption **(α_1)**
Energy generation and supply theoretically estimated deficit **(F_2)**	*RV* - reflects the gap between the estimated overall electricity consumption (α_2) and the estimated optimal share of renewable energy (F_1), calculated in relation to the overall non-renewable energy consumption (α_1), at a certain moment of time.
Trend of renewable energy production **(α_3)**	*Constant* - reflects the expected dynamic of renewable energy share in the total amount of energy produced within a definite period of time
Renewable energy generation and supply theoretically estimated deficit **(F_3)**	*RV* - reflects the correlation between energy generation and supply theoretically estimated deficit (F_2), adjusted with a contraction index (F_4) and the trend of renewable energy production (α_3), at a certain moment of time.
Overall amount of renewable energy **(α_4)**	*Constant* - reflects the expected dynamic of renewable energy share in the total amount of energy produced within a definite period of time

The End Of *Table 1*

Primary variable	Description
Renewable energy operational capacities, on individual energy sources **(F_4)**	*RV* - reflects the downsizing trend of the renewable energy generation and supply theoretically estimated deficit (F_3), as a consequence of the development of new renewable energy capacities, caused by the evolution of the individual sources renewable energy share in the overall amount of renewable energy (α_4).
Average life expectancy of renewable energy capacities **(α_5)**	*Constant* - reflects the necessary time for making available a renewable energy production capacity, since the moment of project initiation, depending on the renewable energy source.
Overall estimated amount of renewable energy production and supply **(α_6)**	*LV* - reflects the renewable energy production capacity calculated taking into account the operational renewable energy capacities (F_5) at present, adjusted with the average life expectancy of renewable energy capacities (α_5).
Learning coefficient of each individual type of renewable energy **(α_7)**	*Constant* - reflects the upward trend of renewable energy production capacities efficiency, as a result of gaining experience during their current use.
Corrected estimated amount of renewable energy production and supply **(F_6)**	*RV* - reflects the amount of renewable energy, as a result of the interaction between the overall estimated amount of renewable energy production and supply (α_6) and the learning coefficient of each individual type of renewable energy (α_7).
Overall adjusted level of renewable energy production and supply **(F_7)**	*RV* - reflects the trend of renewable energy in the total amount of energy, depending on the corrected estimated amount of renewable energy production and supply **(F_6)** and the learning coefficient of each individual type of renewable energy **(α_7)**
Estimated amount of available TGCs at the market, on individual renewable energy sources **(F_8)**	*RV* - reflects the trend of available TGCs at the market, depending on the renewable energy operational capacities, on individual energy sources **(F_4)** and the overall adjusted level of renewable energy production and supply **(F_7)**
Surplus of TGCs at the market **(α_8)**	*Constant* - reflects the amount of TGCs available at the market, after covering the overall TGCs demand.
Renewable portfolio standard (RPS) **(F_9)**	*RV* - reflects the renewable portfolio of economic agents, calculated as a function of corrected estimated amount of renewable energy production and supply (F_6) and the surplus of TGCs at the market, at a certain moment of time (α_8).
Overall estimated amount of renewable energy production and supply **(α_9)**	*LV* - reflects the breakeven point for purchasing green certificates by economic agents, at the end of a year, in order to ensure the fulfilment of mandatory annual quota.
Estimated TGC supply available for economic agents **(F_{10})**	*RV* - reflects the expected amount of TGC bought by economic agents, depending on the renewable portfolio standard (F_9) as well as on the TGC price (F_{13}).
TGC surplus owned by economic agents **(F_{11})**	*RV* - reflects the gap between the amount of TGC necessary for fulfilling the mandatory quota by the obliged parties and the amount of TGC purchased by economic agents.
Overall expenses for fulfilling the mandatory annual quota by economic agents **(F_{12})**	*RV* - reflects the overall expenses of economic agents for gathering the renewable portfolio standard (F_9) as well as for gathering the TGC surplus (F_{11}).
The level of penalties for mandatory quota non-fulfilment **(α_{10})**	*Constant* - reflects the amount of money an economic agent is enforced to pay if it does not manage to fulfil an unit of its annually mandatory quota

The End Of *Table 1*

Primary variable	Description
Supply elasticity coefficient (α_{11})	*Constant* - reflects price variations caused by an 1% increase in TGCs overall supply
Demand elasticity coefficient (α_{12})	*Constant* - reflects price variations caused by an 1% increase in TGCs overall demand
TGC price (F_{13})	*RV* - reflects the dynamics of market mechanisms for setting the TGC price, taking into account demand (F_{10}), supply (F_{11}), price variation limits set by the regulation authority (α_{13}), supply elasticity coefficient (α_{11}), and demand elasticity coefficient (α_{12}).
Relative deviation of rectified level of renewable energy production and supply from the optimal level (β_1)	*RV* - reflects the ratio between overall adjusted level of non-renewable energy production and supply (F_7) and the optimal estimated level of renewable energy production and supply (F_1).
Estimated TGC amount achieved by economic agents, as a consequence of renewable energy investments (β_2)	*RV* - reflects the correlation between the estimated amount of available TGCs at the market, on individual renewable energy sources (F_8) and the corrected estimated amount of renewable energy production and supply (F_6).
The mandatory annual quota coverage rate (β_3)	*RV* - reflects the ratio between the estimated TGC supply available for economic agents (F_{10}) and the overall estimated amount of renewable energy production and supply (α_9).
The average price of TGCs (β_4)	*RV* - reflects the ratio between the overall expenses for fulfilling the mandatory annual quota by economic agents (F_{12}) and the overall estimated amount of renewable energy production and supply (α_9).

6. The interaction between system variables within a causal loop diagram. After identifying the variables at the TGC markets, the next step is defining the relationship between them and performing a scenarios analysis, in order to identify strategic options the economic agents would have if they chose to rationally operate at this market. In Figure 1 we present the causal loop diagram describing the connections between TGC market variables.

The causal loop diagram provides information for decision-makers on demand and supply of TGCs, transaction prices, as well as on the exogenous variables influencing the market.

The loop diagram illustrates an overview of the TGC market's parameters, providing a relevant decision-making background, for the economic agents operating at the market, as well as for those who aim to enter the market. For example, one of the most important variables within the causal loop diagram is the TGC price (F13), which is a rate variable, meaning that it is a non-constant value, resulted from a rate variable function. The function is dependent of supply elasticity coefficient (α_{11}), demand elasticity coefficient (α_{12}), price variation limits set by the regulation authority (α_{13}), and corrected estimated amount of renewable energy production and supply (F6). The first 3 of the variables (which are constant) influence the rate variable function directly, whereas the last one has an indirect influence, both on supply elasticity coefficient (α_{11}), as well as on the demand elasticity coefficient (α_{12}).

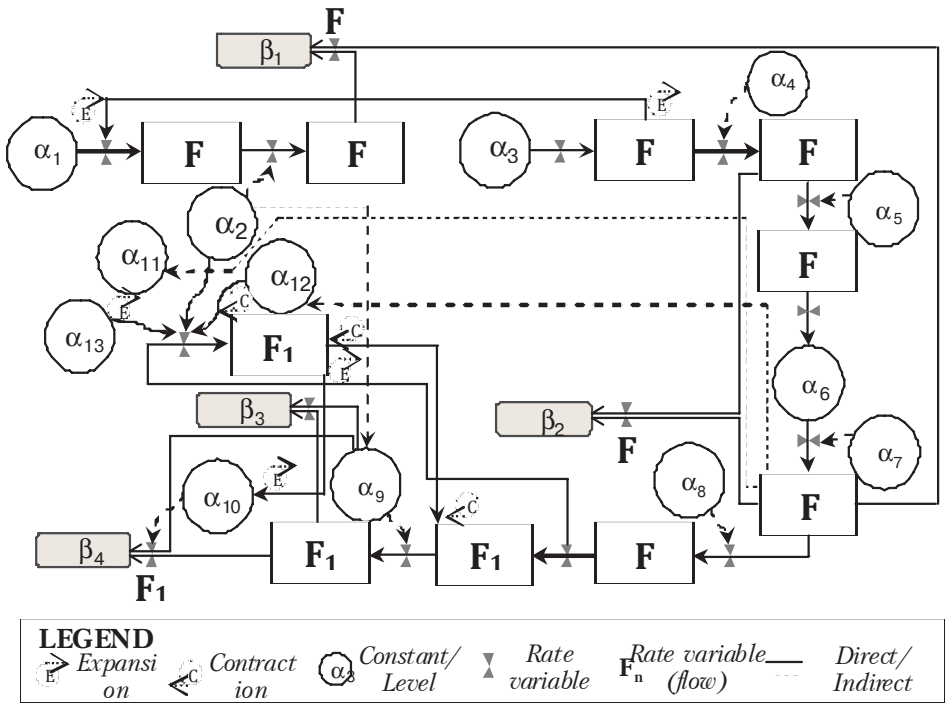

Figure 1. **Causal loop diagram of TGC market**

7. Defining available strategic options. The available strategic options for economic agents at TGC markets are behaviour patterns which they choose to display, depending on what changes are expected to happen at the market. When analyzing the case of emergent countries, such as Romania, the current situation of TGC market reveals an excessive demand of TGC, due to underdeveloped renewable energy production capacities. Therefore, the price of TGC is very high (reaching the buy-out price set by the regulation authority), which places the present renewable energy producers on a very competitive position at the market. Practically, each TGC which is being commercialized at Romanian market is bought at the highest price possible, and the only factor which prevents even a higher price (according to market economy supply-demand principles) is the upper limit set up by the national regulation authority. Under these circumstances, the price acts like an incentive for economic agents, motivating them to invest in developing renewable energy production capacities.

However, if a lot of economic agents choose to invest in developing renewable energy capacities tomorrow, they will have their investments ready in 3-5 years, and, most likely, at the end of these period, the market will face an overproduction of renewable energy, supply will probably become higher than demand, and the price will drop sharply to lower limits, which will lead to the final collapse of the market. Given this situation, the main strategic options available for economic agents are presented below.

Investing in renewable energy. First of all, choosing to invest in renewable energy is a decision which should be implemented immediately in order to avoid the case

in which supply of TGCs becomes higher than demand, when the investment will be fully operational.

Secondly, investing in renewable energy is a matter of risk. Obviously, not all economic agents will choose to invest in renewable energy at the same time, and some of them may choose not to invest in renewable energy at all, which means the overproduction of renewable energy will not occur suddenly, and TGC market could be profitable for a long period of time.

Taking Romanian case, at present, at the underdeveloped renewable energy market, the estimated optimal share of renewable energy (F1) follows an upward trend, which means a deficit of renewable energy at the market. The bigger this deficit is, the most urgent is the need to invest in developing renewable energy production capacities. Also, RPS (F9) is low, as there are no buffers of TGCs held by economic agents, because the market does not stimulate operators to accumulate such buffers.

An economic agent will sell a TGC today at the same price he will sell it over 1 month (because the price is set to its upper limit), and he has no incentive to keep the TGCs for later. Similarly, the TGC surplus owned by economic agents (F11) is very low. Under these circumstances, the TGC price (F13) is influenced only by demand (F10), the price variation limits set by the regulation authority (α_{13}) and demand elasticity coefficient (α_{12}), which can be easily neglected, as TGC market is a regulated market, and demand is given by the regulation authority through TGC market regulations. Thus, if choosing to invest in renewable energy at Romanian market now, the investor should know that there are no market barriers (F9 and F11), there is an increasing demand (F2), and the investment is susceptible to be successful.

However, if demand starts dropping, as a consequence of an increase of F4 and/or α_6, F2 will also drop, the price will become lower than the upper limit, economic agents will not be interested any more in selling TGCs immediately, and they are susceptible to create buffers, and also a green certificates portfolio. When this happens, the breakeven point for purchasing green certificates by economic agents, at the end of a year, in order to ensure the fulfilment of mandatory annual quota (α_9) will be higher, and the market will become unstable. Therefore, relatively high risks of price instability enforce economic agents not to rely on expected profits coming from TGC market.

- *Not investing in renewable energy.* On the opposite, not investing in renewable energy might be also a strategic option for some economic agents. For example, as stated above, when F2 starts dropping, and there is no perspective of an intervention from the regulation authority in order to stabilize the trend, the price will probably decrease continuously until the lower limit set by the regulation authority is reached, and investing in renewable energy will generate no significant economic income from TGC market.

Also, if many competitors have already started investing in renewable energy, and these investments are enough to cover theoretically estimated supply deficit (which could be identified by noticed increases in F4, F5, α_6, F10), the economic agent's investment which has not started yet will hardly ever finish before the already started investments. Therefore, when his investments are finished, the market will probably

be overloaded and the TGC price (F13) will probably be low. Also, if there is any evidence about the existence of TGC buffers (which could be identified by noticed increases in F11, F9, F10, correlated with a decrease in F13, and variations of α_9), the economic agents should consider twice the opportunity of investing into renewable energy market, given that the available supply could be placed onto renewable energy market, given that the available supply could be placed onto the market at any time, leading to a decrease of the average price of TGCs (α_4).

- **Buying and selling TGCs.** Returning to the current example of Romania, where TGCs are traded at the buy-out price, buying and selling TGCs is a zero sum game. As long as F13 is the same for buying and selling, economic agents have no interest in buying TGCs. If an economic agent chooses to buy TGCs, he does it in order to sell them later at a higher price.

Therefore, the only case that could make an economic agent buy TGCs is if he expects an intervention of the regulation authority in order to increase the buy-out price, or if he expects the market to become fully liberalized and the regulation authority not to interfere any more in price setting at the market (which will hardly ever happen, as long as the market does not reach equilibrium between supply and demand).

However, if F4 and α_6 increase, the price will start dropping, in the short run (F13), as well as in the long run (β_4). When the price will reach the lowest level, economic agents should buy certificates, expecting the intervention by the regulation authority for stabilizing the market.

If the price has reached its lowest level (α_9 reached its highest level), any further selling will be done at a higher price than the buying one. However, this strategic option will be probably taken into account by many economic agents. Moreover, most likely, large producers of renewable energy will already posses TGC buffers (as they are expected not to sell the TGCs they were given, because of the low price) and RPS, and therefore, the price will increase considerably, or it will get fixed at the lowest level possible.

- **Banking TGCs.** Banking TGCs is an option for economic agents operating at mature TGC markets, as it involves advanced regulations for the market and a much deeper resemblance of the market with classical liberalized markets. Banking TGCs involves a high amount of buffers (F11) held by economic agents. These supply reserves allow economic agents permanently have a critical mass of TGCs, ready to be sold. At the same time, economic agents are supposed to have enough financial resources to permanently buy TGCs. However, given its complexity, this strategic option will be analyzed in further research.

8. Project management impact on economic agents' strategic options. The role of project management in this analysis is closely related to the strategic option of investing in renewable energy. Other strategic options do not involve the project management approach.

Taking into account that this type of projects are not suitable just for IRR-NPV analysis, we should provide a scheme of analyzing the project in terms of opportunity and viability, as, most likely, none of rational economic agents would choose to invest in developing renewable energy capacities, only for achieving TGCs. The

implications of such a project are much deeper than the consequences of operating at TGC market. We provide further a model of assessing the efficiency of an investment carried out in the field of renewable energy, as shown in Figure 2.

According to the model, the assessment of the investment projects aiming at the development of renewable energy production capacities should be performed in 2 different stages, as follows:

- in the first stage the investment is analysed through a set of global indicators, which ensure the comparability of many projects, aiming to develop renewable energy production capacities by investing in different types of renewable energy sources;
- in the second stage, after deciding which investment type is more suitable, taking into account both the expected benefits of the investor, as well as the natural conditions of the geographical area where the investment is supposed to be developed, the decision-maker will calculate a set of specific indicators, depending on the renewable energy source he decided to focus on.

After deciding if the project is efficient, decision makers should analyze also the TGC market, in order to estimate which is the best moment for finishing the project, given the expected situation at the market. All the elements resulted as a consequence of the analysis should be included in the project logical framework matrix (LFM) as preconditions.

Afterwards, the project team should develop the Gantt chart of the project according to LFM and establish the milestones in order to ensure proper monitoring and evaluation of a project.

The role of project management is also important when considering milestones and deadlines for each activity, and milestones within a project. For a wind plant, for example, it usually takes 3 years to develop a production capacity. If the analysis carried out at TGC markets reveals a positive situation over 2.5 years, the project might be finished earlier, which involves a more severe scheduling of critical activities, additional resources, and additional costs. Project management team should assess exactly which are the additional expenses generated by the shift in project completion, meanwhile decision-makers should assess whether the expected incomes from TGC market are susceptible to cover additional efforts made in order to finish the project earlier.

9. Further research. There are many unanswered questions, which are subject for further research. One of these key issues is related to providing the mathematical background for describing the relations between market variables, and in using system dynamics for simulating behavioural patterns of economic agents at the market. Another direction for further research is analyzing whether the causal diagram loop describing TGC market is also appropriate for use in order to describe the dynamics of mature markets, not only emergent ones.

Deeper analysis should be carried out in the direction of analyzing the economic agents' attitude to banking TGCs and selling them afterwards through options and/or future contracts. Another key issue for further research refers to the impact of these strategic options on pollution control, taking into account that some of the strategic options are directly related to pollution control, while others have low impact on environmental issues.

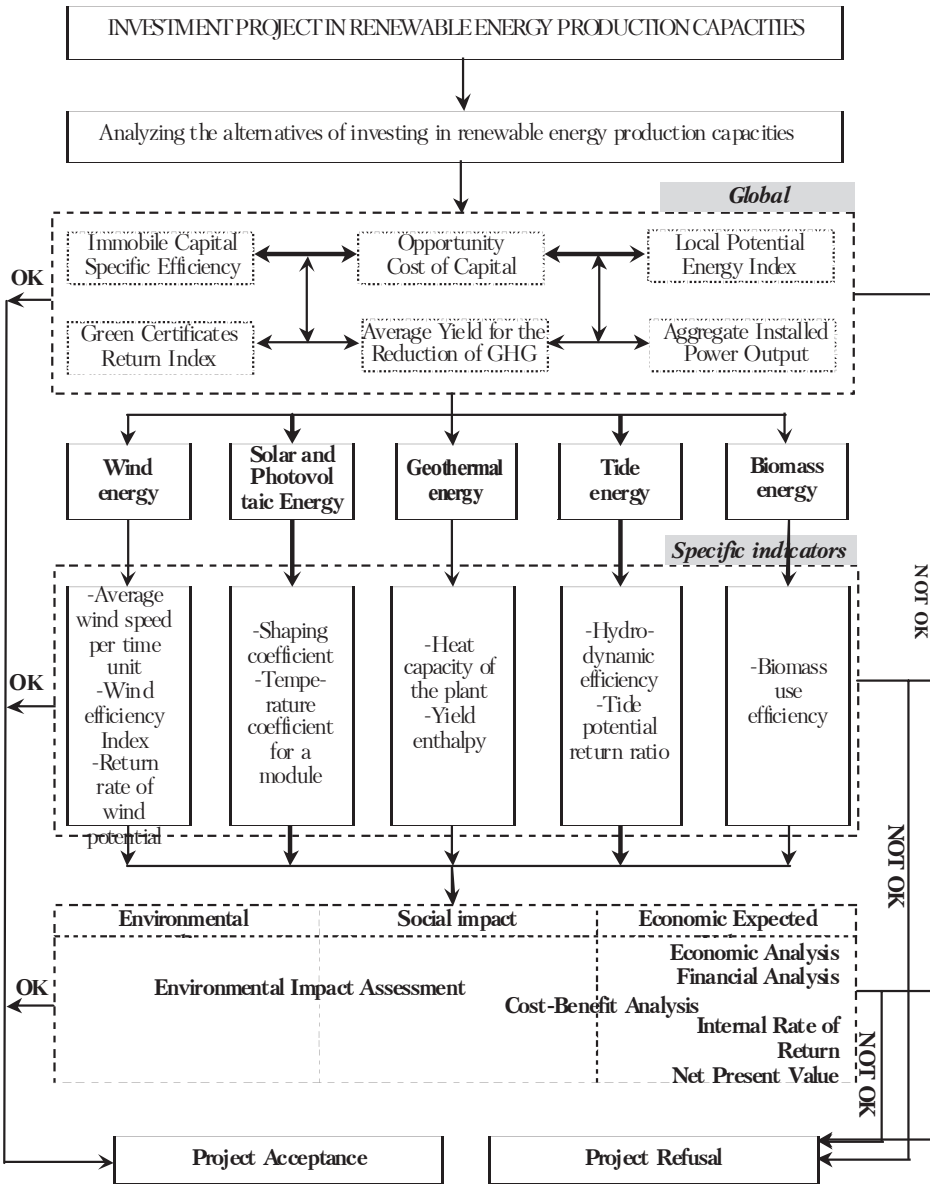

Figure 2. **Model for assessing the efficiency of renewable energy investment projects**

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References:

1. *Aubry, M., Hobbs, B., & Thuillier, D.* (2008). Organizational Project Management: An Historical Approach to the Study of PMOs, International Journal of Project Management, 26(1), pp. 38-43.

2. *Bergek, A., & Jacobsson, S.* (2010). Are Tradable Green Certificates a Cost-Efficient Policy Driving Technical Change or a Rent-generating Machine? Lessons from Sweden 2003-2008, Energy Policy, 38(3), pp. 1255-1271.

3. *Danilovic, M. & Browning, T.R.* (2007). Managing Complex Product Development Projects with Design Structure Matrices and Domain Mapping Matrices, International Journal of Project Management, 25(3), pp. 300-314.

4. *DeMarco, C.L.* (1999). Strategic behaviour in Electric Generation Markets via Dynamic Governor Control Design, Decision Support Systems, 24(3-4), pp. 251-258.

5. *Forrester, J.W.* (1961). Industrial Dynamics, MIT Press, Cambridge, MA.

6. *Ford, D.N.* (1999). A Behavioural approach to feedback loop dominance analysis, System Dynamics Review, 15, pp. 3-36.

7. *Ford, A., Vogstad, K. O. & Flynn, H.* (2007). Simulating Price Patterns for Tradable Green Certificates to Promote Electricity Generation from Wind, Energy Policy, 35, pp. 91-111.

8. *Fristrup, P.* (2003). Some Challenges Related to Introducing Tradable Green Certificates, Energy Policy Journal, 31(1), pp. 15-19.

9. *Haas, R., Panzer, C., Resch, G., Ragwitz, M., Reece, G. & Held, A.* (2011). A Historical Review of Promotion Strategies for Electricity for Renewable Energy Sources in EU Countries.

10. *Kildegaard, A.* (2008). Green Certificate Markets, the Risk of Over-Investment, and the Role of Long Term Contracts, Energy Policy Journal. 36(9), pp. 3413-3421.

11. *Marchenko, O.V.* (2008). Modelling of a Green Certificate Market, Renewable Energy Journal, 33(8), pp. 1953-1958.

12. *Maruyama, M.* (1992). A Quickly Understandable Notation System for Causal Loops for Strategic Decision Makers, Technological Forecasting and Social Change, 42(4), pp. 409-412.

13. *Meadows, D.H., Richardson, H.J. & Bruckmann, G.* (1982). Groping in the Dark, Chichester, England.

14. *Nielsen, L., & Jeppesen, T.* (2003). Tradable Green Certificates in Selected European Countries - Overview and Assessment, Energy Policy Journal, 31(1), pp. 3-14.

15. *Pehnt, M.* (2006). Dynamic Life Cycle Assessment (LCA) of Renewable Energy Technologies, Renewable Energy Journal, 31(1), pp. 55-71.

16. *Tamas, M.M., Bade-Shrestha, S.O., & Zhou, H.* (2010). Feed-in Tariff and Tradable Green Certificates in Oligopoly, Energy Policy Journal, 38(8), pp. 4040-4047.

17. *Vogstad, K.O.* (2004). A System Dynamics Analysis of the Nordic Electricity Market, Doctoral Thesis, Norwegian University of Science and Technology, Trondheim, Norway.

18. *Wustenhagen, R., et al.* (2007) Social Acceptance of Renewable Energy Innovation, Energy Policy Journal, 35(5), pp. 2683-2691.

19. *Yescombe, E.R.* (2002). Principles of Project Finance, Academic Press Publishing House, Eastbourne, U.K.

20. *Zeng, J.A.M., & Smith, N.J.* (2007). Application of a Fuzzy Based Decision Making Methodology to Construction Project Risk Assessment, International Journal of Project Management, 25(6), pp. 589-600.

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