RESEARCH ISSUES REGARDING THE MAIN INDICATORS USED FOR ANALYSING THE INCOMES AND COSTS OF THE RENEWABLE ENERGY PRODUCERS OPERATING IN ROMANIA IN VIEW OF DEVELOPING A DECISION SUPPORT SYSTEM

Cornelia Paulina BOTEZATU *[1]
Cezar BOTEZATU [2]
George CARUTASU [3]
Alexandru PÎRJAN [4]

ABSTRACT:
In this paper, we have analysed the main indicators regarding the incomes and costs of the renewable energy producers, indicators that a Decision Support System must take into account for when predicting, analysing and monitoring the technological and business processes in the field of energy produced from renewable sources in Romania. The results presented in this paper represent a part of the research conducted within the SIPAMER project ("Sistem Inteligent pentru Predicţia, Analiza şi Monitorizarea Indicatorilor de Performanţă a Proceselor Tehnologice şi de Afaceri în Domeniul Energiilor Regenerabile"), financed by the National Authority for Scientific Research (NASR).

Keywords: Decision Support System, renewable energy, economic indicators, green certificates, technologies.

1. Introduction

In Romania, there is a strong need for developing and continuously extending the use of renewable energy resources within the national energy balance in order to ensure the security of energy supply and to reduce the imports of primary energy resources. The renewable energy resources represent an important premise for stimulating the sustainable development at local and regional level, for creating new job opportunities related to the renewable energy business processes [1], [2]. The renewable energy resources are also of paramount importance in reducing the environmental pollution by lowering the pollutant and greenhouse gas emissions [3], [4].

A Decision Support System (DSS) for the prediction, analysis and monitoring the technological and business processes in the field of renewable energy in Romania must take into account a wide range of performance indicators [5], [6]. In this respect, the DSS must analyse the main indicators regarding the incomes and costs of the renewable energy producers. In this paper, we first analyse the methodology for monitoring the system of promoting the renewable energy using the green certificates (CV) scheme [7].

[1] *Corresonding author. Professor, PhD. The Romanian-American University, 1B, Expozitiei Blvd., district 1, code 012101, Bucharest, Romania, E-mail: c2botezatu@yahoo.com
[2] Associate Professor, PhD. The Romanian-American University, 1B, Expozitiei Blvd., district 1, code 012101, Bucharest, Romania, E-mail: c2botezatu@yahoo.com
[3] Associate Professor, PhD. The Romanian-American University, 1B, Expozitiei Blvd., district 1, code 012101, Bucharest, Romania, E-mail: carutasu.george@profesor.rau.ro
[4] Lecturer, PhD. The Romanian-American University, 1B, Expozitiei Blvd., district 1, code 012101, Bucharest, Romania, E-mail: alex@pirjan.com

Afterwards, we identify the indicators that allow quantifying the effects of the green certificate support scheme, for promoting the renewable energy, in terms of extending the use of these resources, the return on investment and its impact on the energy price that the final customers have to pay. A DSS must keep monitoring the results and use them to determine whether the implementation of the green certificates support scheme leads to overcompensation, to elaborate the necessary reports for the national and European public authorities and to devise solutions for improving the green certificates support scheme and the related secondary legislation.
In the second section of the paper, we present the system for promoting the renewable energy using the green certificates scheme and in the following section we study the objectives of monitoring the production process of the renewable energy. In the fourth section, we analyse the main indicators regarding the incomes and costs of the renewable energy producers, necessary to be taken into account for when developing a Decision Support System.

2. The system for promoting the renewable energy through green certificates

The system for promoting the renewable energy using the green certificates scheme is regulated by the legal framework and applies to the producers of electricity from renewable sources, including the electricity that is being produced during the evaluation period, based on the accreditation decision issued by the Romanian Energy Regulatory Authority (ANRE). The legislation stipulates that the system can be applied only if the commissioning or retrofitting of the units/stations had been achieved by the end of the year 2016.
The system for promoting the renewable energy applies for the electricity supplied to the grid and/or to the consumers, produced from: hydraulic energy used in plants with an installed capacity of 10 MW, wind energy, solar energy, geothermal energy, biomass, bio liquids, biogas and sludge fermentation gas from the wastewater treatment plants.
According to the legal framework, the system for promoting the renewable energy does not apply to: the electricity produced from fuels derived from biomass, industrial and/or municipal waste purchased from abroad, regardless of the installed capacity of the power plant; the electricity produced in pumped storage plants using water that has been previously pumped into the upper basin. There are also excluded: the electricity produced in units that use both conventional and renewable energy sources in the case when more than 10% of the total energy content is produced using conventional fuel; the electricity that is used for the power plant's own technical consumption. In the same situation are: the electricity produced in photovoltaic power plants located on land that had agricultural use on 31 December 2013, according to the law; the additional quantities of electricity delivered by the energy producers; the electricity produced in power plants installed on any kind of vehicles.
Currently, in Romania, the mandatory quota system combined with the green certificates trading is implemented for promoting the renewable energy. A green certificate is a document certifying the production of 1 MWh of renewable energy. Basically, this system consists in providing green certificates to the producers of renewable energy, that will be sold afterwards through competitive mechanisms to those suppliers/producers of electricity that are required by law to purchase them. These suppliers/producers have the

obligation to acquire a certain number of certificates according to the amount of energy they had supplied to the end consumers.

The number of certificates that the suppliers/producers of electricity are required to acquire annually for each MWh of electricity sold to the final consumers is determined as the product of the annual mandatory quota of green certificates set for the respective year and the amount of electricity supplied annually by each supplier to the final consumers. Legal penalties are applied to the suppliers/producers of electricity that have not met the mandatory quota of green certificates. The relationship between the annual mandatory quotas of renewable energy and the annual mandatory quotas of green certificates is regulated by ANRE [8].

In the case of renewable energy producers that use production units with an installed capacity under 1 MW per plant or 2 MW per plant for high efficiency cogeneration from biomass, the legislation stipulates the possibility of trading electricity at a regulated price, in conjunction with the obligation that the electricity is purchased by the providers from the area of the license, where the respective production capacities are located. The power plants having a capacity greater than 125 MW are temporarily accredited for a period of 24 months, during which the individual decision regarding the authorization from the European Commission must be obtained.

Monitoring the system for promoting the renewable energy using the green certificates scheme arises from the provisions of [9], according to which ANRE is in charge of monitoring the costs and revenues resulting from the production of renewable energy for the producers that benefit from the green certificate scheme. ANRE is also in charge of analysing the possibility of overcompensation for one or more of the licensed technologies and of proposing measures to reduce the number of green certificates for the new beneficiaries through a public report. The diagram of the system for promoting the renewable energy using the green certificates scheme is depicted in **Figure 1**.

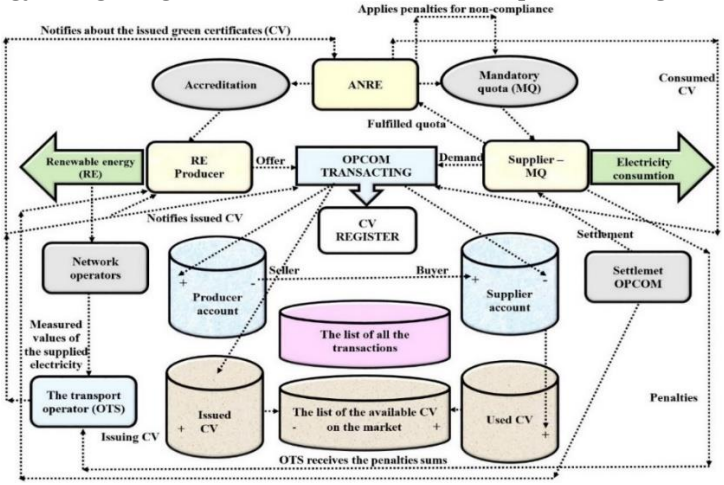

Figure 1. The diagram of the system for promoting the renewable energy through green certificates[1]

[1] The diagram has been created according to public documents of OPCOM, http://www.opcom.ro/opcom/tranzactii_produse/tranzactii_produse.php?lang=ro&id=145 accessed on 15 March 2015, at 16:30 p.m.

The monitoring methodology for the system of promoting renewable energy using the green certificates scheme [7] details how the overcompensation analysis regarding the activity of producing renewable energy for the producers that are beneficiaries of the scheme is performed. The analysis is conducted annually during the period when the activity is promoted through the support scheme, based on the evolution of the following indicators: the average level of the specific investment; the average level of the specific variable costs; the average level of the specific fixed costs; the average level of the production unit's capacity factor.
The mechanism for reducing the number of green certificates within the overcompensation analysis is based on the annual recalculation, on the duration of the support scheme, on the number of green certificates/MWh. In order to achieve the reduction, the internal rate of return for each technology, for the new entrants, at the aggregate level, must not exceed more than 10% of the value set for the respective technology when the promoting system was authorized.
The green certificates market operator (OPCOM) assures the trading of the green certificates and determines the prices used in transacting green certificates on their centralized market, in compliance with the "Rules of organization and operation of the green certificates market"[10]. OPCOM enrols the participants to the green certificates market, forecasts and announces the demand and the supply of green certificates at the national level, registers the bilateral trading contracts for green certificates between the producers of renewable energy and the suppliers.
The operator also sets up and manages the green certificates registry, provides the trading conditions for the green certificates on the centralized market, receives the offers for sale/purchase of green certificates from the producers/suppliers (consumers). OPCOM determines and publishes the closing price of the centralized green certificates market and the number of certificates traded monthly on the centralized green certificates market. Other responsibilities of the operator consist in announcing monthly the aggregate demand and the aggregate supply of green certificates for the current year, defining the rights and obligations of the centralized green certificates market's participants towards the payments.

3. The objectives of monitoring the production process of the renewable energy

In Romania, the methodology for monitoring the system of promoting the renewable energy using the green certificates scheme is applied in monitoring the production capacity, the renewable energy production, the green certificates support scheme and the operation of the green certificate market. The methodology targets the producers of renewable energy, the providers of electricity for the final consumers, the network operators and the green certificates market operator.
Through the annual monitoring activity of the system for promoting the production of renewable energy within the green certificates support scheme, the Romanian Energy Regulatory Authority (ANRE) aims to evaluate the green certificate support scheme's implementation. The efficiency in fulfilling the national objectives is also assessed, the percentage of the renewable energy in the electricity consumption being regulated by law. The green certificate support scheme's efficiency is also evaluated in relation to the

necessary financial costs and it is determined if, after the green certificate support scheme has been applied, the production of energy using renewable energy resources is overcompensated as to allow the readjustment of the scheme according to the obtained results.

The green certificates market is evaluated in compliance with the current legislation and it is mandatory for the scheme to be within the budget that has been forecasted at the time of its authorization by the European Council. The Romanian Energy Regulatory Authority also evaluates the overlapping of the green certificates support scheme with other mechanisms that support the production of energy using renewable resources. The monitoring activity of the energy that was produced using renewable resources and of the green certificates support scheme is structured based on monitoring the following:

- the costs and incomes of the renewable energy producers that use the green certificates support scheme in order to prevent the overcompensation situation;
- the green certificates support scheme and its efficiency;
- the impact that the green certificates support scheme has upon the electricity prices for the final consumers;
- the green certificates market;
- the total amount of energy that was produced using renewable resources in order to determine the fulfilment of the national goals.

4. The main indicators regarding the incomes and costs of the renewable energy producers

Based on the information submitted by the producers of renewable energy that benefit from the green certificate schema, the following indicators are computed [7]:

a) The unit income of the renewable energy producers that benefit from the green certificate schema for each category of renewable energy technology.

$$V_{E-SRE}^{i} = \frac{\sum_j V_{j\,E-SRE}^{i} + \sum_j V_{j\,CV}^{i}}{\sum_j E_j^i} \quad \text{[lei/MWh],}$$

where:

$V_{j\,E-SRE}^{i}$ *= the total income realized by each producer j from the technology category i, after having sold the renewable energy;*

$V_{j\,CV}^{i}$ *= the total income realized by each producer j from the technology category i, after having sold the renewable energy.*

b) The total income realized from the sale of renewable energy, for each technology category.

c) The total income realized from the sale of green certificates, for each technology category.

d) The unitary costs of the renewable energy producers that benefit from the green certificate schema, for each technology category of renewable energy.

$$C_{E-SRE}^{i} = \frac{\sum_j Cf_j^i + \sum_j Cv_j^i}{\sum_j E_j^i} \quad \text{[lei/MWh],}$$

where:

Cf_j^i *= the fixed costs for producing the renewable energy for each producer j from the technology category i;*

Cv_j^i *= the variable costs for producing the renewable energy for each producer j from the technology category i;*

E_j^i *= the quantity of renewable energy sold by each producer j from the technology category i.*

e) The annual evolution of the value of other benefits received by the producers from each category of renewable energy technology granted as state aids, others than those related to the green certificate schema: investment aids, exemptions/ reductions of taxes, state guarantees/subsidized interest credit, allocation of allowances for greenhouse gases etc.

The overcompensation analysis of the renewable energy production activity for the producers that benefit from the green certificate scheme is performed annually during the period when this activity is promoted through the support scheme, based on the evolution of the following indicators:

a) the average level of the specific investment on categories of renewable energy technologies is determined as follows: the arithmetic mean of the specific investments resulted from the data that has been reported by the producers that put into operation new capacities of producing renewable energy in the year preceding the one when the analysis was performed and from those contained in the feasibility studies submitted to ANRE during the same period, in view of obtaining the authorization for setting up new capacities for renewable energy production; this average is compared to the level of the specific investment (capital cost) for the respective technology, for the year of analysis used in the latest World Energy Outlook document presented on the International Energy Agency's website, in the WEO Model\Investment Costs location: *"Assumed Investment Costs, operation and maintenance costs and efficiencies for power generation in the New Policies, Current Policies and 450 scenarios"* (or any equivalent document with a similar credibility, if the one mentioned before is not being published anymore) and converted into Euros according to the rate from the referenced document; in order to compute the overcompensation, the lesser of the values is being used:

$$i_{sp}^i = \frac{\sum_{j=1}^{N} i_{sp,j}^i + \sum_{k=1}^{M} i_{sp,k}^{SF_i}}{N+M} \quad \text{[Euro/MW]},$$

and:

$$i_{sp,j}^i = \frac{I_j}{P_j} \quad \text{[Euro/MW]}$$

$$i_{sp,k}^{SF_i} = \frac{I_k}{P_k} \quad \text{[Euro/MW]}$$

where:

i_{sp}^i *= the average level of the specific investment for the technology category i;*

I_j = the investment costs of the producer j for attaining the renewable energy production capacity commissioned in the year that precedes the one in which the analysis is performed;
P_j = the installed power of the renewable energy production capacity of the producer j, commissioned in the year that precedes the one in which the analysis is performed;
I_k = the investment costs assessed by the producer k for attaining the renewable energy production capacity, resulted from the feasibility study submitted to ANRE in view of obtaining the authorization for setting up that capacity, if it had not been put into operation until the semester previous to conducting the analysis has ended;
P_k = the designed installed power of the renewable energy production capacity of the producer k, taken into account within the feasibility study submitted to ANRE in view of obtaining the authorization for setting up that capacity, if it had not been put into operation until the semester previous to conducting the analysis has ended;
N = the number of renewable energy production capacities put into operation in the year preceding the one in which the analysis is performed;
M = the number of renewable energy production capacities for which a set up authorization was requested and had not been put into operation until the semester previous to conducting the analysis has ended;

$$i_{sp}^{i,calcul} = min(i_{sp}^{i}, i_{sp}^{i,IEA})$$

b) the average level of the specific index of the variable costs on categories of renewable energy technologies is determined as follows: it is computed the ratio between the variable costs made during the year preceding the one in which the analysis was conducted by each producer of renewable energy from a technology category that had capacities in operation during that period and the electricity delivered in the same period of time by that producer; afterwards the arithmetic mean of these unitary values for all the producers in the respective technology category is computed:

$$c_v^i = \frac{\Sigma_j\left(\frac{Cv_j^i}{E_j^i}\right)}{n} \quad \text{[Euro/MWh],}$$

where:
c_v^i= the average level of the specific index of the variable costs for the technology category i ;
Cv_j^i= the variable costs made in the year preceding the one when the analysis was performed for each producer j from the technology category i;
E_j^i= the quantity of renewable energy delivered in the year preceding the one when the analysis was performed by each producer j from the technology category i;

n = the total number of producers from the technology category i that had operating capacities during the year preceding the one when the analysis was performed;

c) the average level of the specific fixed costs index on categories of renewable energy technologies is determined as follows: it is computed the ratio between the fixed costs made during the year preceding the one in which the analysis was conducted by each producer of renewable energy from a technology category that had capacities in operation in that period and the average installed power of the renewable energy capacities of that producer; afterwards the arithmetic mean of these unitary values for all the producers in the respective technology category is computed; one computes the arithmetic mean of this index and the one corresponding to the last 3 years, computed for the total annual fixed costs; in the case of the new technologies for which there is no available data for all the previous 3 years, the average value corresponding to the years for which data is available is filled in, while for the missing years, the value is replaced with an average value obtained from the feasibility studies submitted to ANRE in view of obtaining the authorization for setting up new capacities, that had not been put into operation until the semester previous to conducting the analysis has ended:

$$cf_{an}^{i} = \frac{\sum_{j}\left(\frac{Cf_{j,an}^{i}}{P_{j,E-SRE}^{med,an\,i}}\right)}{n_{s}^{i}} \quad \text{[Euro/MW]},$$

$$cf_{ani}^{i} = \frac{\sum_{t=1}^{D}\left(\sum_{j=1}^{n_{Y-t}}\left(\frac{Cf_{j,Y-t}^{i}}{Pf_{j,E-SRE}^{med,Y-t^{i}}}\right)/n_{Y-t}^{i}\right)+(3-D)\times\sum_{m=1}^{q}\left(\frac{Cf_{m,SF}^{i}}{P_{m,E-SRE}^{med,SF_{i}}}\right)/q^{i}}{3} \quad \text{[Euro/MW]}$$

and

$$Cf^{i.calc} = \frac{cf_{an}^{i}+cf_{ani}^{i}}{2} \quad \text{[Euro/MW]}$$

where:

cf_{an}^{i} = the average level of the specific fixed costs index for the technology category i for the year preceding the one in which the analysis was conducted;

cf_{ani}^{i} = the average level of the specific fixed costs index for the technology category i for the calendar year preceding the one in which the analysis was conducted;

$Cf^{i.calc}$= the average level of the specific fixed costs index for the technology category i;

$Cf_{j,an}^{i}$ = the fixed costs recorded in the year preceding the one in which the analysis was conducted by each producer j from the technology category i ;

$Cf_{j,SF}^{i}$= the fixed costs specified in the feasibility study by each producer j from the technology category i ;

$Cf_{j,Y-t}^{i}$= *the fixed costs recorded in the year* $Y-t$ *by each producer j from the technology category i;*
$P_{j,E-SRE}^{med,an\ i}$ *= the average installed power of the renewable energy capacities of the producer j from the technology category i in the year preceding the one in which the analysis was conducted;*
$Pf_{j,E-SRE}^{med,Y-t^{i}}$ *= the average installed power of the renewable energy capacities of the producer j from the technology category i in the year Y-t;*
$P_{m,E-SRE}^{med,SF_i}$ *= the power of the renewable energy capacities of the producer m from the technology category i stipulated in the feasibility study;*
Y *= the year in which the analysis was conducted;*
D *= the number of years for which there is available data,* $D < 4$*;*
n_s^{i} *= the total number of producers from the technology category i that had operational capacities in the semester previous to conducting the analysis;*
$n^{i}{}_{Y-t}$ *= the total number of producers from the technology category i that had operational capacities in the year* $Y-t$*;*
q^{i} *= the total number of producers from the technology category i that have applied for the authorization for setting up new capacities that had not been put into operation until the semester previous to conducting the analysis has ended;*
t *= the year counter.*

d) the average level of the capacity factor on categories of renewable energy technologies is determined as follows: the multiannual average (for the last 10 calendar years) of the ratio between the electricity supplied in the reporting year and the product between the average installed power in the respective year and 8760 hours; in the case of the new technologies, for which there is no available data for all the 10 previous years, the average value corresponding to the years for which data is available is filled in, while for the missing years, the value is filled in with an average obtained from all the years/months for which there is available data.

$$\overline{F}C_{E-SRE}^{i} = \left(\sum_{t=1}^{D} \frac{\sum_{j=1}^{n_{Y-t}^{i}} E_{j,E-SRE}^{Y-t}}{\left(\sum_{j=1}^{n_{Y-t}^{i}} PI_{j,E-SRE}^{Y-t} \right) \times 8760} \times 100 \right) / D \qquad [\%],$$

where:
$\overline{F}C_{E-SRE}^{i}$= *the average level of the capacity factor on the technology category i of producing renewable energy;*
$E_{j,E-SRE}^{Y-t}$ *= the quantity of renewable energy delivered by the producer j from the technology category i in the year* $Y-t$*;*
$I_{j,E-SRE}^{Y-t}$= *the installed power of the capacity that uses renewable resources of the producer j from the technology category i in the year* $Y-t$*;*
Y *= the year in which the analysis was conducted;*

n_{Y-t}^{i}= *the total number of producers from the technology category* i *that were operating in the year* $Y-t$;
t = *the year counter,* $1 \le t \le D$.

e) in the case of the renewable energy technologies based on the biomass cogeneration, the average level of the ratio between the electricity supplied and the thermal energy supplied and also the average level of the ratio between the electricity that is produced using the high efficiency cogeneration and the electricity supplied, are determined individually as the arithmetic mean of the last 3 calendar years of the reports resulted from monitoring the producers who had capacities in operation. For the years without available data, the mean value is computed using the feasibility studies submitted to ANRE in view of obtaining the authorization for setting up new capacities if these had not been put into operation until the semester previous to conducting the analysis has ended:

$$y_{cog}^{bio} = \frac{\sum_{t=1}^{D}\left(\sum_{j=1}^{n_{Y-t}}\left(\frac{E_{j,Y-t}}{Q_{j,Y-t}}\right)/n_{Y-t}\right)+(3-D)\times\sum_{m=1}^{q}\left(\frac{E_{m,SF}}{Q_{m,SF}}\right)/q}{3} \quad [-],$$

and

$$e_{cogef}^{bio} = \frac{\sum_{t=1}^{D}\left(\sum_{j=1}^{n_{Y-t}}\left(\frac{E_{j,Y-t}^{cogef}}{E_{j,Y-t}}\right)/n_{Y-t}\right)+(3-D)\times\sum_{m=1}^{q}\left(\frac{E_{m,SF}^{cogef}}{E_{m}^{SF}}\right)/q}{3} \quad [-],$$

where:
y_{cog}^{bio} = *the average ratio between the electricity supplied and the thermal energy produced in the biomass cogeneration plants;*
e_{cogef}^{bio} = *the average ratio between the electricity produced in high efficiency cogeneration and the energy produced in the biomass cogeneration plants;*
$E_{j,Y-t}$= *the quantity of renewable energy delivered by the producer* j *in his cogeneration plant in the year* $Y-t$;
$Q_{j,Y-t}$= *the quantity of thermal energy delivered by the producer* j *in his cogeneration plant in the year* $Y-t$;
$E_{m,SF}$ = *the quantity of renewable energy forecasted in the feasibility study by the producer* m *as being delivered from the cogeneration plant that is in the process of being authorized and that had not been put into operation until the semester previous to conducting the analysis has ended;*
$Q_{m,SF}$ = *the quantity of thermal energy forecasted in the feasibility study by the producer* m *as being delivered from the cogeneration plant that is in the process of being authorized and that had not been put into operation until the semester previous to conducting the analysis has ended;*
$E_{j,Y-t}^{cogef}$ = *the quantity of renewable energy produced in high efficiency cogeneration by the producer* j *in his cogeneration plant in the year* $Y-t$;
$E_{m,SF}^{cogef}$ = *the quantity of renewable energy forecasted in the feasibility study by the producer* m *as being produced in high efficiency cogeneration by the*

cogeneration plant for which he has applied for obtaining the authorization and that had not been put into operation until the semester previous to conducting the analysis has ended;
n_{Y-t}*= the total number of cogeneration renewable energy producers that had operating capacities in the year* $Y - t$*;*
q *= the total number of producers that have applied for obtaining the authorization for new cogeneration renewable energy plants that had not been put into operation until the semester previous to conducting the analysis has ended;*
D *= the number of years for which there is available data,* $D < 4$*;*
Y *= the year in which the analysis was conducted;*
t *= the year counter*

The cost-benefit analysis with updates for each category of renewable energy production technology is performed under the following conditions:

- **a)** the Excel application is used within the notification of the support scheme in order to obtain its approval by the European Commission; the analysis is performed at the aggregate level for each category of renewable energy technology and one must take into account the green certificates' price dependence on the level of the renewable energy production within the ensemble of all the sustained technologies, compared with the production corresponding to the mandatory quota established by law;
- **b)** the period for computing the IRR is 21 years when considering a life cycle of 20 years for the capacities and a project development timeframe of 1 year;
- **c)** the first year of the IRR calculation period is considered to be the year following the one in which the analysis was conducted (the year when the first investments are made to which the analysis of over-compensation is applied);
- **d)** the following forecasts are conducted: the gross domestic electricity consumption, the net energy consumption, the commissioning of renewable energy capacities on technologies categories, the electricity price evolution on the wholesale energy market, the thermal energy price evolution, the green certificates price by taking into account the degree of fulfilling the mandatory quota of green certificates.
- **e)** the cost-benefit analysis is carried out at the aggregate level, for each category of technology, taking into account the above mentioned forecast parameters and the determined specific indicators; the number and duration for granting the green certificates depend on the legal framework that regulates the projected capacities that are to be put into service in each year of the calculation period; the result of the conducted cost-benefit analysis represents the IRR value before applying the taxes for each technology at an aggregate level.

If, after having performed the Cost-Benefit Analysis, the resulted IRR value for a category of producers exceeds by more than 10% the reference IRR value, the scheme is considered to be overcompensated for that category. In this case, ANRE recalculates the new values of the number of green certificates for these categories of technologies for

renewable energy production so that the value of IRR for each category of technology, at the aggregate level, is equal to the reference value of the IRR for that technology. The overcompensation analysis is performed in the year of analysis for the previous year and the obtained results are recorded in a report that is published on the ANRE website in March, for each year of implementation of the support scheme.
The data is gathered from the feasibility studies of the new projects in Romania, from monitoring the investments, the operational costs and incomes of the renewable energy producers. If, after having analysed the data, the specific parameters of each technology differ significantly from those taken into account for when authorizing the promoting system according to the regulations, the overcompensation for one or more of the technologies might occur. The Government approves these measures through a governmental decision that applies to the renewable energy producers that start operating after the Government has put into practice the decision.
The above described method of determining the scheme's overcompensation is valid only in the case of the system that promotes renewable energy using the green certificates scheme authorized as a state aid through the authorizing decision of the European Commission, as regulated by the law [9].

5. Conclusions

The main indicators regarding the incomes and costs of the renewable energy producers must be taken into account for by a Decision Support System when predicting, analysing and monitoring the technological and business processes in the field of renewable energy in Romania.
Among the analysed indicators are those regarding the incomes and costs of the renewable energy producers; the analysis of overcompensation of the renewable energy production activity for the producers that benefit from the green certificate scheme; the cost-benefit analysis with updates for each category of renewable energy production technology. These indicators are of particular importance in quantifying the results of the green certificate support scheme and for promoting the renewable energy by extending the use of the available resources, covering the investment's expenses and influencing the energy price that the final electricity consumers have to pay.
A DSS must continuously monitor the results of the analysed indicators and use them in order to generate the necessary reports for the national and European public authorities, devising the necessary solutions if the overcompensation does occur. Obtaining an efficient set of results, after having taken into account the analysed aspects of the economic indicators, is of paramount importance for a sustainable development at both local and regional level. An efficient renewable energy policy leads to new job opportunities and helps reducing the environmental pollution, thus ensuring the security of the energy supply and a cutback in the necessary imports.

6. Acknowledgement

This paper presents a series of results obtained within the SIPAMER research project ("Sistem Inteligent pentru Predicţia, Analiza şi Monitorizarea Indicatorilor de

Performanţă a Proceselor Tehnologice şi de Afaceri în Domeniul Energiilor Regenerabile"), PNII – "Parteneriate în domeniile prioritare", PCCA 2013, code 0996, no. 49/2014, financed by the National Authority for Scientific Research (NASR).

REFERENCES

[1] **Bara A., Lungu I., Oprea S. V., Carutasu G., Botezatu C. P., Botezatu C., Design workflow for cloud service information system for integration and knowledge management based in renewable energy,** Journal of Information Systems & Operations Management, vol.8, no.2, Ed. Universitară, 2014, ISSN 1843-4711.

[2] Bara A., Oprea S.V., Velicanu A., Botha I., Spatial collaborative system for Wind Power Plants using Service Oriented Architecture, The 2013 International Conference of Computer Science and Engineering (ICCSE'13), World Congress on Engineering, London, UK, published in Lecture Notes in Engineering and Computer Science, pp 909-914, Newswood Limited International Association of Engineers, ISBN: 978-988-19252-8-2; ISSN: 2078-0958 (print).

[3] Lin Luo F., Hong Y., Renewable Energy Systems: Advanced Conversion Technologies and Applications, CRC Press, ISBN 9781439891094, 2012.

[4] Freris L., Infield D., Renewable Energy in Power Systems, Wiley, 2008.

[5] Carutasu G., Botezatu C., Botezatu C.P., PNCDI II/Parteneriate nr.2387/2007 Dezvoltarea şi implementarea sistemelor integrate de management în domeniul energiei DI-SIM, 2008-2010.

[6] Lungu I., Bara A., Sisteme informatice executive, ASE Publishing House, 2007.

[7] Monitoring Methodology of the Promoting System of the Renewable Energy, Through Green Certificates, approved by the ANRE Order no. 6/2012, as subsequently amended and supplemented.

[8] Methodology for Establishing the Mandatory Annual Quota of Renewable Energy Promoted by the System of Green Certificates and Those of Green Certificates Acquisition, approved by the ANRE Order no. 49/2014, as subsequently amended and supplemented.

[9] Law no. 220/2008, republished in the "The Official Gazette of Romania", Part I, no. 577/ 13/08/2010, as subsequently amended and supplemented.

[10] Regulation for Organizing and Functioning of the Green Certificates Market, approved by the ANRE Order no. 57/2013, as subsequently amended and supplemented.