Renewable Energy Risk Management

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Abstract: - Renewable Energy it's a necessity of modern society. In order to meet the needs for food, environment, housing, lighting, transport, freight, goods and information technology, it's necessary to supply good energy.
Energy affects the fundamental development of our society. XXI century's Europe cannot have a developed economy, with an adequate social sector, without an effective energy sector. Energy industry was the fourth largest area exposed to risks in 2008. Humanity is increasingly dependent on energy sources; the concern to ensure long-term energy sources is an important political strategy component at both national and international level.
The energy system is exposed to natural hazards, operational and commercial hazards risk generate social risk meanwhile risks resulting from uncontrolled energy can lead to disaster energy. Manifestation of social risk has a significant negative impulse over all the economic and social system. The paper aims to determine and control the renewable energy risks (RER), using risk management's technique, in order to minimize social risk and crisis. The procedures for energy risk management are presented in accordance with ISO 31000/2009.

Key-Words: - renewable energy risk, risk management, social risk, social crisis.

1 Introduction

There is nothing simpler as well as complex, at the same time, than to identify and control risk. Since ever, risks have been one of the biggest and most exciting challenges of human race. Within the definition of a common energy policy, The European Economic and Social Committee reiterate that: "Energy is a necessity of a modern society. In order to meet the needs for food, environment, housing, lighting, transport, freight, goods and information technology, is necessary to supply good energy. Still, the way to meet these needs, can and should be changed" [6].

2 Renewable Energy Risk Management

2.1 Characterization

Renewable Energy is part of Industrial Ecology - the study of material and energy flows through industrial systems. The global industrial economy can be modeled as a network of industrial processes that extract resources from Earth and transform those resources into commodities that can be bought and sold to meet humanity needs. Industrial ecology tries to quantify the material flows and document the industrial processes that make modern society to run. Industrial ecologists are often concerned with the impacts that industrial activities have on the environment, in respect with usage of planet's natural resources supply and with waste disposal issues. Industrial ecology is a young, but growing multidisciplinary field of research, successfully combining aspects of engineering, economics, sociology, toxicology and natural sciences.

Risk is defined as an uncertain element that can, possibly, appear in technical, human, social or political events, reflecting the distribution of all the variations and occurrences of subjective and objective factors with possible damaging and irreversible effects [1].

Risk management is defined as the management of uncertain events, in order to achieve success [3].

Risk management has to cover all the features, methods and means to achieve the social, human and political objectives of the event, focusing on the major risk factors.

Renewable energy risk management is defined as renewable energy management considering the uncertainty of all the events existing in a normal global socio-economic life [2].

Energy Crisis: Energy is vital for any functioning economy. Even more today, because receiving, safe and inexpensive energy period ended. Besides the dependence between increasing imports and higher energy prices, humankind is facing the challenges of climate change, caused mainly by the increase of energy price. Driving normal activities, the dependence of EU energy imports will fall from its current 50%, to 65% in 2030. By the same 2030 year, an increase in dependence on gas imports is forecasted from 57% to 84% and for oil imports from 82% to 93%, both represent a political and economic risk. We should all acknowledge that world energy resources are under extreme pressure [5].

Social crisis: Energy affects the fundamental development of our society. XXI century's Europe cannot have a developed economy, with an adequate social sector, without an effective energy sector. National energy sector has to face major challenges manifested at internal and global level: energy supply security, economic competitiveness increase and reduced environmental impact. These challenges are particularly important for Romania, since it has to catch up economic performance in comparison with EU's developed countries.

The solution to solve these problems consists in using green energy or secondary resources, with reduced energy consumption, all over the product's life cycle, from design to reuse.

2.2 Renewable Energy Risks

Managing risk means risk identification and assessment as well as definition of the proper reaction to these risks, i.e. perform the internal control work means to alleviate the possibility of occurrence if it would materialize. Recent impulse of proper risk management comes from weak risk management that has been identified, by corporative management, as being the main reason for organizations failure. Weak risk management can lead to a crisis within the organization that might eventually turn into disaster.

Principles for renewable energy risk management (RERM) are:

a) creates value
b) integral part of organizational commitment
c) part of decision making
d) explicitly addresses uncertainties
e) systematic, structured ant timely
f) based on the best available information
g) tailored made
h) accounts human and cultural factors
i) transparent and inclusive
j) dynamic, iterative and responsive to change
k) facilitates continuous improvement and strengthening of the organization

The Stages of RERM, with an eye to generic stages of the risk management process, are:

- *Establish context:* covers strategic context determination, organizational and risk management, analysis structure and risk assessment criteria, identification of affected parties/stakeholders and communication, dissemination and consultation policy;
- *Hazard identification:* implies the identification (as a basis of subsequent analysis) of all the events that can occur, their determining reasons and conditions, including the associated risks and consequences;

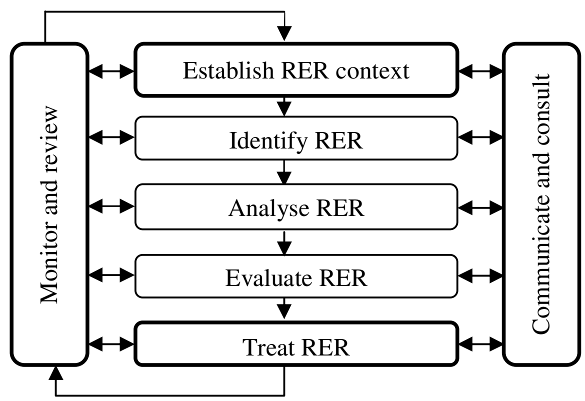

Fig. 1 Energy risk management process [5]

- *Risks analysis:* has to be performed in terms of risk probability and severity, controlling options and the effect of their consequences; probability and severity can be combined to estimate the risk level;
- *Risk assessment:* implies systematic search of risk factors within the studied event;
- *Treat risks:* management plan development and implementation should include considerations about the allocation of natural and financial resources as well as action plan deadlines;
- *Communication and consultation:* with all the affected parties/stakeholders, internal and external, has to be continuous through all the risk management process steps;
- *Monitoring and review:* aims to implement response strategies as well as to monitor the changes caused by these strategies during the event analysis.

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In accordance with ISO, in order to have a continuous energy risk management improvement, the following diagram flow has to be pursued:

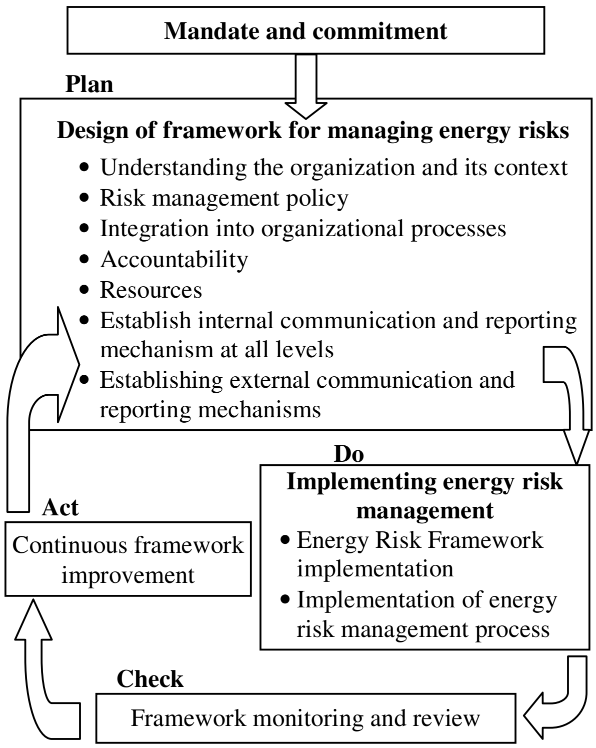

Fig. 2 Continuous improvement of the energy risk management [4]

2.3 Effects of Renewable Energy Risks

Economic and financial risks as effects of energy risk: Financial resources and raw energetic materials are limited. Huge financial amounts are necessary to carry out large scale energy projects; the recovery of those finances has a significant risk whereas finances involved are invested on long term. In this respect, financing within the energy sector is a complex issue.

Social risks as effects of renewable energy risk: Social risks are defined as circumstances which may trigger somebody's income loss or costs growth. Legally, at both local and international level, social risks are usually defined as: seniority, sickness, disability, motherhood, employee rights, unemployment, family task etc. These social risks are covered by Social Convention 102/1952 of International Organization of Labor.

Political risks versus renewable energy risks: Political risks are social and political events, beyond the purchaser's solvency, that prevents the purchaser to fulfill his payment obligations over the supplier (war, strikes). Political risks can also be generated by statutory rules and regulations, imposed by partner's local authorities, materialized as: imports restriction, limitation of the exchange rate, seizure or confiscation of trader's goods, etc. [7]

3 Modeling and Simulation of Financial - Economic Crisis Due To Risk Energy

3.1 Modeling Economics Risks

Developing an energy project represents a clear investment also expected to induce an associated technical and socio-economical effect; namely construction of a flat building that will also generate an associated income (electricity, heat).

In practice, an energy project development is associated with a basic economic model with two parameters – income and risk. Depending on the configuration of internal and external factors, for a given system, we can estimate income-risk pairs. For any given income distribution (pairs of income-risk) there are two typical characteristics to be calculated and used on decisional modeling:

- average income:

$$E = \sum_{i=1} p_i V_i \quad (1)$$

- square mean income deviation, σ:

$$\sigma^2 = \sum_{i=1} p_i (V_i - E) \quad (2)$$

where:

p_i – probability to obtain income V_i;
n – number of possible states (incomes);
σ – square mean income deviation;
V_i – income.

There are proper graphs used to differentiate the decision maker with risk tendency from the one with risk aversion. The one with risk tendency prefers alternatives offering great income amounts, difficult to achieve therefore with a higher dispersal (σ).

Total risk is divided as follows:

a) upon the possibility to reduce its components:

$$r_T = r_{sist} + r_{spec} \quad (3)$$

r_T – total risk;
r_{sist} – systematic risk, generated by certain macroeconomic factors (interests level), that cannot be eliminated;
r_{spec} – specific risk that can be reduced using appropriate techniques:

b) upon risk origin:

$$r_T = r_B + r_F \quad (4)$$

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r_B – energy business risk, given by the activity nature in which finances are invested;
r_F – financial energy risk, given by the financing type of the business.
Modeling risk for an electricity generating company is:

$$\sigma \cdot R_{financial} = \sigma \cdot R_{economic} + \sigma \cdot (R_e - R_d) \cdot g_{ic} \quad (5)$$

$$\sigma \cdot R_{economic} = \sigma \cdot R_{interest} + \sigma \cdot (R_m - R_d) \cdot S_{af} \quad (6)$$

$$S_{af} = (g_{ic} \cdot S_{ci} + S_{cp}) / (1 + g_{ic}) \quad (7)$$

where: $\sigma \cdot R_{financial}$ – financial risk;
$R_{economic}$ – economic risk;
R_d – interest rate
g_{ic} – company indebtedness degree;
S_{af} –design, execution and development portfolio assets' sensitivity;
R_m – market return rate for studied products;
S_{ci}, S_{cp} – return rate sensibility over equity (cp) or over lone (ci).

Brainstorming design, execution and development of energy targets is performed using the updated net income (VNA) and the financial viability internal rate (RIRF).

Thus, acceptance conditions for the energy project proposed solution can be written as: $VNA > 0$ and $RIRF > \text{capital opportunity cost}$.

These indicators complement each other whereas VNA reflects the total attainable income meanwhile RIRF reflects the reported profit. These guidelines can be applied when the energy projects don't have financial restrictions. When there are financial restrictions and the design targets have different durations, the correlation between VNA and RIRF indicators is performed both graphical and analytical.

The analytical method, consist in calculate the VNA and RIRF coefficients' variation determining their global influence as:

$$F_g = \frac{VNA}{I} \left\{ \left[C_v(VNA) \right]^{\sigma} + \left[C_v(RIRF) \right]^{1-\nu} \right\} \quad (8)$$

$$\gamma = \frac{I_{surse\_proprii}}{I_{capitol\_total\_proiect}} \quad (9)$$

$$C_v(VNA) = \frac{\sigma_{VNA}}{VNA} \quad (10)$$

$$C_v(RIRF) = \frac{\sigma_{RIRF}}{RIRF} \quad (11)$$

$$\sigma_{VNA} = \frac{\left[\sum_{i=1}^{n} (VNA_i - VNA)^2 \times p(VNA) \right]^{1/2}}{\left[\sum_{i=1}^{n} p(VNA_i) \right]^{1/2}} \quad (12)$$

$$\sigma_{RIRF} = \frac{\left[\sum_{i=1}^{n} (RIRF_i - RIRF)^2 \cdot p(RIRF) \right]^{1/2}}{\left[\sum_{i=1}^{n} p(RIRF_i) \right]^{1/2}} \quad (13)$$

where: C_v, $C\sigma$ – variation (ν) and standard deviation (σ) coefficients

Financial return rate leads to financial risk if there are deviations from the calculated values, using the following formulas:

$$R_f = R_e + (R_e - R_d) \cdot g_v^c \quad (14)$$

$$\sigma_{(R_f)} = \sigma \cdot \left[R_e + (R_e - R_d) \cdot g_v^c \right] \quad (15)$$

where: $\sigma(R_f)$ – estimates the profitability risk level depending on standard deviation (σ). Risk can be divided into asymmetric risk ($\sigma \cdot R_{fns}$) and symmetric risk ($\sigma \cdot R_{fs}$) as following:

$$\sigma(R_f) = (\sigma \cdot R_{fns} + \sigma \cdot R_{fs}) = R_1^{controlable} + R_2^{non-controlable}) \quad (16)$$

Control is achieved by decision makers that can oversee projects performance, financing efficiency, project's closing and delivery time, including company strategy. The risk omitted from the decision makers control depends on external factors such as tax and custom policies, technological process, social, economic and political aspects (competition, recession, equity costs, etc.).

Financial risk σ (R_f) is defined, in relation with the economic profitability (R_e), as:

$$\sigma(R_f) = \sigma(R_e) \cdot (1 + g_i^c) \quad (17)$$

$$R_e = R_d + (R_m - R_d) \cdot S_{ap} \quad (18)$$

S_{ap} – project assets sensitivity;
R_d – risk-free loan interest rate;
R_m – market return rate;
$S_{ap} \cdot (R_m - R_d)$ – risk premium

Using the above notations, financial risk became:

$$\sigma(R_f) = \sigma[R_d + S_{ap} - (R_m - R_d)] \cdot (1 + g_i^c) \quad (19)$$

$$S_{ap} = (S_{cp} + S_{ci} \cdot g_i^c) \cdot g_i^c \quad (20)$$

where: S_{cp}, S_{ci} – return rates sensitivity over capital (cp) and over loans (ci).

Dynamic control of energy projects in order to structure them as per profitability can be quickly performed applying Markov's analysis method. The performance operating functions used by Markov's analyses are: the updated net income; the financial return rate; the generalized function (f_g) and the variation coefficient (C_v). These functions can define the analyzed system status by quantifying state VNA, RIRF and C_v as initial (0), maximum (max) and minimum (min) admissible values as per the project's return rate on fixed capital. The initial return rate $(RIRF)_0$ represents the marginal capital cost and (RIRF) represents the minimum opportunity capital cost reflected through the expected maximum incremented value of the analyzed range (project life). The statuses associated with Markov's development analysis are defined as:

$$\begin{cases} VNA > VNA_{min} \Rightarrow 2 \\ VNA \in [VNA_0, VNA_{min}] \Rightarrow 1 \\ VNA > VNA_0 \Rightarrow 0 \end{cases} \quad (21)$$

$$\begin{cases} RIRF > RIRF_{min} \Rightarrow 2 \\ RIRF \in [RIRF_0, RIRF_{min}] \Rightarrow 1 \\ RIRF > RIRF_0 \Rightarrow 0 \end{cases} \quad (22)$$

$$C_v \Rightarrow \begin{cases} C_v > C_{v\,max} \Rightarrow 2 \\ C_v \in [C_{v0}, C_{v\,max}] \Rightarrow 1 \\ C_v < C_{v0} \Rightarrow 0 \end{cases} \quad (23)$$

All these status dimensions may be associated as S_1, S_2, S_3. These statuses characterize each evolution stage of the system, from the initial $(S_1, S_2, S_3)_0$ feasibility study and going through statuses $(S_1, S_2, S_3)_k$, where (k = 1….n). Favorable statuses (without the digit 0 in their structure) are retained. Each status is affected by both inherent and transitioning probability between project statuses. If the transition probability matrix is stationary, stationary Markov models are used to solve it, otherwise depending on the given situation, discrete variable or continuous Markov models are used.

Once we know the transition matrix structure, we can determine the probability range $C_p(k) = p_1(k)$, $p_2(k)$, $p_3(k)$.

4 Conclusions

Renewable energy, regardless its form, is indispensable for society, both for human comfort and as a production factor. The greater the economic and social development degree is the greater will be the energy demand.

Covering the energy demand is an issue included in all governmental development strategies, but these strategies should take into account the energy resources (which are highly volatile in terms of reference price) as well as a multitude of risks associated with energy production and trading.

During the last decades, energy resources exhaustion and energy security are dominant topics all over the world. Competition for energy resources remains an important source for crises and conflicts, with a particular role to polarize and/or catalyze forces, as long as demand grows faster than supply, and major oil reserves are located in unstable political and economic areas.

US, EU, China and Russia are in competition and cooperation at the same time in the process of access, control and exploit these resources. Driving the attention towards these areas leads to disputes between energy consumer's competitors. Rather than energy independence, interdependence looks to be the most viable way to solve the constantly increasing energy consumption.

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