NEW SOLUTIONS FOR FINANCING THE INVESTMENTS IN ENERGY CRITICAL INFRASTRUCTURE

Prof. univ. Gabriela Prelipcean, PhD
Assoc. prof. Mircea Boscoianu, PhD
University „Stefan cel Mare" of Suceava

Abstract

In a report published in the EU Observer on 7th of February 2008, the World Energy Council (WEC) encourages the European officials and companies of the Energy Market to act together in order to ensure the necessary energy supplies and to reduce the present and future vulnerabilities. The document shows that the energy safety within the EU could be affected by the measures taken against the global warming, meaning that greenhouse gasses reduction could lead to lower investments and canceling the plans of building new energetic objectives. The WEC, a professional agency representing the energy companies from 96 countries, pleads with the EU for strategies against incoming energetic crises, such as suspending the oil and gas shipments, considerable rising prices, and other similar situations.

The energetic security, with its three basic elements, has been defined by the EU as follows: the security of the energy infrastructure, creating a free energy market and the guarantee of sustainable development. As for the New Energetic Strategy of Romania, this concept must be adjusted to the current problems of our country and redefined on ground of the recent events and dual crises (the energetic resource crises are dramatically combined with the new global financial crisis in 2008).

The impact of the climate changes is being analyzed, along with the economic impact and investment risks associated with the volatility and uncertainty of the fuel price evolution.

The analysis of investments brings out an approach on guaranteeing long-term private investments of public-interest, the way the energetic capacities and energetic transports are being financed, investments in CDI-Energy Programs, which can stimulate the transition process of this particular market.

The paper considers the analysis of the impact caused by the dual crises of the energy market and its specific investments. The existing crises of the energetic markets, which have already surpassed the shock-level of the prices due to energetic uncertainty, increase of import dependence caused by the international competition for energetic sources, are combined with a new global financial crisis, which caused the financial crisis in the US. Therefore, a new approach is absolutely necessary, in order to help understand the implications on the energetic security through energetic investments.

Key words: Financing investments, Competitiveness, Critical infrastructure, Dual crises

1. Introduction in energy sector financing

Financing the investments in energy critical infrastructure represents a very important task in the current situation of the recent turbulences in the financial global markets. The total investment requirements of the global energy over next 20 years are estimated to 14 trillion

Euros. The bulk of that investment is needed for electricity markets, although we could place the requirement for oil and gas projects as being of a similar magnitude. The required rate of investment flows is bigger than the capital available to achieve optimal strategic solutions. The energy market radically differs from other markets because of the highly complexity of the market rules, the production process and the delivery of the electricity, the different patterns of the restructuring of the electricity industry. The new energy market is not a perfect market. Not all of participants, both public and private companies and institutions respond in an efficient manner to market signals. There are high asymmetries in the access to capital and other market imperfections that prolonged the chronic underinvestment in energy sector.

The success of competitive Romanian energy market and the capability to assure energy security is linked to the internal market's ability to finance the investments necessary in the critical infrastructure.

2. Some aspects regarding the investments needed to overcome future risks to energy security

European Union (EU) is the second world primary energy consumer with 17.5% of global consumption. Poor in energy resources (5% in oil and 12% of gas production), EU is import depended for more than a half of its energy. The UE energy mix sources are presented in Table 1.

Table 1. European energy sources and import dependencies dynamics

Energy sources		Share (% of consumption)	Import dependency (%)	Projected energy mix (2020)	Evolution
1	Oil	37%	81% (Russia 32 + Middle East 30 + Africa 14)	35	-
2	Natural gas	24%	55% (Russia 40 + Algeria 30 + Norway 25)	28	+
3	Coal and lignite	18%	36%	13,8	-
4	Nuclear	15%	98% (Uranium)	12,5	-
5	RES	6% (biomass, hydro, wind)	-	10,5	+

Based on an average 2% GDP growth, but including a lower growth of the population, the energy consumption in EU will increase 13.5% until 2020. This increasing of energy demand accompanied by a severe diminishing of resources, will be covered by imports (oil and natural gas), raising import dependency to 65-70%.

The concept of *energy security* is changed in the context of energy crises and recent events in the financial global markets. There is a strong sentiment of insecurity due to tremendous increase of energy prices, the uncertain and controversial state of energy reserves, the disequilibrium between the increase of demand and the contraction of the supply related to a high volatility. EU's increasing energy dependence associated with a decrease of its indigenous energy production and a limited contribution from RES (renewable energy sources) and nuclear sources is critical.

EU energy security concept aims at "*ensuring the uninterrupted physical availability of energy products on the market at an affordable price for all consumers, whilst respecting environmental concerns and looking towards sustainable development*" (Towards a European strategy for the security of energy supply, COM 2000-769) and is defined by 3 main objectives: the security of supply, creation of a free market (in which producers acts on free competition and consumers could select the best services) and assuring the coherence of energy with the policy of sustainable development.

The EU Commission has argued that member states could substantially increase energy supply security and network, but also the cost efficiency by integrating national energy markets into the EU's unique market, but despite the reforms to liberalize markets, national markets remains largely under member state control.

There are two different strategies: (a) market integration and liberalization will increase energy security by forging network connectivity and interdependence and diversifying the complementary supply sources; (b) a continued national protection capable to guarantee stable and secure supply and distribution and protect consumers from high volatility and unpredictability of a free market.

The principles of a competitive EU-27 energy market:

- to implement the single energy market by promoting open market competition and efficiency (CRS Report RS22468);
- to lower prices and give all customers the opportunity to choose their energy supplier;
- to help improve the environment;
- to enhance energy security and to integrate all of these in the New National Strategy.

These investments in energy critical infrastructure are very expensive, and the characteristics of this sector require a governmental intervention on long term, that allows the functionality of the new liberalized market.

3. The financing principles of strategic investments in energy sector

The rate of capital mobilization is more important than capital availability and depends on market signals, particularly on the efficiency of longer term prices. Even if in general the market is sending the correct price signals, there can still be inequalities and imbalances in the access to capital. Industries can be constrained in the scope of their sources of capital. They can for instance find they have less than optimal access to international capital and be confined to domestic capital markets with insufficient liquidity. International and national sanctions can impinge on access to capital. Differential credit ratings due to past sector, national or regional performance can also impact to capital access. This leads to our second proposition;

The access to capital can be uneven in small or emerging markets, and this task is more complicated in periods of high turbulences, like the one in the aftermath of subprime crisis.

The sources of the uncertainties in the information flow influence the optimal investment in energy. The uncertainties in the amount of long term capital are due to supply side uncertainties and most particularly the rate of depreciation. Some of the investments being made today will need total replacement within 20-25 years, and all of the existing fixed capital will need significant replacement. The bulk of investment in energy over this period will replace existing supply side capacity, rather than to service incremental demand. It is important to note that the current problems in energy infrastructure are related to governments promoting and policy.

A new perception of governments and markets towards the imperatives of energy investment represents an important part of reversing the chronic process of underinvestment. The problem of underinvestment in energy is critical in the context of global contagious dual crises in the aftermath of *subprime* crisis and in the context of high volatility and uncertainty of primary non regenerable resources prices. Given the lags involved, an approach that is too complacent or dogmatic may have consequences that are difficult to reverse. In general, the policy of least regret is normally the optimal one in terms of energy investment and it's financing.

Current EU energy security policy is closely related to Common Foreign and Security Policy (CFSP) and contains a link between energy and climate change policy, external relations, indigenous energy supply and the internal energy market efforts. There are some disagreements

regarding the protection of national energy industries (Germany, France, and Spain) and a reluctance to open energy sectors to more competition.
EU is increasing its role in coordinating and financing the development of RES and the storage and use of emergent energy supply. EU also plays a larger role in determining power grid interconnection arrangements and energy infrastructure investment levels.

The EU-27 will need to invest approximately 1.1 trillion Euros in new technologies over the next 14 years in order to achieve their carbon emissions and accompanying renewable and energy efficiency targets (McKinsey and Company Report, 2007). This is a long term effort, made in difficult financial market conditions and the strategy to overcome the actual liquidity crisis represents a difficult milestone for the future.

4. Financial resources for priority investments in Romanian energy market

This analysis begins with main objectives proposed on the New National Energy Security Strategy:
a) environment protection: the costs internalization and including in the final energy prices, promoting clean energy
b) improvement of energetic efficiency: reducing energetic intensity until 2011 with 3% annually (saving potential 50%, in residential and 17%, in industry); the growth of investments related to energy efficiency, reducing the losses in centralized supply in urban areas, creating favorable conditions for attracting private funds (capital) in energy services.
c) in investments:
- necessary in mining: necessary investments - 200 mil Euro annually (20% to close the activity and to ecologize affected areas);
- Oil and gas: to expand the national transportation system, the distribution network for gas, and to improve the supply security;
- electrical and termic energy: necessary investments 1,3 billion annually- to close inefficient capacities, efficient utilization of hydroelectric potential, to finalize the privatization process in the case of distribution companies and to begin the privatization in the case of energy production companies, to promote the public-private partnership for funding investments, to continue a reorganization process in energy production industry.

The effective financial resources proposed are the following:

a) financial resources obtained from the restructuring and privatization of the companies in energy sector: realization of structures of independent producers, promoting an institutional framework to extend energy market regional operations, initial public offers and listing on stock exchange (after Transelectrica and Transgaz are expected Nuclearelectrica and Hidroelectrica), special investments for unities 3 and 4 Cernavoda in an independent producer structure, selling stocks to salariates (SNP), attracting private capital from micro hydro centrals selling, privatization of energy companies, stocks transfer to energy companies from Proprietatea Investment Fund.
b) financial resources obtained from structural funds accessing for competitive energy projects: a better energetic efficiency, new equipments (including rehabilitation and re-technology), optimizing electricity grids, optimizing interconnectivity between national electricity and gas pipeline grids (there is a chronic underinvestment and a lack of coordination which needs special efforts), promoting energy services, a better energy services market, the growth of RES and reducing the environmental impact.
c) financial resources for companies obtained from external financial institutions (World Bank, EBRD, European Investment Bank, JBIC)
d) financial resources obtained from creating new energy mixed companies
e) financial resources obtained from utilizing the Kyoto specific mechanisms
f) financial resources obtained from commercializing green certificates.

5. Strategies for selection alternative investment opportunities

The interest is to select alternative investment opportunities that result in high volatility and uncertainty, in an optimal manner. The investors' preferences in electricity markets and the optimality of a portfolio, is similar to finance modeling.
Friedman, Savage (1948) proposed *utility functions* and their connection with the implied risk preferences. Investors could be: *risk-averse, risk-neutral,* or *risk-seeking.* The risk preferences translate to the properties of utility functions: risk-averse investor's utility function is strictly concave, while the risk-neutral investor's is linear and the risk-seeking investor's strictly convex
Markowitz (1952) optimal portfolio selection method is focused on the choice between several risky assets and depends on the estimates for returns and covariance. Such selection results in an estimated variance minimizing portfolio that has an estimated expected return.
Tobin (1958) included the possibility of holding capital in a risk-free asset, introducing new investment risk-return considerations.
A utility function is usually assumed to be a twice continuously differentiable increasing function of wealth. Portfolio *wealth* is given by

$$W(\pi(t),S(t,\omega)) :=\pi^T(t)S(t,\omega),$$

where $\pi(t)$ gives the portfolio holdings and $S(t, \omega)$ gives the market prices for the assets.
After Markowitz and Tobin the literature has combined optimal portfolio selection and utility function theories. Hanoch, Levy (1969) generalized mean-variance setting to any utility function. Pratt (1964) and Arrow (1965) proposed utility functions in terms of how large a risk premium a risk-averse investor with some specific utility function would like to receive in comparison to a risk-neutral investor. Kallberg, Ziemba (1983) studied the properties of utility functions in optimal portfolio selection problems, concluding that the selection of a utility function to match certain risk preferences can be build on the basis of Arrow-Pratt risk characterization. Luenberger (1993) considered theoretical justifications for choosing a particular utility function that maximizes the expected growth, while Hakansson, Ziemba (1997) considered the importance of utility function choice for the long-term growth in wealth. Rabin (2000) and Rabin, Thaler (2003) criticized the utility theory and the assumption that rational investors are risk-averse and demonstrated that the estimation of a concave utility function based on a decision on a certain level of wealth implies irrational choices on other levels of wealth. Rabin, Thaler suggested an alternative functional form that would capture risk preferences in a more relevant manner.

New optimal portfolio selection literature is based on utility maximization over time. The static one-period optimal portfolio selection theory was elaborated to a dynamic multi-period setting by Samuelson (1969) in discrete time and by Merton (1969, 1971) in continuous time. Dynamic optimal portfolio selection framework allows portfolio adjustments. If the investment period is long, the possibility of adjusting the portfolio according to new information yields better optimization results. *Steinbach* (2003) presented some new refinements in the modern optimal portfolio selection theory.
The participants in uncertain markets often have an interest in *hedging* against risks. Leland (1998) argued that hedging enables greater leverage, meaning the company can better optimize its capital structure. The question of *hedging can be formulated as an optimal portfolio selection problem*.

The introduction of electricity spot and derivatives created new opportunities. High spot market price volatility exposes spot market participants to a high level of profit uncertainty. Hedging with spot electricity derivatives reduces profit uncertainty. The problem is to know how much to hedge and with what instruments. Kaye et al. (1990) and Amundsen and Singh (1992) considered the use of derivatives to hedge risks in spot electricity markets. Weron (2000) presented a detailed analysis based on the special characteristics of electricity markets. Bessembinder, Lemmon (2002) argued that companies operating in electricity markets could benefit from reducing their profit uncertainty more than companies in other sectors.

Bjorgan (2001) presented an application of the Markowitz model together with hedging decisions. Fleten (1999, 2004) and Mo (2003) analyzed a stochastic programming approach for solving the *optimal portfolio selection problem in electricity markets* (optimal generation decisions and hedging decisions are coordinated). Bjorkvoll (2001) optimized generation and the corresponding hedging portfolio but separated the generation and hedging decisions demonstrating that hedging decisions that take place with market prices do not affect the generation decisions.

In addition to the influence of risk on optimal portfolio selection, the quantification of risk is an interesting question in itself. Markowitz (1952) associated risk with the variation of portfolio return but increased competition and consequent tighter margins have increased the need to a stronger risk analysis. Baumol (1963) presented an alternative risk measure, the *value-at-risk (VaR)* measure. Jorion (1997) presented a thorough analysis on VaR defined for the wealth in a portfolio π at a given probability α and over a given time τ. But VaR does not indicate how low wealth can be if the probabilistic limit breaks. Artzner (2001) introduced risk measures that are more suitable for optimization problems and give more intuitive risk quantifications. Follmer and Schied (2002) gave a detailed analysis of the properties of risk measures. The choice of a risk measure is dependent on investors' preferences, as is the choice of a utility function.

Philipovich (1997) applied value-at-risk to electricity markets. In finance, value-at-risk measures the potential change in portfolio wealth in the short-term. Electricity portfolios that include physical assets are held over a longer time. Lemming (2004) presented a variation of value-at-risk called the *profit-at-risk* that gives more relevant risk quantifications in electricity markets. Profit-and-risk is identical in form to value-at-risk, but the time horizon is different. Value-at-risk focuses on the short-term changes in portfolio wealth, while profit-at-risk focuses on the wealth after longer time periods.

6. Conclusions

Technologies, companies and energy infrastructure require different type of financing depending on their particular stage of development, the financial environment and the governmental support. For success, the right financial strategies must be selected and instruments must be available along the entire finance continuum from technology/ venture/ project development.

The modeling of competitive electricity markets include: market price modeling, derivative instrument pricing, and optimal portfolio selection. Inspired from finance, it is possible to construct new models and explain electricity spot prices and forward price dynamics on the basis of market fundamentals. The inclusion of economic and market fundamental factors should help to increase the explanatory power. The variety of models in the literature calls for a comparative study to assess the performance of approaches in explaining observed price movements.

In incomplete electricity markets, it is difficult to apply arbitrage-free pricing rules that are the basis of derivative pricing in financial markets. Derivative prices based on some subjective price models have no theoretical relation to market prices and p. rice relations in electricity markets are difficult to build. A new idea is to apply other observed market prices to create arbitrage-free derivative price intervals in witch prices can be selected on the basis of investors' preferences, environment and market views. There are similarities between finance and electricity markets and some concepts are directly usable in electricity. Optimal portfolio selection and risk management represents an interesting application and possible following the approaches in financial markets. Due to the large electricity price uncertainty, risk measurement is very important. Dynamic optimal portfolio selection and development of risk measures in electricity markets could be interesting aspects.

To support the new market, the mechanism of financing of investments must be adapted to local conditions and fill an existing investment gap.

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