An Environmental and Financial Risk Assessment Protocol for the Investments in the Energy Sector

Antonio Nesticò, Gianluigi De Mare, Shuquan He, and Gabriella Maselli

Abstract The programmatic guidelines provided by the European Community encourage Member States to invest more and more in the energy infrastructure sector in order to promote sustainable development. These are projects characterized not only by high complexity profiles but also above all by multiple risk rates, including extra-financial ones. Thus, the aim of this paper is to characterize an innovative risk assessment protocol that overcomes the limits of the economic evaluation techniques generally used in practice. This can be done by characterizing a decisional protocol that allows providing objective criteria for the acceptability of the investment risk, considering also the social and environmental implications that the initiatives of the energy sector generate on the community. The innovative idea is based on the integration of the logic "As Low As Reasonably Practicable" (ALARP) in the procedural schemes of Cost–Benefit Analysis (CBA). In accordance with the ALARP principle, widely applied to problems concerning health and safety in high-risk sectors such as industrial engineering, a risk is tolerable when the costs to reduce it further are disproportionate to the benefits obtainable. The attempt to use the ALARP logic in the management of investment risk leads to defining a useful tool for informing on the financial, economic and social sustainability of the project initiative. This with consequent repercussions on the entire process of resource allocation is to be earmarked for the environmental sector and, specifically, for the energy.

Keywords Energy projects · Environmental and financial risk assessment · Cost–benefit analysis · ALARP logic

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1 Introduction

Recent political concerns regarding sustainable development have led to the definition of Community policy guidelines aimed at encouraging investments of the European Union (EU) states in the energy infrastructure sector. Specifically, the objectives of the EU energy policy aim at the realization of cross-border interconnections, the diversification of production sources and transmission routes, the promotion of energy efficiency and the need to accelerate the transition to low emission energy sources of carbon [1, p. 265]. There are two macro types of projects in the energy sector with which it is possible to face the challenge proposed by the programmatic documents: (a) construction, modernization and extension of energy production plants, i.e. storage, transmission, transport and distribution; (b) redevelopment of public and private buildings or industrial production systems to reduce energy consumption.

In order for the decision-maker to be oriented to select those energy projects that are financially and environmentally sustainable, the resource allocation process must be as coherent and transparent as possible [2–5]. To this end, the aim of this research is to characterize an innovative protocol for the assessment of the economic risk related to these investment initiatives. In an attempt to overcome certain limits relating to traditional economic feasibility studies, the protocol aims to achieve two objectives: take into account all the risk, including extra-financial rates, related to investment initiatives; provide logical and coherent criteria that allow to establish in an objective manner the acceptability of the economic risk for the investor or the community.

2 Traditional Approaches in the Economic Evaluation of the Projects: Limits and Critical Issues

The Cost–Benefit Analysis (CBA) is used to assess both the economic feasibility of a single intervention and the best of several possible alternatives [6, 7]. The estimate of economic profitability indicators—generally the Net Present Value (NPV) and the Internal Rate of Return (IRR)—is carried out starting from the analysis of the costs and benefits that the project is able to generate during the analysis period. The CBA requires to transform into cash terms the Cash Flows (CFs) produced by the investment, in order to make them comparable and to summarize the result in a single indicator. This represents the major limitation of the technique in cases where it is necessary to evaluate the environmental and social externalities of the project. In fact, such externalities constitute considerable contributions in the case of interventions in the energy sector and, therefore, it is impossible not to consider them. Yet it is difficult to explain them in quantitative terms.

Another critical issue concerns the uncertainty related to the sensitive variables of the investment. The impossibility of deterministically expressing the CFs leads the

analyst to estimate economic performance indicators in probabilistic terms. This can be done by implementing risk analysis, which allows you to assess the riskiness of the investment. Very briefly, the CFs generated by the project are treated as random variables; then, using the Monte Carlo method, the probability distribution of the profitability index is estimated; finally, from the results obtained it is possible to envisage interventions aimed at mitigating the failure risk of the investor [8]. In this case, however, there are no strict and objective criteria to establish whether the investment risk and the residual investment risk, that is the one that remains despite the proposed mitigation measures, are acceptable to the investor or the community.

3 Characterization of an Economic-Environmental Risk Assessment Protocol

With this research, we intend to characterize a protocol for the evaluation of economic and environmental risks related to initiatives concerning the energy sector. The attempt is to overcome the main limitations of the techniques of economic analysis, namely, (a) the difficulties of quantifying environmental and social externalities in monetary terms; (b) the impossibility to express an objective judgment on the acceptability of the risk and the residual risk, namely the risk that remains despite the mitigation option.

As regards point (a), it is necessary to implement approaches for the quantification of extra-monetary benefits, so as to include externality in the CFs such as increasing the efficiency of energy consumption by estimating the variation in the economic costs of energy sources; or the reduction of greenhouse gas emissions in the air by estimating the shadow price of the pollutant.

The major novelty of the work, however, is substantiated in the attempt to overcome the limit (b). The idea is to integrate the logic "As Low As Reasonably Practicable" (ALARP) into the procedural schemes of Cost–Benefit Analysis (CBA). According to the ALARP principle, widely applied in high-risk sectors of industrial engineering, a risk is tolerable when the costs to reduce it further are disproportionate to the benefits obtainable. In other words, it allows a triangular balance to be made among risks, mitigation costs and corresponding benefits that can be pursued [9–16]. Specifically, the possibility of characterizing the thresholds of acceptability and tolerability of economic risk by drawing on the ALARP logic can provide the decision-maker with a rigorous criterion for expressing an objective judgment on the acceptability of investment risk. In other terms, with this research we want to show how the integration of the ALARP principle with the traditional CBA can lead to a new economic approach, useful for verifying the investment risk based on objective and shared evaluation criteria. In practice, the model can become an assessment tool capable of guaranteeing a more correct and transparent resource allocation process for projects of the energy sector. Figure 1 details the operational logical steps of the protocol for the assessment of economic-environmental risk.

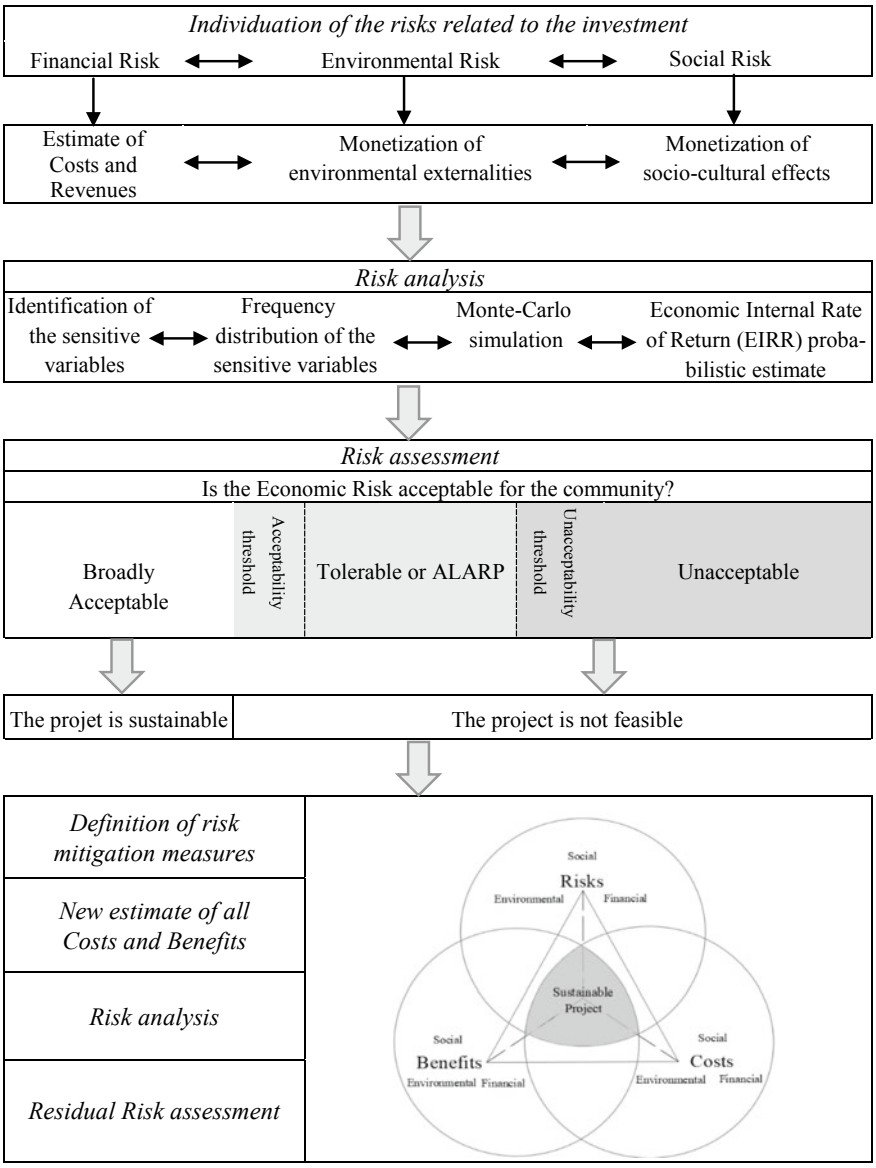

Fig. 1 Economic-environmental risk assessment protocol

4 Conclusions

Investments in the energy sector, to which the Community guidelines aim in order to promote sustainable development, are characterized by multiple risk components, including extra-financial ones, which significantly affect their concrete feasibility.

Thus, with this research we want to define a protocol for the acceptability of the economic risk, also taking into account the social and environmental implications of the investment [17]. The evaluation protocol outlined in Fig. 1 shows how these objectives can be achieved by integrating the ALARP logic in classic investment risk management procedures for civil projects. Specifically, the estimate of the probability distribution of the Economic Internal Rate of Return (EIRR) and then the comparison of the probability of failure with specific thresholds of acceptability and tolerability of the risk allow expressing an objective judgment on the feasible economic nature of the initiative. In this regard, the possibility to predict the thresholds of acceptability and tolerability of risk in probabilistic terms can represent the next step of this research. Finally, the study shows that such an approach can support public and private investors, who can more consciously decide on the execution of the initiative [10].

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