

How to deal with the complexity of assessing the local impacts of Renewable energy sources?

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Abstract: *In response to climate change, European Union directive set the goal of 20% share of renewable energy sources in the final energy consumption in 2020 to mitigate the CO₂ emissions. The Czech Republic has committed to the goal of 13%. Based on the Czech National Action Plan, Ministry of Industry and Trade expects to exceed this goal. There are a number of studies evaluating the impacts of constructing renewable energy sources (RES) at national level, which provide information about impacts on GDP or employment. These cover mostly the macro-economic level. Alternatively, the method of regulatory impact assessment (RIA) may be used. Another group of studies and analyses consists of environmental impact assessment (EIA), which is applied to evaluate the impact of construction of a specific resource.*

None of the above mentioned methods cover the complex assessment of the implementation of RES at the regional/local level. Given the wide variety of impacts (ranging from the impact on employment and municipal budget to the environmental impact), impact assessment on local level is a difficult task for decision-makers. To overcome these challenges, Regional impact assessment framework (RegioIAF) was developed. This method is based on a combination of RIA, EIA, LIA (local impact assessment) and multi-criteria analysis. The size of the positive/negative impact is determined for specified categories such as employment, regional GDP, revenues for municipality and environment. The main user of the RegioIAF will be the mayor who faces the decision, whether to build a renewable energy source or not.

Key words: Climate Change · Renewable Energy Sources · RegioIAF · Impact Assessment

JEL Classification: Q20 · Q50 · H72

1 Introduction

The EU goal of 20% share of renewable energy sources in the final energy consumption in 2020 increases the demand for these sources. As the Czech Republic has committed to contribute to the EU level with the 13% share of RES at the national level (Ministry of Industry and Trade, 2015), a lot of mayors face a decision whether to build a renewable energy source in the municipality and whether the municipality will benefit from it.

Currently, a few methods of impact assessment are used in the Czech Republic. Regulatory impact assessment (RIA) focuses on analyzing the social and economic impacts before a certain law comes into force. Environmental impact assessment (EIA) usually takes into account only positive or negative environmental effects when it comes to RES. Both of them evaluate the macro-economic level and do not focus on local/regional disparities. They do not cover all the locally relevant aspects. Local impact assessment (LIA) is not used in the Czech Republic, but it covers the local/regional situation.

Extensive literature research and the lack of available data show the impossibility of completely quantifying the overall impacts of construction and operation of the RES at the local/regional level. Literature research (e.g., Del Rio et al., 2008) also shows that mostly macro-economic level has been chosen to evaluate the operational impacts of renewables.

Decision makers and mayors must make a number of various decisions which means a lot of unnecessary bureaucracy. Concerning renewables, mayors face the decision whether to support building of a new source or not, whether this kind of RES is suitable for the municipality and which impacts (positive or negative) are linked with the operational processes. The demand for a complex impact assessment tool/framework arises among the mayors.

The aim of the paper is to answer a research question “How to comprehensively assess the impact of RES construction (from economic, social and environmental point of view)?” As the currently used evaluation methods do not cover

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all the important aspects for mayor's decision, the paper introduces a new framework (RegioIAF) for the assessment (Del Rio et al., 2008).

The following chapter deals with the current methods, which are often used to assess the impact. Moreover, it briefly introduces the most important groups of impacts. The third chapter presents the logic of the RegioIAF and impact categories. The further use of the method is described in the conclusion.

2 Methods

Many different impact assessment methods are used in practice (EIA, SEA, RIA, LIA, TIA, LCA etc.). Their purpose is to reveal the impacts and to help with decision-making. In many cases, their results are the basis for bargaining, choosing the right option or for regulatory settings.

Each method focuses on certain impacts. Building of RES generates a wide spectrum of impacts, which includes not only environmental, but also economic and social impacts. This range of impacts is closest to the EIA. However, EIA is based on a more detailed analysis of the planned construction, which is too demanding (time and cost) for the initial assessment of the RES construction project. In order to simplify the impact assessment, we developed a new framework, which is based on a combination of the current methods. Instead of a common cost-benefit analysis (CBA), the tool is based mostly on a qualitative assessment and multi-criterial analysis. The goal is to assess the complex impacts in a simple way.

Our new framework combines impacts of three methods into one:

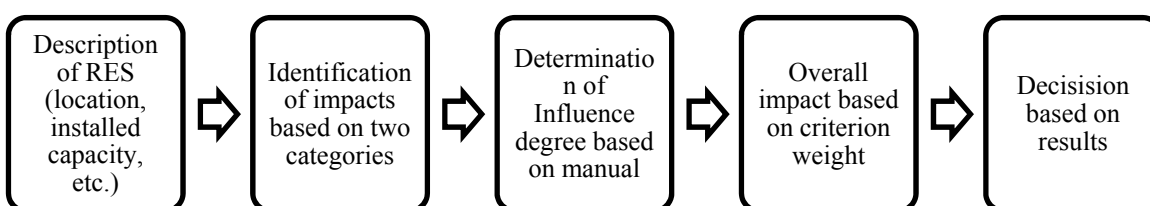
1. Social and economic impacts from regulatory impact assessment (RIA) (regional GDP, employment etc.) (e.g., Caroll, 2010)
2. Environmental impacts from environmental impact assessment (EIA) (Land use, agriculture, air or water quality etc.) (e.g., Tsoutsos et al., 2005)
3. Local principle from local impact assessment (LIA), which is used for social, economic and environmental evaluation of the municipality.

This framework is called RegioIAF and combines economic, environmental and social impacts at the local or regional level. The tool introduces an overall guideline for the mayors and focuses on more than macro-economic level. The impacts are based on the extensive literature research, which provides a comprehensive view of the importance of each impact. These are divided into two categories. There are primary impacts, which include regional GDP, costs and revenues for the municipality associated with the RES, employment (e.g., Dvořák et al., 2017), impacts on agriculture (land use), forestry and water management and environmental impacts. The environmental impacts (e.g., Lohse, In Press) are evaluated separately, because there are a few topics, which can be influenced by the RES in a positive or negative way. These include CO₂ emissions, biodiversity, erosion, water quality and consumption, air quality, noise and impacts on health. The secondary impacts are separated because of an existing probability of being calculated twice. Those are impacts, which may or may not occur and their estimation is based on the soft data. Situation in individual municipalities may differ significantly. Secondary impacts are e. g., energy prices, energy savings from waste heat utilization (e.g., García et al., 2017), business environment, infrastructure and technical level, education and human capital, municipality development (e.g., Kazak et al., 2017).

3 Research results

Based on RIA, EIA and LIA, the assessment process is divided into several steps (Fig. 1). First of all, it is necessary to define the RES project. Within this starting point, the location of RES, its capacity etc. are described. The next step consists of identification of impacts using the list of primary and secondary impacts and the description of each impact, including its size. Using the criterion weight, the overall impact is set. It is also appropriate to take partial values into account.

Figure 1 RegioIAF step by step



Source: own processing

This chapter consists of two tables, which together with the table of secondary impacts form the multi-criteria analysis of the regional impact assessment framework, which serves as a guideline for mayors of municipalities. The impacts are divided into two categories: primary impacts, which are the most important ones for the impact assessment and a high relevance of these impacts for the mayors can be expected and secondary impacts. The environmental impacts (as a part of the primary impacts) can be divided into several categories and each RES may influence just some of them. Therefore, a separate table for this type of impacts was designed.

3.1 Primary Impacts

The table 1 shows the multi-criteria analysis of primary impacts described in the previous chapter. The influence degree will be evaluated by the mayor himself and it will be based on the description of each impact and mayor's awareness of the local/regional situation. The possible degrees are "positive", "negative" and "no impact" and the mayor will decide about the degree of significance.

Table 1 RegioIAF for primary impacts of RES

Regional Impact Type	Influence degree							Criterion weight	Overall impact
	NEGATIVE (-)			No	POSITIVE (+)				
	significant	middle	low		low	middle	significant		
	-3	-2	-1	0	+1	+2	+3		
Long-term employment									
Short-term employment									
Regional GDP									
Revenues for the municipality									
Costs for the municipality									
Agriculture/Forestry/Water									
Environment (summary)									
Overall impact								100 %	

Source: own processing

3.2 Environmental impacts

The next table (Table 2) describes the environmental impacts based on the literature research. Those are the most important impacts of different types of RES. Different kinds of the RES come with different impacts, e.g., photovoltaic energy will not affect water quality, but may influence biodiversity and land use. 1 MW of photovoltaic energy requires 7 acres of land, but no CO₂ emissions are associated with the energy generation (Workman et al., 2016). Overall, it is assumed that renewables bring more positive than negative impacts compared to fossil fuels. Positive externalities are expected in these cases, but for example small hydropower plants may affect the water quality in a negative way as well as threaten the biodiversity in a river (Vezmar et al., 2014).

Table 2 RegioIAF for environmental impacts of RES

Regional Impact Type	Influence degree							Criterion weight	Overall impact
	NEGATIVE (-)			No	POSITIVE (+)				
	significant	middle	low		low	middle	significant		
	-3	-2	-1	0	+1	+2	+3		
Erosion									
Biodiversity									
Water quality and consumption									
Air quality									
CO ₂ emission									
Noise									
Health									
Overall impact								100 %	

Source: Own processing

3.3 Secondary impacts of RES

Included secondary impacts are: (i) Energy prices and potential of waste heat utilization; (ii) Business environment; (iii) Infrastructure level; (iv) Municipality development; (v) Education and Human capital. It is not mandatory to take them into account. These data should be included very carefully, because there is a probability of counting some impacts multiple times as was described above. More secondary impacts could arise, these are the most important ones.

4 Conclusions

The paper focuses on the methods of assessing the impacts of RES construction and operation. With the EU directive requirements comes an increasing demand for the RES development. Mayors of the municipalities face the decision whether to support it or not. There are regulatory impact assessment and environmental impact assessment currently used in the Czech Republic. RIA is mostly based on the macro-economic level. EIA is not appropriate for the initial decision making due to high costs and time intensity. RegioIAF (as the output of the paper and the overall guideline for mayors) is based on social and economic impacts from RIA, environmental impact from EIA and the local/regional point of view from LIA. Regional Impact Assessment Framework together with multi-criteria analysis tables of primary, environmental and secondary impacts provides a tool for a complex evaluation as an argument for the municipality mayor.

The method is also applicable from the perspective of investors to promote the project and gain the support from the decision makers. The method can also be generalized and used to evaluate any other project.

However, the ambition of this approach is not to replace the EIA process, but only to develop a framework of assessing the impacts in the initial phase. It aims to help the decision makers to conclude, whether it is in the municipality's interest to start a construction. The EIA's task is to assess the environmental impacts in more detail and, if necessary, identify more favorable solutions.

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