Guidelines for employment impact assessment of renewable energy deployment – general aspects and net employment studies

Contribution to the special session: "Renewable energy policies – modelling challenges and economic results"

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Abstract:
The use of renewable energy (RE) sources plays a significant role in increasing the security of energy supply and mitigating climate change. Whereas this role is undisputed, there is an ongoing discussion about the employment impacts of promoting RE deployment. So far no common methodological approach has been developed on how to assess employment impacts of RE deployment. This paper represents the result of a project (IEA-RETD) that intends to develop guidelines for the assessment of employment impacts and contribute to insights in impact mechanisms for modelling RE deployment effects. Therefore, the different focus of gross and net impact studies is elucidated and relevant aspects of gross and net impact assessment studies are discussed. Further, a few selected methodological approaches for impact assessment studies and their implication on the impacts are outlined. The focus of this presentation will be on net impact assessment studies.

Keywords: *renewable energy, net employment impacts*

1. Introduction

This paper summarises the outcomes and findings of a study commissioned by the IEA-RETD. The study was conducted by a consortium of Fraunhofer ISI (Germany), Rütter+Partner (Switzerland) and the Energy Economics Group (Vienna University of Technology, Austria). It was the first that strives to provide an overview of various employment impact assessment studies of RE deployment, to classify the main assessment approaches and elaborate a guideline how to assess the different employment impacts of RE deployment. For further details on the overview, approaches and suggestions for impact assessments we refer to [1] and [2].

1.1. Background

The use of renewable energy (RE) sources for electricity generation or heat plays a significant role for the security of energy supply and the mitigation of climate change. While this role is undisputed, there is an ongoing discussion about the economic and employment impacts of promoting renewable energy deployment. Whether RE promotion will result in benefits or cause high economic costs is still disputed. The macro-economic effects are mostly expressed in form of employment or economic growth. As stated in the Renewable Energy roadmap [3], studies vary in their methods and, hence, in their estimates about the employment or GDP impact. Although several studies have aimed at clarifying this issue during the past years, no consensus has emerged on the impact and assessment

approach of RE deployment on employment. Since there is a strong interest to expand the use of renewable energy, it is somehow of public interest monitoring its impact on employment and welfare. This is the reason, why the IEA-RETD has agreed to commission a project that gives an overview of impact assessment studies, provides guidelines for an impact assessment of RE deployment in the power sector, and proves the feasibility of the guidelines for gross impact studies, by applying them to selected countries.

1.2. Objectives

In line with the specific objective of the commissioned IEA-RETD project this paper represents the different effects that could be included in an employment assessment study, shows which specific questions would be answered with the selected type of assessment study and which methodological approaches should be applied. In brief, we intend to answer: What is the research focus or goal of the respective type of assessment study? Which impulses, impact mechanisms are included? Which methodological approach is chosen? Hence, this is a methodological paper that refers to the impact assessment of RE use in electricity generation.

2. Approach and definitions

To classify impact assessment studies and to understand what kind of effects are included, we choose an analytical approach that is depicted in Figure 1. It shows which steps or elements are the most crucial when analysing an impact assessment and it clearly shows how the elements depend on each other. We call this a functional chain (Figure 1).

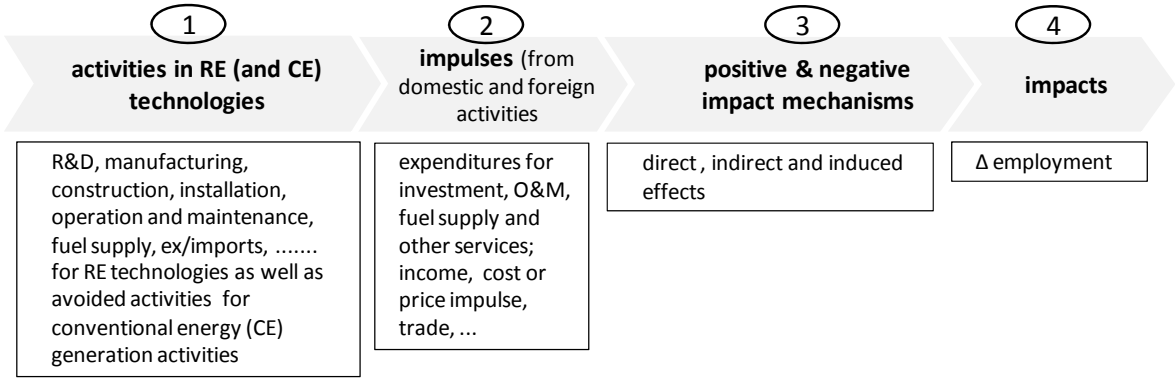

Figure 1: functional chain

Source: own depiction; Note: RE: Renewable energy;

The four elements of the functional chain are:

1. The **activities** in RE technologies include all economic activities in RE technologies and conventional energy (CE) generation technologies like research and development of technologies (R&D), manufacturing of equipment, installation, construction (MIC) and all kind of related services such as operation and maintenance (O&M), etc.
2. The activities generate economic **impulses** in form of expenditures for investments, fuel supply and services for e.g. operation and maintenance. Further impulses come from trade, e.g. export of equipment due to foreign RE activities stimulates temporary activities in the manufacturing sector while imports of equipment lead to permanent activities in the field of operation and maintenance. Moreover, income of people working in the RE industry and upstream sectors is considered as an impulse that

stimulates demand for consumption goods while the impulse 'changes in energy prices' affects demand of households and all industries.

3. All impulses are translated into economic impacts by **impact mechanisms** that have positive and negative economic effects. They are depicted in Figure 2. The impact mechanisms that is depicted in Figure 2 represents economic cause-effect-relationship. We distinguish between primary and secondary effects:
   a. The primary effects are defined as the immediate results of the activities (MIC, O&M, ...) in the RE industry and its related sectors. They represent the effects of the demand for technologies in the industry. So, RE deployment affects demand for RE equipment, construction and services while it might reduce demand for products of the CE sectors. Primary effects can be distinguished into
      i. direct effects that relate to the RE industry and in
      ii. indirect effects that relate to the upstream sectors of the RE industry.
   b. The secondary effects reach beyond the RE industry and are the economic outcome of the primary effects and the RE power generation. They are induced via prices and income and affect in the first instance demand for consumption (households) or intermediary goods (industry). They can be distinguished into
      i. induced effects of type 1, which refers to the impact of income generation in the RE industry due to higher demand in the RE industry on consumption goods and hence on the consumption goods industry and, in turn, via an increasing demand of the consumption goods industry for intermediary products on all industries; and
      ii. induced effects of type 2, which refers to the impact of electricity prices on the relative income and, hence, on demand of households as well as on the cost structures and, hence, on demand for intermediary products of industries.

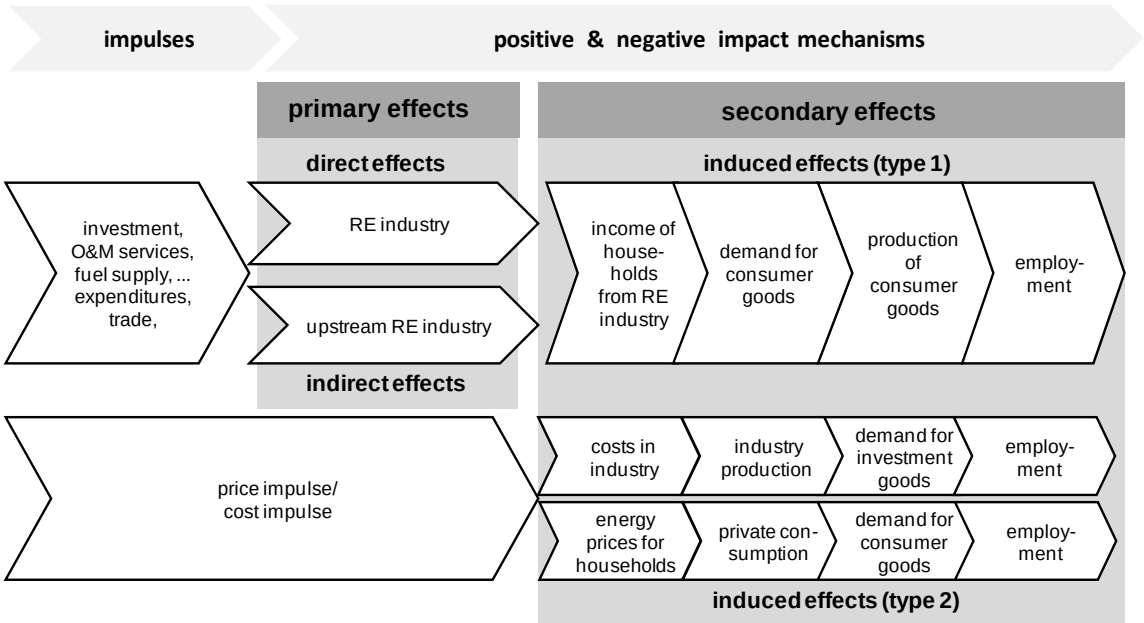

Figure 1: direct, indirect and induced effects

Source: own depiction, based on Haas (200x); Note: RE: Renewable energy;

The differentiation between primary and secondary effects is crucial, since they show the impacts at different economic levels: at the RE industry level or the at the level of the whole economy – economy wide. For example, higher prices for electricity reduce the available relative income of private households. Under the assumption that demand for energy is relatively inelastic, the households' demand for other consumption goods shrinks. A shrinking demand for consumption goods leads to lower production and, hence, to lower input and, subsequently, to lower employment in the consumption goods industry. Taking into account the multiplier effect, namely that lower employment results in lower income of households and, hence, again in lower consumption, we have an enforcing negative effect in the whole economy.

4. Finally, the functional chain leads to an **impact** on employment that is either measured in number of jobs or in changes in employment. When looking at the primary effects only, the impact is restricted to the RE sector (RE industry and its upstream industries) and is normally expressed in number of jobs. Economy wide impacts require the inclusion of secondary effects as well, which might be positive or negative and, therefore, depict changes in employment.

3. Some key results

Overall, so far there has been no clear guideline or description how to calculate which kind of impact. Therefore, the relevant features of assessment studies need to be illuminated. In line with the objectives of the study, at first, the focus of an impact assessment study must be clarified: What impact at which economic level analyses the impact assessment study?
The distinction of impact levels leads to the key result of the IEA-RETD study: a distinction between two main types of impact assessment studies has to be made, namely between a:

- RE sector study, which is also called a gross employment study, and
- "real" impact assessment study which depicts the economy wide impact; it is called net employment study (net impact study).

So far, neither for a gross employment nor for a net employment study exist any kind of general definition. Subsequently, some criteria, how to classify these types of studies are needed. To investigate this, we use the functional chain (Figure 1) and differentiate between different economic impulses and impact mechanisms that result in an impact expressed in number of jobs or changes in employment.
In the following, the main elements or characteristics of the two types of study are elaborated on the basis of the distinct features depicted in Figure 3. It shows the contingency between the features of a study and the recommended approaches to assess impacts of RE deployment. The studies are analysed regarding the following criteria:

- main focus or question
- impulses
- impact mechanisms or effects
- resulting impacts and
- suggested modelling approaches.

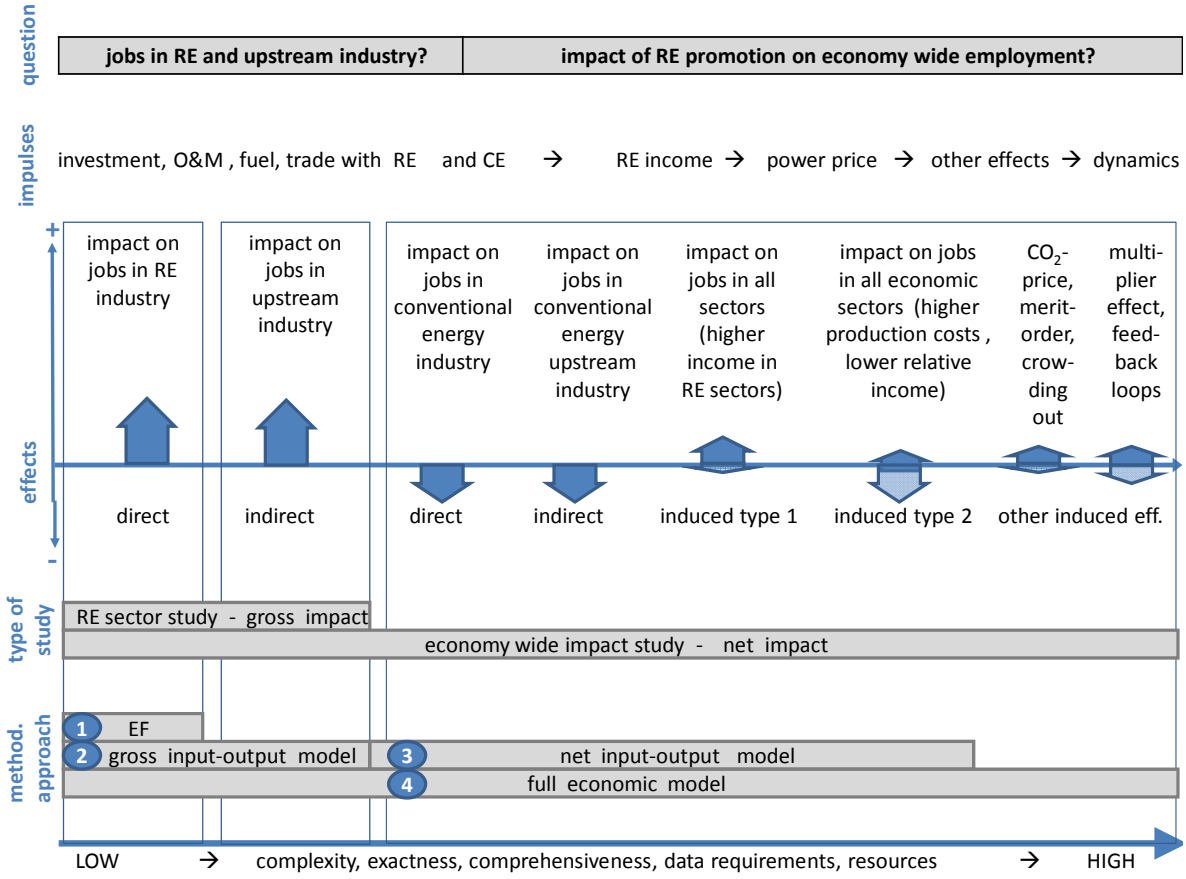

Figure 3: Overview on types of studies and their impulses and effects

Source: own depiction, Note: RE: Renewable energy; CE: Conventional energy

3.1. First type of study: Effects in the RE sector – gross employment

This type of study focuses on the effects of RE deployment in the RE sector that includes all industries and services that are somehow related to the activities manufacturing, construction, installation, operation and maintenance as well as to fuel supply for RE. Subsequently this study includes direct positive effects that result from the respective expenditure impulses of the respective activities. It is called a gross employment study and neglects any potential negative effects like avoided investment in conventional power generation. It could be assessed based on employment factors (employment per capacity or generation) if these factors are available.

To depict also the effects on the upstream industries, indirect effects have to be included. Therefore, the impact scope is extended to the upstream industry. This extension is also called a gross impact study. It can be assessed with an input-output approach (or if available with indirect employment factors) and provides a somehow broader picture of the impact in the RE sector.

The final outcome of both gross impact studies is the number of jobs in the RE industry and its upstream sectors if indirect effects are included.

Developing two different RE deployment scenarios and assessing the impacts of both potential economic developments allows to depict the differences between the outcome of the two scenarios (number of jobs in the RE sector and its related sectors) but it does not indicate how the economy wide employment is affected. The main features of the gross employment assessment are depicted in Table 1.

research focus	**RE industry**	**upstream sectors of RE industry**
impulses	**expenditures for investment, operation and maintenance, fuel supply, trade**	
Impact mechanisms	**direct effects: on demand in RE industry**	**indirect effects: on demand in RE upstream sectors**
impacts	**number of jobs in RE industry and upstream sectors= gross employment (employment in the RE sector)**	
approach	**employment factor, input-output model**	

Table 1: Overview on features of gross employment studies
Source: own depiction, Note: RE: Renewable energy;

3.2. Second type of study: economy wide impacts - net employment effects

The main focus of a net impact study is on the whole economy. The study intends to answer how economy wide employment is affected by the RE deployment. Therefore, the effects go beyond the RE-industries and include impacts on all industries. Thus, this extended focus requires the inclusion of more impulses and effects than in an RE sector study.

research focus	**economy wide**
impulses	**expenditures for investment, operation and maintenance, fuel supply, trade, R&D, administration for RE; avoided expenditures for investment, operation and maintenance, R&D, fuel supply for CE; income and price impulse;**
Impact mechanisms	**direct effects: demand in RE industry; indirect effects: demand in RE upstream sectors; induced effects (type 1 and 2): demand in all other industries;**
impacts	**change in employment = net employment; based on a comparison between the outcomes of two scenarios, a no- or low-RE deployment scenario and an advanced RE deployment scenario; present and future impacts;**
approach	**extended input-output model (closed model); macro-economic model with trade and energy sector module;**

Table 2: Overview on features of net employment studies
Source: own depiction, Note: RE: Renewable energy; CE: Conventional energy

Subsequently, besides the expenditure impulse from investment, operation and maintenance, administration and R&D, the price and income impulses are included such that other sectors e.g. consumption sector or other sectors of intermediary products are affected. Further, avoided investments in conventional energy generations and hence avoided expenditures and trade should be taken into account. Subsequently, positive as well as negative direct, indirect and induced effects of RE deployment enter the assessment

approach. In addition, effects like crowding out of other investment activities could be included, too, but are not listed here.
The incorporation of negative direct and indirect effects is often done via two scenarios, a strong RE deployment scenario and a zero or low RE deployment scenario. The difference between the outcomes – number of jobs in the whole economy – of each scenario reflects the impact of RE deployment on employment. This impact is called a net impact since it takes into account all main positive and negative effects and is normally expressed as change in employment (% or change in number of jobs).
To assess the economy wide impact, one can use an extended input-output model that consists of a (partially) closed quantity model to depict the induced effects of type 1 and a (partially) closed price model to depict the induced effect of type 2. However, the input-output coefficients rely on constant returns on scale, express a fixed relation and allow no interaction between prices and quantities. But the model depicts changes at a rather detailed sectoral level. To comprise all economic impact mechanisms a rather sophisticated macro-economic model that includes an energy sector as well as a trade module is necessary.

So far, quite a few impact assessment studies have comprehensively analysed the impact of RE deployment on the whole economy. Among these are the most recent studies: EmployRES [4], BMU job study [5] and DIW study [6]. They are all based on a macro-economic model that incorporates not only an energy sector module but also trade relations. All main effects (direct, indirect and induced) are included in diverging depth. While the EmployRES study assessed the employment impacts for the EU, the BMU job and DIW study focused on Germany. The latter two used input data (costs or investments) from the RE deployment scenarios of the German Ministry for Environment while the first study assessed the impulses from an energy sector model GreenX that reflects in its results policy measures and targets. Moreover, EmployRES assessed the macro-economic net effects with two independent models which are based on two different modelling approaches, an econometric and systems dynamic approach. Whereas the BMU job study used detailed information on turnover, cost structures, import and export shares of the RES industry with the help of an industry survey in Germany, the EmployRES study depended on information available in literature, expert knowledge and diverse statistics. Overall, it can be said, that the net employment of each study depends to a large extend on the scenario assumptions. High net employment effects can be produced when a zero RE deployment scenario is applied as baseline scenario, the assumed prospective export shares are high and the additional generation costs (price effect) decreases over time due to increasing fossil fuel prices and decreasing RE technology costs. Therefore, it is important to take into account all relevant impulses and effects but also important are the assumptions that form the RE deployment scenario and hence the impulses (price impulse, trade impulse, actual and avoided investments).

4. Conclusion

The analysis of impact assessment studies has produces some interesting results.
First, there exists a broad variety of employment impact studies whose results are not comparable since they investigate different type of questions that rely on a contingent set of activities and technologies, impulses, impact mechanisms and methodological approach to assess the impacts. Subsequently, before choosing any of the parameters or methodological approaches, it should be clarified, which policy or research question – economy wide or RE sector – is in the focus of the analysis. Then, based on data and model availability, the parameters and approach can be specified.

Second, so far net – or gross - impact studies have not been clearly defined. Therefore, we suggest to define net impact studies as all assessment studies that include impacts beyond the RE industry, namely impacts via income and power prices on demand for consumption and intermediary goods as well as impacts on the CE industry. The first two effects are often triggered by prices (additional generation costs for RE power) and income from the RE industry while the negative effect on the CE industry is often depicted in the scenario comparison.

Third, although the comprehensive incorporation of key impulses and effects is crucial to be classified as net impact study, the net employment impact of the study depends to a large extend on the impulses that are developed within the scenarios.

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