Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

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Executive Summary

Raw material requirements in the field of renewable energies

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Objective and task

The aim of this report is to present the current and future effects of renewable energies on raw material requirements in Germany. In addition, the economic importance of the renewable energy sector and its effects on the labour market are examined. The focus thereby lies on the renewable generation capacities that are essential for the energy system transformation (in particular wind power plants, photovoltaics (PV) and bioenergy plants). However, the overall effects of a comprehensive energy system transformation, including the necessary grid expansion, mobility transformation and sector coupling, cannot be considered within the framework of this project. The same applies to a currently not finally defined hydrogen strategy of the federal government. The editorial deadline for the report was the 23rd of August 2019. In this respect, the results of the ongoing discussions on the federal government's climate package could not be integrated into the report.

Executive Summary

Germany has been a member of the international “Extractive Industries Transparency Initiative” (EITI) since 2016 and has met the international EITI standard since May 2019 with the first German D-EITI report. This first D-EITI report is distinguished by the fact that, in addition to mandatory topics, the context section also included special topics that are of relevance for the raw materials market or sector in Germany. One of these topics was the importance of renewable energies. The so-called Multi-stakeholder Group (MSG), which steers the EITI process, has set itself the goal of examining the effects of renewable energies on future raw material requirements and the associated socio-economic implications in more detail for the second D-EITI report, drawing on external expertise.

This report first classifies renewable energies as part of Germany's overall energy supply and then presents the raw material requirements for renewable energy plants (RES-plants) (Chapter 1). The second chapter deals with the socio-economic significance of renewable energies. This includes a brief description of the Renewable Energy Act (EEG) as an important funding instrument for renewable energies, but also employment and value-added effects as well as challenges and obstacles to the expansion of renewable energies. At the request of the MSG, the socio-economic effects will be presented using three model regions in Germany, where wind power, bioenergy and photovoltaics (PV) play a particularly important role respectively.

The role of renewable energies in Germany's energy supply and presentation of raw material requirements for renewable energy plants

With the aim of reducing emissions of human-induced greenhouse gases, the energy system is undergoing a far-reaching transformation away from the provision of electricity, heat and fuel from fossil resources towards renewable energy sources. This transformation does not consist solely in replacing energy sources with electricity and heat. Energy conversion (e.g. the way electricity is generated), energy distribution (e.g. the expansion and conversion of networks) and the use of energy (e.g. for electric mobility in transport) are also changing. This has a significant economic impact on the energy sector.

Renewable energies already account for a large and growing share of the energy supply in Germany. In 2018, renewable energies accounted for 14% of total primary energy consumption. At 37.8%, the share of renewable energies in gross electricity generation in Germany is significantly higher. Investments in plants for the provision of renewable energies amounted to 13.5 billion euros in 2018 and have thus remained roughly constant since 2013. In addition to the direct investments, the operation of the plants, and thus the demand for personnel, electricity, spare parts or fuels, generated economic impulses of 16.8 billion euros in other sectors in 2018.

The conversion of the energy supply to renewable energy sources creates an additional demand for raw materials, while the demand for fossil raw materials is declining. The analysis of the raw material requirements carried out in the report relates both to energy conversion plants (wind power and photovoltaics) and to significant technological changes in the use of energy sources (stationary storage facilities and batteries for electric mobility). The study examined construction raw materials, base metals and technology metals. The estimation of the raw material requirements is carried out until 2030. The estimations are based on a future development of the energy

system in Germany according to scenario B of the German grid development plan 2019 of the German transmission grid operators. This scenario shows a possible development path of the energy system taking into account the political objectives, i.e. in particular to achieve a share of renewable energies in gross electricity consumption of 65%.

In the case of construction raw materials, raw materials for concrete production play a significant role. In 2018, the demand for concrete used for newly installed wind turbines amounted to 1.8 million tonnes. The average annual demand is expected to remain constant at around this level in the future. However, the demand for construction raw materials caused by the energy transition is rather low compared to the demand in residential and road construction (Germany had a demand for ready-mix concrete of around 115 million tonnes in 2018).

Important base metals for the energy transition are steel and aluminium as well as copper and nickel. Steel is used in many plants as a building material. The demand for steel caused by the energy transition is of secondary importance compared to the overall demand for steel in Germany. Aluminium is widely used in wind turbines and car components. The expansion of electromobility is expected to result in an additional annual demand for aluminium of around 162,000 tonnes in 2030. In addition to wind power and PV systems, copper is also used in electric mobility. Copper is likely to experience significant demand impulses as a result of the energy transition. While the copper demand for wind power and PV plants was 11,200 tonnes in 2013, the annual copper demand will increase by an additional 73,500 tonnes for batteries, electric motors and power electronics by 2030. The demand for nickel for electromobility is estimated to be around 1,050 tonnes in 2016. A ramp-up to around 1 million newly registered electric vehicles in 2030 would result in a nickel requirement of around 56,000 tonnes.

In connection with the energy transition, the technology metals gallium, indium, selenium and silicon are of relevance due to their use in PV modules. The same applies to cobalt and lithium due to their use in lithium-ion batteries and to neodymium and dysprosium due to their use in wind turbines and electric motors. The future annual demand for technology metals for the production of PV modules will remain more or less constant. The annual demand for cobalt and lithium is rising significantly due to increasing battery sales. The same applies to the demand for the rare earth metals neodymium and dysprosium. This is in particular due to the increase in electromobility and to a lesser share due to the construction of wind turbines. Table 1 provides an overview of the future demand for technology metals for key technologies of the energy turnaround.

The primary extraction of some of the raw materials required, e.g. cobalt, can be associated with high human rights, social and ecological risks, especially in countries with weak governance structures. In artisanal mining, child labour and a lack of social and safety standards can go hand in hand, which can also lead to health problems for the local population. Environmental pollution from the extraction of primary raw materials is also caused, for example, by deforestation (e.g. bauxite extraction), water evaporation (e.g. lithium extraction from salt lakes) and dam fractures (risk at mining sites).

Table 1: Demand for technology metals for key technologies of the energy transition according to scenario B 2030

Technology metals	Technologies considered	Cumulated demand, 2018 – 2030, in tonnes	Calculated average, in tonnes per year
Gallium (Ga)	Thin-film PV	12	0.92
Indium (In)	Thin-film-PV, thick-film-PV	165	13
Cobalt (Co)	Lithium-ion-batteries (e-mob. und stationary storage)	74,000	5,700
Lithium (Li)	Lithium-ion-batteries (e-mob. und stationary storage)	50,000	3,800
Neodymium (Nd)	Permanent magnet generators for wind turbines, electric engines for HEV, PHEV, BEV, Pedelecs	3,750	290
Dysprosium (Dy)	Permanent magnet generators for wind turbines, electric engines for HEV, PHEV, BEV, Pedelecs	660	50
Selenium (Se)	Thin-film PV	64	5
Silicon (Si)	Thick-film-PV (thin-film-PV)	132,000	10,150

Source: own calculations based on (OEKO 2019) and (OEKO/IZT 2019)

Socio-economic significance of renewable energies

In 1990, the Electricity Feed-in Act (Stromeinspeisungsgesetz) introduced a subsidy mechanism to initiate the transformation of the energy system. For the first time, energy supply companies in Germany were obliged to purchase electrical energy from renewable generation processes (wind- and hydropower as well as solar energy and biomass). Today, the use of renewable energies in Germany is largely promoted financially by the Renewable Energy Act (EEG). The EEG introduced a levy on electricity consumption (with the exception of energy-intensive commercial consumers) in addition to the electricity price. The levy is used to finance the feed-in tariffs for renewable power generation. The EEG levy for 2019 is 6.4 ct/kWh. The expected levy for 2019 amounts to EUR 23 billion.

Employment in the lead market "environmentally friendly energy generation, transport and storage" amounted to 284,000 full person equivalents in 2018. The number of direct and induced jobs is subject to fluctuations and stood at 338,500 in 2016. Fluctuations in employment can be attributed among other things to fluctuations in the production of renewable energy plants and fluctuations in the number of plants installed in Germany.

A declared goal of the federal government is to increase the share of gross electricity consumption from renewable energy sources to 65%. Currently, the share of renewable energies in gross electricity consumption is approx. 38%. In order to achieve the targeted share, the installed capacity must be increased accordingly from 2018 to 2030. These expansion targets face numer-

ous challenges in the development of renewable resources. Challenges exist with regard to the designation of suitable areas and securing social acceptance.

The report then illustrates the socio-economic significance of renewable energies based on a regional analysis. The following three German regions will be presented:

- A north German wind region (consisting of the federal states Schleswig-Holstein, Mecklenburg-Western Pomerania and Lower Saxony) with a focus on wind energy,
- a central German bioenergy region (Hesse, Saxony-Anhalt and Thuringia) with bioenergy use as well as
- a south-east German solar region (Baden-Württemberg, Bavaria and Brandenburg) where solar energy plays a major role.

In 2017, 8,100 companies and 50,000 employees were active in the field of renewable energies in the north German wind region. The gross value added in 2018 was about EUR 5 billion. In the wind energy sector, around 4,000 companies and around 17,900 people were employed in 2018, which is roughly double the figure for 2010. Despite the strong growth to date, fluctuations are to be expected regarding future developments. For example, if the expansion of wind power plants stagnates, employment is expected to fall.

In 2017, 5,900 companies and around 37,000 employees were active in the renewable energy sector in the central German bioenergy region. Gross value added in 2018 was around EUR 4.5 billion. In the field of bioenergy, around 2,000 companies with around 7,600 employees were active in 2018, which corresponds to a slight increase from 5,100 employees in the industry in 2010. The largest increase took place in the area of operation and maintenance.

In 2017, 16,700 companies and almost 100,000 employees were active in the field of renewable energies in the Southeast German solar region. The gross value added in 2018 was around EUR 11 billion. In the field of solar energy, around 5,500 companies with around 20,100 employees were active in 2018, which corresponds to less than half of the 2010 active workforce in the sector. The reasons for the decline in employment and value added include the relocation of plant production abroad and a decline in the installation of new plants compared with the high installation figures during the years 2010 to 2012.

The expansion of renewable energies also faces challenges. These include issues of volatility and security of supply as well as social acceptance of generation capacity expansion. While the majority are generally in favour of expansion, this support varies depending on the type of technology and appears to be decreasing depending on the degree of direct impact. Questions of nature and species conservation as well as noise and odour emissions also lead to acceptance problems.