Chapter 14

Assessing Social Impacts in Current and Future Electricity Production in the European Union

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Abstract In this chapter social impacts of European electricity production are compared between the current situation and the REFLEX scenarios for 2050 from a life cycle perspective using the SOCA tool. The analyses indicate that for a limited number of social impact categories the SOCA add-on tool can identify geographic locations where improvement in social performance may non-negligibly improve the social impacts for future energy systems. Results show that gas supply from Russia is a major cause of social impact for all future scenarios in the subcategory “fair salary” due to the fact that the minimum wage is below the living wage in the country. The specific process for electricity generation in Europe contributes to social impacts in the same category to a lesser extent.

14.1 Introduction

The development of environmental life cycle assessment (eLCA) as currently practiced is often traced back to the early 1990s. Meanwhile, only in the past decade interest has been directed toward using a life cycle perspective to perform social assessments—so-called social life cycle assessment (sLCA).

A major step in the methodology’s development was the publication of the sLCA Guidelines (UNEP 2009). The technical framework for sLCA is based on the structure of the eLCA standards (ISO 2006a, 2006b), considering goal and scope definition, life cycle inventory analysis, life cycle impact assessment and life cycle interpretation (UNEP 2009). Among other things, the Guidelines identify a set of stakeholder categories each of which cluster a group of different stakeholders that “are expected to have shared interests due to their similar relationship to the investigated product

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systems” (UNEP 2009, p. 46). The stakeholder categories so identified are workers, local community, society (national and global), consumers and value chain actors.

The years since the publication of the Guidelines have seen a certain amount of research activity in the field, as testified by recent review papers (Arcese et al. 2018; Dubois-Iorgulescu et al. 2018; Zanchi et al. 2018). Databases have also been developed that collect social performance data for several products, product systems and functions for a wide variety of social contexts, where leading examples are the social hotspots database (Benoit-Norris et al. 2012) and the product social life cycle assessment (PSILCA) database (Ciroth and Eisfeldt 2016). The SOCA database add-on (Eisfeldt 2017) meanwhile connects the social inventory and impact assessment methods used by PSILCA with the ubiquitous environmental LCI database ECOINVENT (Wernet et al. 2016). Data in the SOCA tool aim to support social assessment from the perspective of four stakeholder categories (workers, value chain actors, local community and society) and 37 connected social impact categories established according to the Guidelines (UNEP 2009). The stakeholder category workers are well-represented in SOCA, covering 18 separate indicators. Having first been made available in 2017, the tool is still quite new and there exist few if any examples of its application in literature, a gap that is aimed to be filled by the work carried out here.

Meanwhile, the aim of the REFLEX project is to analyze and evaluate the development toward a low-carbon energy system in the EU up to the year 2050 to support a better system integration of RES. The central approach in achieving this objective is to perform scenario-based energy economic system modeling (cf. e.g. E3MLab 2016; Fichtner et al. 2013; Fragkos et al. 2017; Herbst et al. 2012; IEA/OECD 2016; Schade et al. 2010 for examples of previous work in the same field).

Though the energy systems modeling performed in REFLEX provides important insights to support the path to carbon neutrality and beyond, the approach in general and REFLEX models specifically do not aim to cover in particular a range of social issues. Nevertheless, EU energy policy is guided by three fundamental principles—security of supply, competitiveness and sustainability (European Commission 2016). Furthermore, the EU is committed to implement the Sustainable Development Goals (SDGs) in internal and external policies (European Commission 2019), including notably significant social issues such as good health and well-being, the elimination of poverty, labor rights, safety at work and fair wages. In light of the intersection of EU energy policy and development policy through the lens of sustainability, it is important to understand how an envisaged future energy system may affect the potential to achieve such goals as exemplified in the SDGs.

Considering the aforementioned ongoing development of methodologies, tools and databases for sLCA and since EU policy is guided simultaneously by the need for transition to a low-carbon energy system and to fulfill the SDGs, the main aim of this chapter is to compare social impacts for EU electricity production between the current situation and the REFLEX scenarios for 2050 from a life cycle perspective using the SOCA tool. Through fulfilling this aim it is intended to provide an example of the application of the SOCA add-on for social assessment and also to formulate policy recommendations for achieving improved social outcomes in the energy system transition.

14.2 Method

14.2.1 Background to the SOCA Add-on for Social Life Cycle Assessment

The SOCA add-on tool provides a quantity of worker-hours (the activity variable in social LCA, cf. UNEP 2009) and a social risk profile for each ECOINVENT unit process (as defined by a reference flow and functional unit). This is done in a few steps. Firstly, the sectoral allocation (according to International Standard Industrial Classification, United Nations 2008) and geographical allocation (cf. Mutel 2014) for each ECOINVENT unit process are mapped to the corresponding sectoral and geographical allocations in the PSILCA database, which is in turn based on the EORA database (cf. Ciroth and Eisfeldt 2016). Afterwards, each ECOINVENT unit process can be assigned a social risk profile in terms of four stakeholder categories (workers, value chain actors, local community and society) and 37 connected social impact categories established according to the Guidelines (UNEP 2009). In a second step, cost data given for each ECOINVENT unit process is multiplied by the labor intensity for the sector to which it has been mapped in PSILCA (in worker hours per unit monetary output) to yield an activity variable in worker-hours for each ECOINVENT unit process.

The final impact assessment step is performed by assigning the raw value for a given social indicator a *qualitative* level of risk (varying from no risk, very low risk, low risk, medium risk, high risk and very high risk) each of which is assigned a *quantitative* impact factor. As an example for the purposes of understanding, Table 14.1 shows the procedure for social impact assessment for the social indicator “Disability adjusted life years (DALYs) due to indoor and outdoor air pollution”. The left hand column shows the intervals for the raw indicator values for each qualitative level of risk. For example, an ECOINVENT process with a social performance 7.8 DALYs per 1,000 inhabitants (i.e. the raw value of the social indicator) falls between 5 and 15 DALYs per 1,000 inhabitants and is therefore assigned a qualitative level “low risk” according to the central column in Table 14.1. Finally, the qualitative risk level

Table 14.1 Example of semi-quantitative risk assessment for indicator “DALYs due to indoor and outdoor air and water pollution” (Ciroth and Eisfeldt 2016)

Raw value of indicator (y) (DALYs per 1,000 inhabitants)	Qualitative risk level	Quantitative social impact factor
0	No risk	0
$0 < y < 5$	Very low risk	0.01
$5 \leq y < 15$	Low risk	0.1
$15 \leq y < 30$	Medium risk	1
$30 \leq y < 50$	High risk	10
$50 \leq y$	Very high risk	100

is assigned a quantitative social impact factor. Following the previous example, the unit process with a qualitative level “low risk” is assigned a social impact factor of 0.1. It should be noted in Table 14.1 that the impact assessment scheme is set up so that each increase in qualitative risk level causes an increase in quantitative risk factor by a *factor of 10*. Therefore, there is an exponential increase, and the level “very low risk” with a risk factor of 0.01 is ten thousand times less than the level “very high risk” with a risk factor of 100. The final social impact for a given ECOIN-VENT process (defined in terms of a reference flow and accompanying functional unit) is then calculated as the product between the worker-hours for that process’s reference flow and the quantitative social impact factor for that process. Reasoning about the setting of the scales for qualitative risk levels and the values for the quantitative social impact factors are presented further in the PSILCA manual (Ciroth and Eisfeldt 2016).

14.2.2 Establishing the Life Cycle Model for Social Assessment

Starting points for the assessment follow those of the environmental assessment. In line with the goal of the study, the four temporal cases considered in the social assessment are as those used for the environmental assessment, namely the base year (2014), the year 2050 according to the REFLEX Mod-RES scenario (hereafter 2050 Mod-RES), the year 2050 according to the REFLEX High-RES centralized scenario (hereafter 2050 High-RES centralized scenario) and finally the year 2050 according to the REFLEX decentralized High-RES scenario (hereafter 2050 High-RES decentralized scenario). For each temporal case the quantity of 1 kWh of grid electricity production is studied.

For each temporal case it is thus intended to assess EU electricity production from a social life cycle perspective. The electricity system as considered includes all capital and consumed material from the stage of raw material extraction up to the final production of electricity for delivery to the grid. For capital goods, only dismantling, demolition and disposal processes are considered for the end-of-life stage. No credits are considered for any potential recycling of capital materials.

Data on total electricity generation disaggregated by generation technology for each temporal case is taken from the REFLEX model ELTRAMOD (cf. Chapter 10). In order to reduce data quantities, a cut-off requirement was set that only generation technologies contributing to over 1% of total generation in any given temporal case was considered. It should be noted that after applying this cut-off criteria, over 99% of total generation was included in the system in all temporal cases.

Starting from the ELTRAMOD data for electricity generation, the life cycle inventory is developed for one unit of electricity production for each generation technology in each temporal case. A process flow diagram in Fig. 14.1 shows the

Fig. 14.1 Generic process flow diagram for social life cycle inventory for generation of 1 kWh electricity with a specific generation technology (*Source* Own illustration)

generic process stages included when gathering inventory. Where available, background data is taken from relevant ECOINVENT processes for electricity generation in Germany. This is because electricity generation in ECOINVENT is generally modeled for specific countries and there are many different generation technologies in the database modeled for German conditions. For example, for electricity generation with natural gas combined cycle gas turbine, the background process is taken to be “electricity production, natural gas, combined cycle power plant | electricity, high voltage | cut-off, U—DE”. Such processes cover all of the stages shown in Fig. 14.1. However, this approach provides a sound generic starting point for the assessment. It is necessary to develop system specific data for the models used, as described further below.

14.2.2.1 Capital Goods

In general, activity variables and social risk profile for capital goods production for each generation technology are based on the background ECOINVENT processes used to model each generation technology, and they are kept constant for all temporal cases.

However costs for wind (onshore and offshore) and photovoltaic (ground mounted and rooftop) power plants are currently changing rapidly (cf. Chapter 4 and e.g. Louwen et al. 2018). Therefore, activity variables connected to the entire “capital goods” processes for wind power and photovoltaic technologies in the assessment are

Table 14.2 Sector and geographical region for social risk profiles for “onsite power plant production” and “electricity production, plant operation”. Table according to United Nations (2008) and ECOINVENT Centre (2015)

Production stage	Economic sector	Geographical region
Onsite power plant construction	4220a: Construction of utility projects for electricity production, except for liquid fuels	Europe (abbreviated to RER in ECOINVENT)
Electricity production, plant operation	3510: Electric power generation, transmission and distribution	ENTSO-E (the European transmission grid)

changed for the current case compared to the background ECOINVENT processes according to recent capital investment data for each technology (IRENA 2018a; IRENA 2018b; Louwen et al. 2018). Furthermore, since costs for these technologies are further expected to decrease significantly up to 2050, updated activity variables are calculated for the 2050 scenarios using a learning curve approach based on an estimated global installed capacity for each technology (Brown et al. 2019).

A specific process is developed to model “onsite power plant construction” according to average European conditions (cf. Table 14.2). This is done since it is considered that the German conditions used for each background process are not sufficiently representative for the European case. Table 14.2 also shows the specific sector which this process is assumed to belong to. Other than the inputs noted above, inventory data is used directly from the selected ECOINVENT background process.

14.2.2.2 Fuel Supply

For coal and gas-based generation technologies, the countries of origin for respective fuels (i.e. “fuel supply” in Fig. 14.1) are modeled in the base year according to data for supply to the entire EU according to Eurostat (2019). For nuclear generation, the generic global fuel supply considered in the background ECOINVENT process is used for the current case. This is considered relevant in light of the global nature of nuclear fuel supply to the EU—from Canada, Russia, Kazakhstan, Niger and Australia (World Nuclear Association 2019). Meanwhile, for biomass-based generation a mixture of EU-sourced wood chips and globally sourced wood pellets are assumed in the current year.

It is also assumed that the countries of origin for these fuels are the same in the 2050 scenarios as for the current case. This is considered reasonable considering the significant uncertainty in the future development of countries of origin.

Other than the inputs noted above, inventory data is used directly from the selected ECOINVENT background process. Of course, countries of origin may (or will most likely) change until 2050, however, due to the lack of knowledge with regard to the contribution of the countries of origin, the assumption to use today's countries of origin is still the best guess.

14.2.2.3 Electricity Production and Plant Operation

A process is also specifically developed to model “electricity production, plant operation” according to European conditions. The economic sector and geographical region according to ECOINVENT to model this process are shown in Table 14.2. The activity variable (i.e. number of worker-hours) for this stage is calculated based on the labor intensity of the specific sector and geographical location shown in Table 14.2 and generic cost data in ECOINVENT for the specific technology in question. Note that this is done for all generation technologies considered.

14.2.3 Social Impact Categories

The assessment focuses on the stakeholder category workers since this is judged to be a category directly connected to and affected by supply chains for electricity production. From the indicators available to assess the worker stakeholder category, 12 are selected as shown in Table 14.3 below. Table 14.3 also shows how the selected indicators are related to the UN Sustainable Development Goal 8 Decent work and economic growth.

14.2.4 Calculation Method

Firstly, the total quantity of worker-hours for 1 kWh of electricity generation for each generation technology in each temporal case is calculated using the LCA software tool open LCA. These data are extracted to excel. This gave the pure activity variable for production by each technology. The quantity of worker-hours required for a given generation technology in a given temporal case is then calculated as:

$$X_{T,Y} = x_{T,Y} \cdot P_{T,Y} \quad (14.1)$$

where $X_{T,Y}$ is the total number of worker-hours due to generation technology T in temporal case Y , $x_{T,Y}$ is the number of work hours required to generate 1 kWh of electricity with generation technology T in scenario Y and $P_{T,Y}$ is the quantity of electricity generated in with technology T in temporal case Y in kWh. The total amount of worker-hours required for electricity generation for all n generation technologies in a given temporal case $X_{Tot,Y}$ can then be calculated as:

$$X_{Tot,Y} = \sum_{T=1}^n X_{T,Y} \quad (14.2)$$

Table 14.3 Subcategories and indicators for social risk used in this assessment, also showing the connection to UN Sustainable Development Goal 8 Decent work and economic growth

Subcategory	Indicators	Connection to UN Sustainable Development Goal 8 Decent work and economic growth
Forced labor	Frequency of forced labor	8.7 Take immediate and effective measures to eradicate forced labor, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labor, including recruitment and use of child soldiers, and by 2025 end child labor in all its forms
	Trafficking in persons	
Child labor	Child labor, total	
Health and safety	DALYs due to indoor and outdoor air and water pollution	8.8 Protect labor rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment
	Non-fatal accidents	
	Safety measures	
Workers' rights	Right of association (Yes/No)	
	Right of collective bargaining (Yes/No)	
	Right to strike (Yes/No)	
Fair salary	Living wage, per month	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value
	Minimum wage, per month	
	Sector average wage, per month	

Secondly, the *social impact* for 1 kWh of electricity production for each generation technology in each temporal case is calculated in openLCA and extracted to excel. See the earlier Sect. 14.2.1 called “Background to the SOCA add-on for social LCA” for how this latter step is performed. The indicators and subcategories for which social impacts are calculated are given in Table 14.3. The calculation of the social impact due to electricity generation for a specific technology in a given temporal case is performed according to the method summarized by Eq. 14.1. The calculation of the total social impact due to electricity generation in a given temporal case then follows the format shown in Eq. 14.2.

Quantitative social impact factors (according to the scale shown in the right hand column in Table 14.1) for each temporal case and for each social subcategory considered is then calculated as the social impact calculated in the subcategory (see paragraph above) divided by the amount of worker-hours (see earlier in the Sect. 14.2.4 and Eq. 14.2).

14.2.5 Contribution Analysis

The first step in the contribution analysis is to identify the electricity generation technologies making a *significant contribution* to any social risk subcategory considered in any the temporal case. This group included coal generation (in the base year only), natural gas-based technologies (in all temporal cases, mainly combined cycle gas turbine with and without carbon capture and storage technology), nuclear generation (mainly in the base year), wind power (mainly in 2050 High-RES scenarios) and solar power (mainly in 2050 High-RES scenarios).

The second step in the contribution analysis is to assess the percentage-wise contribution of different parts of the supply chain (according to the process flow diagram shown in Fig. 14.1) for each generation technology using the contribution tree function in openLCA. Finally, all unit processes in the supply chain for a given generation technology are arranged in descending order of their social impact contribution for each subcategory. According to this analysis, specific regions (or countries) and sectors making significant contributions to social impacts in each temporal case could be identified.

14.3 Results

Figures 14.2, 14.3 and 14.4 shows results from the social assessment of electricity production in the EU. Comparing Fig. 14.2 with Fig. 14.3 it can be deduced that increased labor intensity (by about 10% comparing High-RES decentralized scenario with the current case) is responsible for a certain portion of the increase in social impacts seen in Fig. 14.2. Having said that, the large increase in calculated impacts seen in for example fair salary or forced labor show that an increase in risk levels (cf. Table 14.1) is also responsible for the observed increase in social impacts. The contribution analysis shows that the increases in social impacts in future scenarios observed in Fig. 14.2 (for all impact subcategories except for health and safety) is due to the increasing share of gas-based generation in the future. Gas technologies have higher than average impact considered per unit electricity generation.

As shown in Fig. 14.2, the largest contributors to impacts across the board in the current case (2014) are fossil-based generation technologies and nuclear power. One significant reason for the large impacts from coal and nuclear power is that they constitute large shares of the total generation in Europe in the current case—22 and 28%, respectively. Gas represents a smaller share of the production mix, only 6% but contributes to impacts because of relatively high impacts per unit electricity generation. Contribution analysis shows that for gas generation, it is “fuel supply” (according to the process flow diagram in Fig. 14.1) that is responsible for over 90% of total impacts. For coal generation, “fuel supply” also dominates and is responsible for between 75 and 85% of total impacts depending on the impact category.

Fig. 14.2 Calculated social impacts per unit electricity generation in the EU-27, Norway, Switzerland, United Kingdom and Balkan countries for all subcategories and temporal cases considered. Impacts are normalized to calculated impact in the 2014 base year. Abbreviations: PSP—pumped storage plant, CCS—carbon capture and storage, PV—photovoltaic. For total electricity generation in scenarios please see Chapter 10 (Source Own illustration)

For nuclear technology, fuel supply answers for between 42 and 74% of total impacts depending on the impact category. In the subcategory fair salary, the process “Electricity production, plant operation” (cf. Figure 14.1) contributes 43% of the total impact for nuclear power. Solar power and wind power make more modest contributions in all impact categories in the current case. Impacts per unit of electricity for wind generation technologies are close to the average across all generation technologies. For wind power onshore,¹ the process “capital goods” (see flow diagram, Fig. 14.1) contributes over 90% of the total impact from the technology for all subcategories with the exception of fair salary, where the impact from “capital

¹Chosen for contribution analysis because it dominates the wind power category in terms of share of total generation and in observed social impacts. Largely similar contributions are observed for offshore wind power.

Fig. 14.3 Calculated worker-hours per unit electricity generation in the EU-27, Norway, Switzerland, United Kingdom and Balkan countries for all subcategories and temporal cases considered. The values are normalized to the calculated worker-hours in the 2014 base year (*Source* Own illustration)

Fig. 14.4 Average social impact factor per unit electricity generation in the EU-27, Norway, Switzerland, United Kingdom and Balkan countries for all subcategories and temporal cases considered. The values on the y-axis are comparable to the quantitative social impact factors given in Table 14.1

goods” amounts to 66%. In this category, the process “Electricity production, plant operation” (cf. Fig. 14.1) contributes 30% of the total impact. In the current case, solar power (all types) contributes only 3% of the total generation, so the impacts arise because solar power has impacts per unit electricity generation that are significantly higher than average across all impact categories. The processes “raw material extraction” and “material and component manufacture” (see flow diagram, Fig. 14.1, i.e. the production of panels and mounting systems and raw material production required) together account for between 70 and 98% of total impacts per unit generation for rooftop solar² depending on the impact subcategory.

In all future cases, gas-based generation technologies dominate in all impact categories. This is because the share of gas-based technologies in total generation increases to around 30% in all scenarios, combined with the fact that for all impact subcategories except for health and safety, gas technologies have higher than average impact considered per unit electricity generation. This is the case in spite of an assumed small increase in generation efficiency for gas technologies. Coal and lignite based generation have been largely eliminated from the mix in all 2050 scenarios. Wind power meanwhile increases its share of total generation to around a third in each 2050 scenario, leading to the increases in wind power’s share of total impacts shown in Fig. 14.2. The share of impacts is nevertheless mitigated by the fact that the cost for capital goods (i.e. the wind power plant itself and necessary grid connection) reduced by about a third for each wind power technology, causing the specific impact per unit electricity generation to reduce by about the same amount between the current case and 2050. One interesting feature arising from the contribution analysis for wind power is that in future cases, the production of steel including its supply chain accounts for large proportions of the total impact per unit electricity generation. For example, it amounts to 56% of the total for onshore wind power in the subcategory child labor and 28% in the subcategory health and safety for the same technology. The social impact per unit electricity generation decreases by about two thirds in 2050 scenarios for each solar generation technology thanks to the learning curve approach applied. Nevertheless, due to the increase in PV share in the electricity mix, solar’s contribution to social impacts grows up to 2050. The contribution analysis shows that even in 2050 between 48% (for the subcategory fair salary) and 91% (for child labor) of the total contribution due to the ground mounted PV arises due to the processes “raw material extraction” and “material and component manufacture”. Similar trends are observed for rooftop PV.

The scale on the y-axis of Fig. 14.4 can meanwhile be compared to the values of the quantitative social impact factors in Table 14.1. The figure shows that on average, for all temporal cases, child labor, fair salary and health and safety have between a medium risk level (a value of 1 on the y-axis) and a high risk level (a value of 10 on the y-axis). Meanwhile, forced labor has on average slightly more than a medium risk level and workers’ rights between a medium risk level and a low risk level. If it is accepted that the qualitative performance levels can be reasonably compared

²Chosen for contribution analysis because it dominates the PV rooftop category in impacts in the current case. Similar trends are observed for PV ground mounted plants.

Table 14.4 The proportion of social impacts that are identified to specific countries or geographic regions according to contribution analysis. High-RES centralized scenario was not selected for this analysis

	Current		Mod-RES 2050		High-RES dec 2050	
	Identified with	Not identified with	Identified with	Not identified with	Identified with	Not identified with
	Geographic specificity					
Child labor	0%	100%	0%	100%	0%	100%
Fair salary	41%	59%	58%	42%	62%	38%
Forced labor	27%	73%	49%	51%	50%	50%
Health and safety	12%	88%	11%	89%	11%	89%
Workers' rights	8%	92%	2%	98%	2%	98%

between impact subcategories (i.e. a medium risk in for example “fair salary” can be compared with a medium risk in “child labor”) then Fig. 14.4 establishes a clear prioritization of which social performance categories should be addressed in order to improve the performance. On the other hand, considered from an ethical perspective it is problematic to objectively compare risk in this way, and it is at least an issue that should be left to the decision-maker (see discussion in Ciroth and Eisfeldt 2016).

Table 14.4 shows the breakdown of calculated social impacts between those that could be assigned to a specific geographic location (country or region) according to the modeling approach used and those that are calculated according to non-geographically specific (e.g. global or rest-of-world) average social performance values according to the modeling approach. The main observation is that a large proportion of social impacts for the subcategories considered are calculated according to non-geographically specific average values and therefore provide weak support for decisions for improved social performance. For example, as good as all impact in the child labor subcategory occurs due to non-geographically specific processes in all temporal cases (cf. Table 14.4). The geographic specificity of calculated impacts for workers' rights is only 2% in future scenarios and therefore not considered further in this analysis (cf. Table 14.4).

Table 14.4 also shows that for forced labor and fair salary in particular, geographically specific processes are identified as making significant contributions in all temporal cases shown. A major cause here is fuel supply from Russia. In the current case these impacts amount to 23% of the total assessed impact in the category, with 12% arising from the sourcing of natural gas from Russia, 12% from the sourcing of coal in the country and 3% from nuclear fuel cycle-related activities. Meanwhile, for the future cases (where High-RES decentralized is the case analyzed), as much as 42% of the total risk in the category can be attributed to Russia, all due to the natural gas supply chain from the country. That the proportion due to Russia increases

between the current case and the future scenarios is due to the increase in the proportion of gas-based generation, which occurs for all future scenarios. Russian gas production is further assigned a level of “high risk” for the indicator for “trafficking in persons”. According to source data for the indicator (U.S. Department of State 2014) this is because the country is one of few with a tier 3 designation, meaning that it is judged not to be making significant efforts to comply with the minimum standards in the Trafficking Victims’ Protection Act (TVPA) (U.S. Department of State 2008).³ There are meanwhile small contributions in the forced labor category from certain activities geographically specific to Europe, up to 8% of the total in future scenarios. Data sources used for the risk assessment in the category (International Labour Organization 2012; U.S. Department of State 2014) and other relevant sources (Walk Free Foundation 2018) suggest that the occurrence of forced labor particularly in the Eastern and Southern peripheries of the EU (although it is judged to occur to some extent in all parts of the EU) and the lack of complete application of the Trafficking Victims’ Protection Act (TVPA) (U.S. Department of State 2008) in certain EU countries causes this. The judged risk level for forced labor geographically specific to Europe is only medium. However, a large proportion of the total worker-hours for in particular wind power are specific to Europe, causing the processes to feature as non-negligible in this analysis.

About 20% of the total calculated impacts for fair salary in the current case arise due to coal and natural gas supply from Russia. Meanwhile source data in the category fair salary (Guzi and Kahanec 2018) demonstrates that the reason that processes geographically specific to Russia (in particular in the natural gas supply chain) play such a large role is the fact that the estimated living wage in the country is above the lowest estimated level for a minimum wage in the country (cf. Guzi and Kahanec 2018 for more information about how living wage is evaluated). A smaller, though non-negligible proportion of social impacts in fair salary also arise due to the power production process across the different generation technologies and for onsite plant construction for wind power and solar power, performed according to European average conditions. This arises largely because the living wage is relatively high in the European geographic designation. The major increase in total impact (cf. Figure 14.2) and in geographic specificity between the current case and the future scenarios for fair salary is due to the increased demand for gas from Russia, mitigated somewhat by the elimination of social impact from coal due to the fact that it is not used in any future scenario.

Considering health and safety, only 12% of the total impact in the category can be identified with any geographic specificity in the current case. Breaking this down further, the geographically specific impacts can be localized to coal mine operation in Columbia and North America (specifically a very high risk of non-fatal accidents), nuclear fuel production in Russia and Europe (due to very high risk of lack of sufficient safety measures) and for onsite construction of wind power plants at European average conditions (high risk of non-fatal accidents). Geographic specificity for impacts remains at just over 10% in all future scenarios, but arises principally as a

³However, this appraisal may change dependent on actions taken (or even not).

result of onsite construction of wind power plants under European average conditions due to increase in the significance of wind power in the energy mix and the decrease in nuclear and coal generation over the same period.

14.4 Concluding Discussion and Policy Implications

This work has shown that the SOCA add-on can identify geographic locations where improvement in social performance will non-negligibly improve the performance of future energy systems. However in this work it is only possible for a limited number of social impact categories.

Since all indicators assessed in the analysis have been related to the UN SDGs (cf. Table 14.3) SOCA is therefore shown to be useful in demonstrating areas for improvement in consideration of the SDGs. However, the fact that large proportions of the total impacts (in particular for categories such as child labor and workers' rights) could not be assigned a geographically specific location point to ongoing limitations with applying SOCA. A large number of SDGs remain to be addressed by the approach. Also the fact that much of the calculated impact could not be assigned to geographically specific regions implies that SOCA does not facilitate a screening to identify the largest areas of social impact. Indeed, the development of geographically specific processes for major stages for generation technologies that is performed in this study (e.g. for onsite plant construction and power generation, cf. Table 14.2) is a delicate and time-consuming process. Facilitating this in future is therefore a key step in the further development of the SOCA add-on.

Furthermore, though the contribution analysis allows geographically specific potential social impacts to be identified, source data themselves in many cases lack sector specificity. A sustainability report from a large company engaged in gas production and supply in Russia demonstrates that in the industry there is an intention to work actively with salary issues and to apply International Labour Organization standards, including the elimination of forced labor and trafficking in persons (Gazprom 2018). Reporting standards could of course be stricter. Considering the evidence of e.g., lack of implementation of the protocol on trafficking in persons in the country, Russian gas suppliers could provide further evidence of initiatives to track and eliminate such violations affecting their own organizations. The issue could on the other hand be addressed on a diplomatic and political level through the implementation of the Trafficking Victims' Protection Act (U.S. Department of State 2008) in Russia, as well as comprehensively in European nations.

Considering the issue of fair salary arising in Russian fuel supply and in electricity production according to European conditions, beyond general salary-related policies, statistics could be produced to track the relationship between salaries in relevant industries (gas supply in Russia and electricity production in Europe) and relevant measures of living wage and minimum wage in the respective geographic locations.

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