Sustainable Development in North Rhine-Westphalia: a scenario analysis

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Introduction

Sustainable Development is hard to measure, but most scholars agree that it entails the achievement of goals in three dimensions: environmental, economic, and social. In the past it was often believed that there are massive trade-offs between these dimensions, especially between the environmental and economic ones. However, intelligent strategies and new technology could and will make it possible to overcome some of these trade-offs. To shed some light on this, we present a case study of a particularly interesting region: the federal state of North-Rhine-Westphalia in Western Germany.

North Rhine-Westphalia is a region characterized by massive economic and structural change. Historically it was the industrial core of the German economy, with important industries like hard coal mining and steel production. Hard coal mining has virtually disappeared, and so have many associated jobs. Unemployment is relatively high compared to the national average. Lignite mining, however, still plays an important role, and electricity production is heavily reliant on coal-fired power plants. As a result, greenhouse gas emissions per capita are significantly higher than the national average.

Under these circumstances, there is a lot of pressure on policymakers to stimulate job creation. The trade unions' association (DGB NRW) has called for the creation of 500,000 additional jobs (covered by social insurance) between 2014 and 2020. At the same time, however, greenhouse gas emissions must be reduced. The official goal of the government is to reduce greenhouse gas emissions by 25% in 2020 (compared to the base year 1990). This goal has been officially defined in the climate protection act in 2013, together with a goal of 80% reduction by 2050.

The goal of our study is to shed some light on the question if and how both goals can be fulfilled. To this end, we develop a scenario analysis based on a multi-regional input-output (MRIO) model. First, we develop a business as usual (BAU) scenario, assuming that past trends will persist in the future. In this scenario, some additional jobs are created and emissions are reduced, but neither of the two goals is actually achieved. We then develop a "goal" scenario which describes a possible development in which both goals are achieved. Comparing the two scenarios shows how additional effort and measures can contribute to fulfilling employment and emission reduction goals.

The goal scenario draws on information which has been gathered in semi-structured interviews with decision makers in selected firms from several branches (mining, manufacturing, energy production and distribution, waste disposal and recycling, transport infrastructure, services). The interviews consisted of a quantitative part (energy consumption, total consumption of intermediate inputs etc.) and a qualitative part to identify challenges and potential strengths. The evaluation of the interviews allowed us to construct a plausible goal scenario.

Interviews

In order to acquire a reasonable amount of bottom-up information from companies in the region of analysis, we conducted semi-structured interviews. DGB NRW was able to help us establish contact with firms from some of the branches that are likely to play key roles in the transition to a sustainable economy. This help was very valuable because as we experienced it is generally difficult to convince companies to participate in a research project when there is not direct incentive (financial or otherwise) for them to do so. Nevertheless, we managed to conduct interviews with companies from the branches listed in Table 1.

Table 1: Branches in which interviews were conducted

NACE code	Title
08	Other mining and quarrying
11	Manufacture of beverages
24	Manufacture of basic metals
28	Manufacture of machinery and other equipment n.e.c.
35	Electricity, gas, steam and air conditioning supply
38	Waste collection, treatment and disposal activities; materials recovery
52	Warehousing and support activities for transportation
65	Insurance, reinsurance and pension funding
70	Activities of head offices; management consultancy activities

Source: compiled by the authors

The project was integrated in the teaching activities of Bochum University of Applied Sciences. Eight students from different bachelor and master programs participated in the project. Each of them was assigned one company. He or she then contacted the company, performed online research on the company and its environment, and conducted interviews with one or more persons from that company. The interviews were conducted as semi-structured interviews; in many cases questions were sent to the interviewees in advance of the actual interview. This allowed them to research some of the information before the interview took place.

We promised all the participating companies to treat the information provided by them confidentially. Hence, we are not able to report their answers in detail or to reveal their identities. From a scientific point of view this is regrettable, but from a practical point of view confidentiality must be guaranteed because otherwise private companies are not willing to share sensitive information. For these reasons we can only report a summary of our findings.

All companies were aware of the concept of Sustainable Development, and some of them had a very good understanding of it. In some cases, companies publish Sustainability Reports on a regular basis.

The representatives of the company from the “other mining and quarrying” were well aware of Sustainable Development. They had a favorable opinion and had already made significant efforts to adjust their strategy in line with the concept. In their case this is quite a challenge because they are extracting a non-renewable resource from the earth. From a very strong sustainability perspective, this activity might be considered unsustainable by definition. However, the representatives of the company argued that if they shut down production completely their business would stop – hence, it would not be a sustainable business strategy. Instead, they are deliberately limiting the speed at which they extract their resource in order to prolong the lifetime of their business. Interestingly, despite the limitation of resource extraction they managed to increase turnover and profit in recent years. They did this by improving the quality of their output. Thus, they are not consuming a limited amount of the resource per year, but simultaneously they moved from average quality products to high quality product and thereby increased the profitability of their business.

The company from the beverage industry also displayed significant familiarity with Sustainable Development. Compared to their competitors, they see themselves as “a very sustainable company” and certainly “above the average” of their industry. The operations manager of the company stated that in his view “sustainability is the precondition for an economically viable operation”. He also stated, however, that

this company has almost reached the limit of its possibilities, and that there is little scope for further improvement at this time.

The company has invested significant amounts to improve its energy efficiency. However, it has not neglected the social dimension of Sustainable Development. When asked about the social dimensions, the representatives of this company mentioned several examples, such as flexible hours and the opportunity to work at home, which helps workers to manage a professional career and family matters. Management and employees' representatives (both sides were interviewed) stated that they are "very satisfied" with their relationship. Workers earn more than the union wage because the company adds voluntary payments on top of it. The company supports the formation of car pools and it has initiated a "refugee project" to help refugee workers find jobs in the German labor market. The only point of contention that was mentioned was the setting up of a company kindergarten (which employees would like to have, but so far the company has not done it).

The machine manufacturer was less enthusiastic about Sustainable Development. Its representatives clearly stated that "so far Sustainable Development has not played a significant role". They believe that in many cases a conflict exists between economic and environmental goals. In a highly competitive market environment, they are not able to sacrifice economic profitability for the sake of environmental goals because that would put them in a seriously disadvantaged position compared to their competitors. They do not, however, oppose environmental legislation or regulation if it affects all companies in this industry equally.

We managed to contact and interview representatives from an energy provider. This company states that its electricity is relatively "clean" compared to the average – it does not own or use coal-fired power plants nor nuclear power plants. Its electricity production relies on natural gas, burning of waste, and renewable energy. Furthermore, the company donates funds to promote sport and cultural events in its region of origin, and it enjoys a reputation as a good employer. Compared to other firms from the energy industry, the company can be considered a forerunner in Sustainable Development.

The branch "waste collection, treatment and disposal activities; materials recovery" is highly relevant for Sustainable Development, but its importance is often overlooked in the political and even scientific debate. We were therefore delighted to have found a company from this branch that was willing to cooperate with us. The company has a Sustainability Strategy and publishes Sustainability Reports that discuss the three dimensions of sustainability. In the interviews, the representatives mentioned a number of potential measures that would contribute to Sustainable Development in NRW.

A company that supplies support activities for transportation was also a valuable addition to our project. From an environmental point of view it is quite interesting because transportation is associated with significant amounts of GHG emissions and noise. However, the interviewed persons were very well aware of these issues and had developed ways to deal with them. They are undertaking considerable effort to reduce the burden of their activities on the environment and society. Employees' representatives reported a good relationship with the company's management and a "very low labor turnover", which indicates that the workers in this company are generally satisfied with their working environment.

The insurance company that participated in our project, owing to its nature as a service provider, does not consume much energy or generate high emissions. However, it is still interesting because it takes the idea of Sustainable Development very seriously. For example, it has implemented Sustainability Reporting already in

2009, and it has developed an explicit Sustainability Strategy. It tries to develop sustainable products and uses sustainability as one criterion when designing investment strategies. Moreover, its representatives argue that Sustainability should be high on every insurance company's agenda because "in a world that is four or five degrees warmer, risks and costs will probably become impossible to calculate". In other words, the assessment of costs and risks that is integral to every insurance company's operation becomes much harder if climate change continues unchecked.

Finally, we contacted and interviewed a representative from a business service provider. This company did not pay much attention to Sustainable Development. It did not seem very interested in the topic. Although this was disappointing for the student conducting the interview, it certainly helped us to maintain a balanced view. The reality is that Sustainable Development is a topic that we (the authors) discuss every day, but outside academia it is not on everyone's agenda all the time.

Specification of the business-as-usual and of the policy scenario

For figuring out what policy measures might be required for reaching the goal of creation 500,000 additional jobs and a reduction of green-house gas (GHG) emissions 25% compared to 1990 until 2020, we first examine the prospective employment and emission pathways of a business-as-usual (henceforth, BAU) scenario, i.e. a scenario without further policy interventions.

The specification of our BAU scenario is based on regional GDP growth rates & value added shares of industries from 2007 to 2020 described in Heinrichs et al. (2017). Total GDP growth rates up to 2016 are based on data from regional economic accounts. Since regional employment data by sector is available up to 2016, we only have to estimate the development of employment from 2017 to 2020. We do so, by assuming that the average annual change in labor productivity (i.e. the number of employees per unit of value added by sector) between 2017 and 2020 is equal to the sectoral averages reported for Germany between 2011 and 2016 by the federal statistical office. For GHG emissions, however, only information on regional totals from 2007 to 2013 for the calculation of average annual changes in efficiency are available. Therefore, sector specific improvements of emission efficiency cannot be taken into account.

North Rhine Westphalia's development of GDP, employment and GHG emissions in the BAU scenario are summarized in Table 2, where red colored digits refer to data and black digits refer to figures based on assumptions and model calculations. It can be observed, that both policy goals are not reached. The number of new jobs is by about 100,000 employees lower as required by the policy target of 500,000, whereas GHG emissions are only reduced by 21.3% compared to 1990.

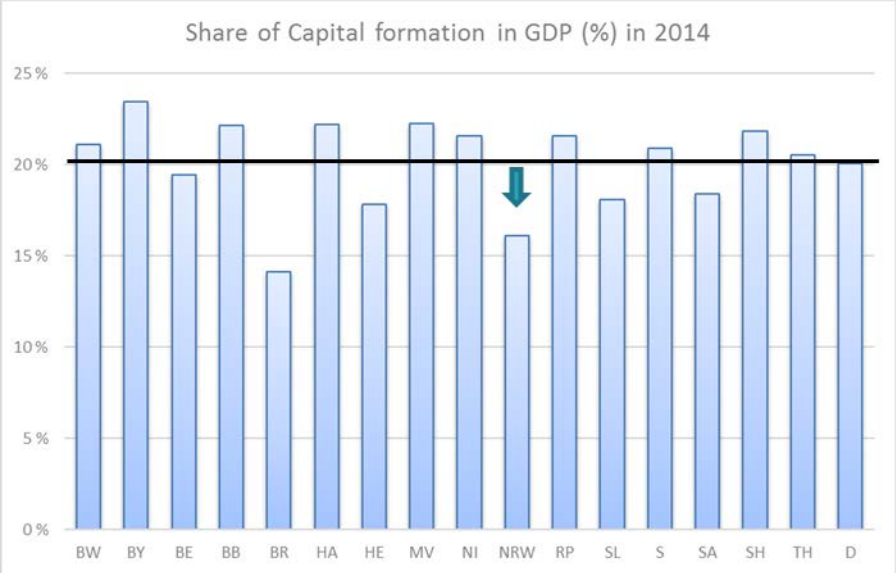
Table 2: Development of NRW's GDP, Employment and GHG emissions in the base scenario

Year	Value Added (Δ%/a)	Employment (millions)	GHG (Δ%/a)
2014	2.05%	6,259	-0.05%
2015	-0.22%	6,381	-2.27%
2016	3.97%	6,507	1.83%
2017	1.58%	6,583	-0.51%
2018	0.93%	6,615	-1.15%
2019	0.80%	6,641	-1.27%
2020	0.78%	6,666	-1.29%

Source: authors' calculations

In order to reach the policy targets in terms of employment and GHG emissions, additional investments into energy efficiency appears as an obvious measure to address both targets at the same time. A further important argument for investment policies in NRW is the fact this region has by far the lowest share of capital formation in GDP out of all territorial states. A comparison of the shares across the federal states can be seen in Figure 1. While nationwide capital formation makes out about 20% of GDP, the respective share in NRW is only about 16%. Consequently, we propose that NRW's government should increase own investments and incite regional companies and households to invest into GHG reduction. For the scenario analysis, we assume that NRW makes up at least half of the difference in between the regional and the national share of capital formation in GDP in 2020. This means that capital formation needs to increase by 3 billion EUR in each year.

Figure 1: Comparison of regional and national shares of capital formation in GDP in 2014



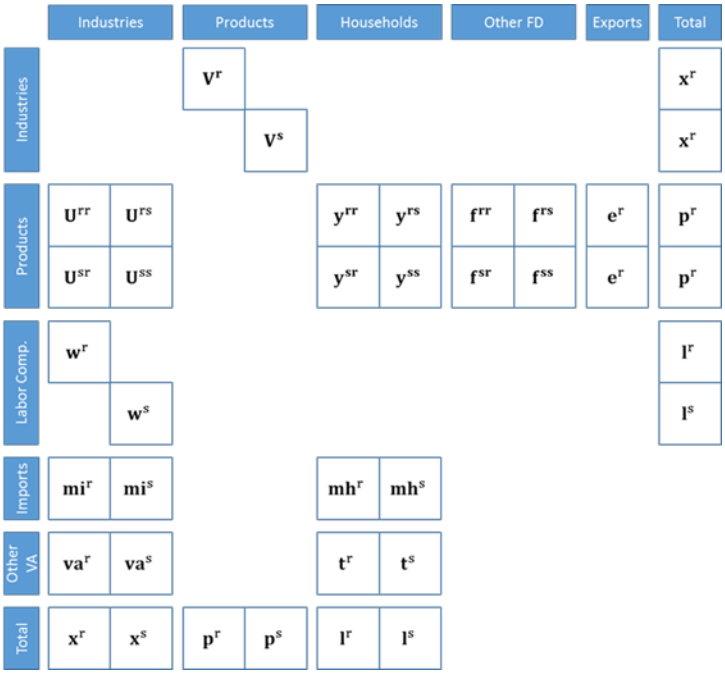
Source: VGR der Länder, authors' calculations

The effects of these additional investments on regional GDP growth, employment and GHG emissions are estimated by means on bi-regional Input-Output model with endogenous households. The additional final demand for products from NRW associated with the increase in capital formation is computed based on two assumptions. Firstly, we assume that the product composition of the additional investments (i.e. the shares spent on machines, rolling stock, construction etc.) is the same that reported in NRW's capital formation vector of the Supply-Use table. Secondly, we split the investment demands for these products into demands directed to NRW, to the rest of the country and to the rest of the world by applying the respective product specific trade shares from the Supply-Use table.

The bi-regional Input-Output model

The estimation of the effects of additional investments in the policy scenario carried out by means of bi-regional Input-Output model with endogenous consumption of households, which models the sectoral and interregional relationships between industries and households in NRW and the rest of Germany. The Input-Output model is formulated on an aggregated version of the multiregional supply-table for Germany's federal states in 2007, developed in Többen (2017a, b). The structure of this table is shown in Figure 2.

Figure 2: Structure of the bi-regional Supply-Use table for NRW and the rest of Germany.



Source: authors' illustration

The bi-regional Supply-Use table consists of following elements:

u_{ji}^{rs}= intermediate use of product j from region r by industry i in region s

v_{ij}^{s}= supply of product j by industry i from region s

y_{j}^{rs}= final consumption of product j from region r by households in region s

f_{j}^{rs}= final consumption of product j from region r by the remaining final demand sectors (i.e. governments, NPISH and capital formation) in region s

e_{j}^{r}= exports of product j from region r to the rest of the world

p_{j}^{r}= total supply of product j by region r

x_{i}^{r}= total output of industry i in region r

mi_{i}^{s} = imports from the rest of the world of industry i in region s

mh_{i}^{s} = imports from the rest of the world of households in region s

va_{i}^{s} = value added other than labour compensation of industry i in region s

w_{i}^{s} = (gross) labour compensation of industry i in region s

t^{s} = deductions from gross labour income at net taxes on products payed by households in region s

l^{s} = total (gross) labour income of households in region s

Across, these elements three different accounting balances must hold.

The first one requires that total output of products by an industry i from region s has to be equal to the sum of intermediate inputs consisting of inputs from the own region, from the rest of the country and imported from the rest of the world, and labour inputs and value added other than labour, i.e.

$$x_i^s = \sum_j v_{ij}^s = \sum_j^r u_{ji}^{rs} + mi_i^s + w_i^s + va_i^s. \quad (1)$$

The second balance requires that total supply of product j from region r is equal to the sum of its intermediate use by industries and its final use by households in the own region and in the rest of the country, other final demand and exports to the rest of the world, i.e.

$$p_j^r = \sum_i v_{ij}^s = \sum_i^s u_{ji}^{rs} + \sum^s y_j^{rs} + f_j^{rs} + e_j^r. \quad (2)$$

Finally, it is required that gross income of households from labour is equal to total gross labour compensation of industries in a region, i.e.

$$l^s = \sum_i w_i^s = \sum_j^r y_j^{rs} + mh_i^s + t^s. \quad (3)$$

For the derivations of the bi-regional Input-Output model, we need to combine these accounting balances with following assumptions regarding fixed coefficients:

- $b_{ji}^{rs} = \frac{u_{ji}^{rs}}{x_i^r}$, fixed intermediate inputs, u_{ji}^{rs}, per unit of industry output, x_i^r. (4)
- $n_i^r = \frac{w_i^r}{x_i^r}$ fixed labour inputs, w_i^r, per unit of industry output x_i^r. (5)
- $c_j^{rs} = \frac{y_j^{rs}}{l^s}$ fixed private consumption, y_j^{rs}, per unit of gross income, l^s. (6)
- $d_{ij}^r = \frac{v_{ij}^r}{p_j^r}$ fixed industry market shares. (7)

The solution of the bi-regional Input-Output model, that delivers the direct, indirect and induced effects of an increase in capital formation in NRW on industry output is then given as:

$$\Delta x_t = LD\Delta F_t = (I - DB - DCN)^{-1} D\Delta F_t \quad (8)$$

Reading this equation from the right to the left shows that the increase in capital formation (product dimension) ΔF_t is translated into demands directed to industries via the market-share matrix D and, then, multiplied by the extended industry-by-industry Leontief-Inverse $L = (I - DB - DCN)^{-1}$. In the Leontief-Inverse, the first term DB models the interindustrial relationships, while the second term, DCN, represents the Keynsian income multiplier. Pre-multiplying (8) with a vector of value added coefficients, finally, delivers the total impacts on value added of an increase in capital formation, which are, then, translated into the corresponding effects on employment and GHG emissions as described for the BAU scenario.

Results

The total impacts on value added, employment and GHG emissions of an increase in NRW's capital formation in the investment scenario in comparison to the pathways in the BAU scenario are shown in Table 3. It can be observed that the annual growth rate of value added is increased by about 0.3% percentage points. As a consequence, the number of employees increases by almost 100,000, which means that the

policy target of 500,000 in 2020 compared to 2014 will be reached. On the other hand, the stronger growth in value added worsens achievement of GHG reduction target by about 0.3% percentage points compared to the BAU scenario. However, this outcome should be taken with caution, as we, firstly, do not model the effects of investments on energy efficiency and, secondly, the effect of structural change are not taken into account as no sector specific GHG data are available.

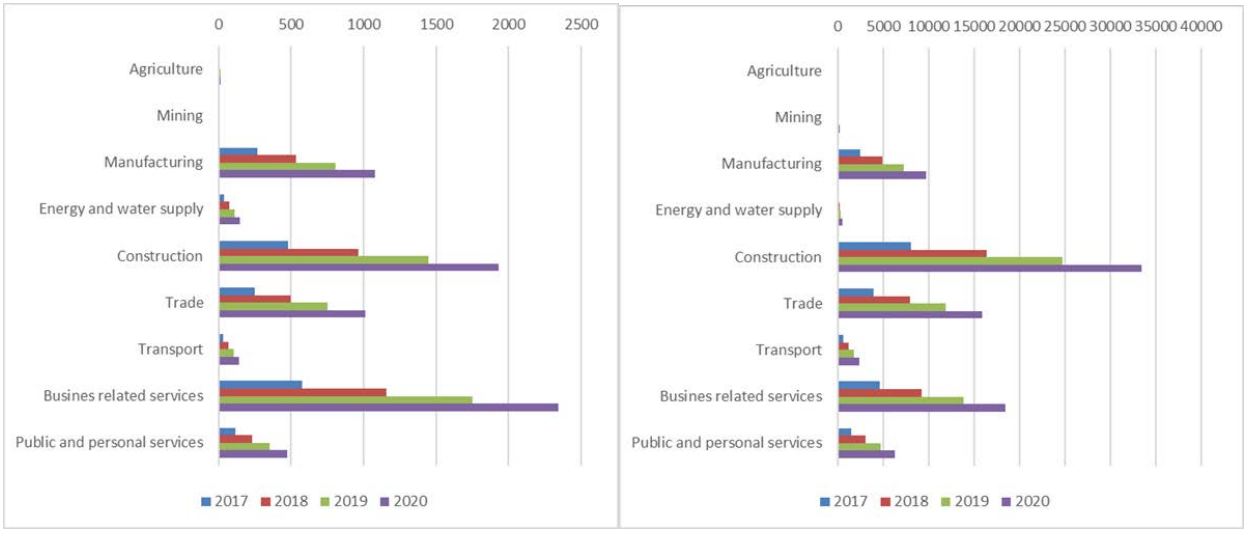
Table 3: Effects on value added, employment and GHG emissions in the investment scenario compared to the BAU scenario

Year	Value Added (Δ%/a)	Employ-ment	GHG (Δ%/a)
2017	0.31 %	23,683	-0.30 %
2018	0.30 %	47,908	-0.29 %
2019	0.30 %	69,356	-0.29 %
2020	0.29 %	97,856	-0.29 %

Source: authors' calculations

Finally, the sectoral distribution of impacts is shown in Figure 3. It can be observed that, in terms of value added, in particular business related services and construction would benefit significantly, followed by manufacturing and trade. Taking the different employment coefficients, shifts this ranking significantly. The, by far, largest effects on employment can now be observed in the construction sector, followed by business related services, trade and manufacturing.

Figure 3: Total effects of value added and employment in the investment scenario



Source: authors' calculations

Discussion

We would like to emphasize one important aspect of every scenario analysis approach: It is impossible to attach a certain likelihood to any of the scenarios coming true. In reality, the future may turn out to be similar to the BAU scenario, or to the investment scenario, or very different from either scenario. Nevertheless, some important lessons can be learned from the evaluation the scenarios.

In a nutshell, the results presented in the previous section illustrate that it is possible for NRW to reach the goals formulated by DGB NRW. As we can see in the BAU scenario, these goals will not be achieved without further efforts. If the trends of the past persist, the emission reduction goal for 2020 will not be fulfilled. If, on the other hand, NRW manages to break the trends of the past and increase the speed of emission reduction, it is possible that both the emission goal and the employment goal are achieved in 2020.

However, it should be pointed out that the scenario analysis was conducted in the context of a project launched in the summer of 2016. The database for the model includes data up to and including the year 2013. Recently, new data on GHG emissions for the years 2014 and 2015 have been published by the office of nature, the environment, and consumer protection (*Landesamt für Natur, Umwelt und Verbraucherschutz*, henceforth LANUV).

Table 4: GHG emissions in NRW, 2005-2015 (million tons, CO2 equivalents)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Energy	174.4	179.4	185.6	176.2	157.6	167.2	166.6	168.9	170.3	160.9	151.1
Industry	62.6	63.4	62.3	60.2	47.4	56.9	55.2	53.5	54.6	54.5	54.7
Transport	36.4	35.5	34.2	34.1	33.6	32.6	33.2	32.8	33.1	33.4	33.9
Households	35.7	37.8	29.7	36.1	33.3	33.4	28.6	31.2	32.0	27.7	28.7
Others	19.4	18.4	17.7	17.8	16.2	15.9	16.0	16.5	16.6	15.8	16.0
Total	328.5	334.5	329.5	324.4	288.1	306.0	299.6	302.9	306.6	292.3	284.4

Source: Landesamt für Natur, Umwelt und Verbraucherschutz (2016)

The data for 2015 are marked preliminary. Nevertheless, they should not be ignored. According to Table 4, NRW has achieved a remarkable reduction of GHG emissions in 2014 and 2015. From 2013 to 2014, GHG emissions fell by 4.7%, and from 2014 to 2015 they fell by 2.7%. These significant reductions could signal the beginning of a new and faster trend. If this is indeed the case, the BAU scenario becomes less likely because it is based on the assumption that the old trend will persist until 2020. However, it is also possible that the years 2014 and 2015 are merely a deviation from the trend and that the development of GHG emissions will return to the old trend after all[1]. In fact, the LANUV itself states that the significant reduction in 2014 can be attributed "to a large extent to the mild weather" (LANUV, 2016, p. 26, authors' translation). This would imply that with harsher weather conditions the level of GHG emissions might increase again. The ministry of the environment therefore states in its environmental report (*Umweltbericht 2016*): "Significant efforts are still necessary to achieve the goals defined in the climate protection act" (Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur und Verbraucherschutz, 2016, p. 40, authors' translation).

Another recent event that may affect the likelihood of achieving the GHG emission goal for 2020 was the state election on 14 May 2017 in which the current government lost its majority. That government, which was formed by a coalition of Social Democrats and Greens, had designed the climate protection act of 2013 in which the emission goals for 2020 and 2050 are formulated. A new government may not feel the need to pursue the same goals. In fact, Armin Laschet, the leader of the victorious Christian Democrats and in all likelihood the new prime minister of NRW, has publicly stated that he does not support the emission goals of the climate protection act. The decisions of the new government will certainly affect the likelihood of the emissions goals being achieved or not.

[1] When observing a time series in real time, it is extremely difficult to discern fluctuations around a trend from a change in the trend. A well-known example of this problem is the discussion about the global warming "pause" (The Guardian, 2017).

Conclusion

We divide the conclusions into policy recommendations and lessons for sustainability science.

In terms of policy recommendations, our findings indicate that goals of climate policy and the goal of more "Decent Work" are not mutually exclusive. Given the right circumstances, it is possible to reduce GHG emissions as planned and simultaneously generate the 500,000 additional jobs. The next question is how to create the right circumstances. Our study can provide some indications, for example the measures that were reported in the interviews with representatives from several firms. However, we are not in a position to provide a concrete "checklist" with things to do that will guarantee the achievement of the aforementioned goals. Finding successful measures that take NRW to a path of Sustainable Development remains a task for discussion and exchange of information among experts and stakeholders. What is clear, however, is that some political action will be required if the goals are to be achieved.

From a scientific point of view, this project has been a valuable experience. In our view, interviews and contact with stakeholders are indispensable for projects of this kind. Examining data from the statistical offices will never yield a complete picture of a problem; a reasonable amount of fieldwork is definitely required. Furthermore, the project has shown the special challenges that arise when conducting scenario analysis for relatively short time horizons. In this case, there has been a remarkable reduction of GHG emissions from 2013 to 2014. It is hard to tell if this is simply a relatively large deviation from a stable trend or the emergence of a new trend. Finally, we would argue that better data on GHG emissions in subnational regions would be extremely valuable. The Environmental Economic Accounts (EEA) offers very good data at the national level. At the regional level, the power of scenario analysis is limited owing to the relatively poor availability of emission data. Perhaps a research project focussing on emission data collection could be useful.

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