How to Assess Investment Needs and Gaps in Relation to National Climate and Energy Policy Targets: a Manual - and a Case Study for Germany

- Summary for Decision Makers -

Berlin, August 2019

A report by

Juergens & Rusnok Advisors

Ingmar Juergens, Malte Hessenius, David Rusnok and Stefanie Berendsen

A deliverable under subcontract with IKEM e.V. and as part of the EUKI project "Climate Investment Capacity – Strategies for Financing the 2030 Targets" for the German Federal Ministry of the Environment . This project is supported by:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

European Climate Initiative EUKI

1. Introduction & Project Overview

The overall EUKI project and this report – One cornerstone of raising capital for the 2030 targets!

This report is part of the European Climate Initiative (EUKI) project "Climate Investment Capacity 2030 – Strategies for Financing the 2030 Targets". With the overarching objective of strengthening decision makers' capacity in tackling the 2030 investment challenge, the project is structured into three working packages to help address the following set of key questions:

1. **How much is invested (how, by whom, and in which sectors)?**
   Learning to analyse climate finance and investment flows and drawing up a Climate and Energy Investment Map (CEIM) for Germany.

2. **How much needs to be invested to reach the 2030 policy objectives?**
   Building up the necessary know-how for carrying out an Investment Need and Gap Analyses (INGA). A thorough discussion of the required analytical framework and a case study for Germany, including two sectoral prototypical analyses, are presented in this report.

3. **How do we get from the current investment level and structure (see 1.) to an investment framework, which leverages sufficient capital (see 2.) for achieving the climate and energy targets?**
   Based on CEIM (1.) and INGA (2.), this work package strengthens the capacity of the public sector to devise Capital Raising Plans (CRPs) and leverage the significant levels of (particularly) private finance required for a successful low-carbon and energy transition.

The project aims at strengthening the capacity of the public sector in the Czech Republic (CZ) and Latvia (LV), gearing and adapting the decision makers' know-how to the country challenges with the help of two national implementing partners (Czech Technical University in Prague [České vysoké učení technické v Praze - CVUT] and Riga Technical University [Rīgas Tehniskā universitāte - RTU]). Germany serves in this context as a case study to derive relevant learning and insights to inform the development and successful implementation of the national climate and energy plans in CZ and LV. This summary for decision makers presents the key findings of the report "Assessment of investment needs and gaps in relation to the 2030 climate and energy targets of Germany".

Why is this type of analysis relevant for decision makers?

The discussion of the most pertinent analytical approaches and models presented in the report provides an excellent basis for decision makers to understand what is required to get a solid, evidence-based understanding of the investment challenges posed by the complex transformation processes required to achieve national climate and energy targets. The National Energy and Climate Plans (NECPs), that every EU member state is required to draw up by the end of 2019, will need to specify how respective investments will be mobilised. Yet, the draft versions of these reports submitted to the European Commission in June 2019 showed very little reference and no detail regarding the investment dimension. The European Commission asked member states to provide more detail about their strategies to mobilize respective capital in the final versions of the NECPs. The ability to make use of the available analytical tools, to commission respective studies, to understand and appreciate the limitations and make use of the investment and finance estimates to inform policy decisions will be critical in filling this gap – and for implementing the NECPs successfully. Our report and related capacity building and networking activities contribute to further strengthening the skills of policy makers in the target countries. To make the material more tangible and concrete, we combine a thorough review of relevant tools (incl. their applications and limitations) with a German case study and two prototype reports at sectoral level (for renewable energy in the power sector and for the buildings sector). This provides credible insights from existing approaches employed by decision makers in a country with a long experience of implementing climate and renewable energy policies and leveraging significant levels of private climate and energy finance (Juergens et al 2012; Novikova et al 2019).

2. Methodical Framework

Building blocks for analysing the investment challenge: from mapping current investments (CEIM) to estimating investment needs/gaps (INGA) to plans for raising capital (CRP).

Figure 1 depicts the building blocks and their respective relationship mapped onto a timeline to guide the reader through the workstream of the project. The starting point for the analytical work is an establishment of the status quo, by developing climate and energy investment maps (CEIM), see Novikova et al. (2019) for a detailed discussion. In the next step, which is the focus of this report, investment needs for reaching national climate and energy policy objectives are estimated. In this context and as shown in Figure 1, the *Macroeconomic Factors* can be described as the basic starting point to assess investment needs as they determine the overall activity of an economy. *Energy Demand* is highly influenced by the overall economic activity. *Energy Supply* is usually derived from energy system and market models, which determine the share of fossil fuels and renewable energy. *Technologies* are adopted on supply and demand side. Based on these elements, models can project investment needs required to achieve national climate targets. Combined with the in-depth analysis of where the country stands regarding current investment flows (the CEIM), it is possible to get a better understanding of the remaining investment challenges or investment gaps. The final building block addressed in the third work package is the development of capital raising plans (CRPs), strategies to mobilize (private) capital to "fill the climate and energy investment gap".

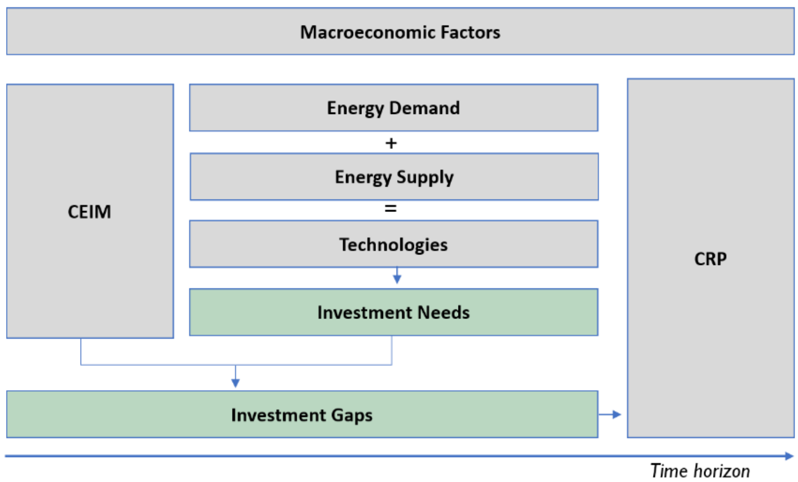

Figure 1 - Building blocks to assess investment need

3. Range of Tools to Assess Investment Needs (Model Families)

For the assessment of investment needs, different types of models and modelling frameworks can be used, which are briefly presented in Figure 2. The model families are used to illustrate the range of relevant models in use and to exemplify key elements of different analytical frameworks. Each of the modelling approaches is introduced in the following section.

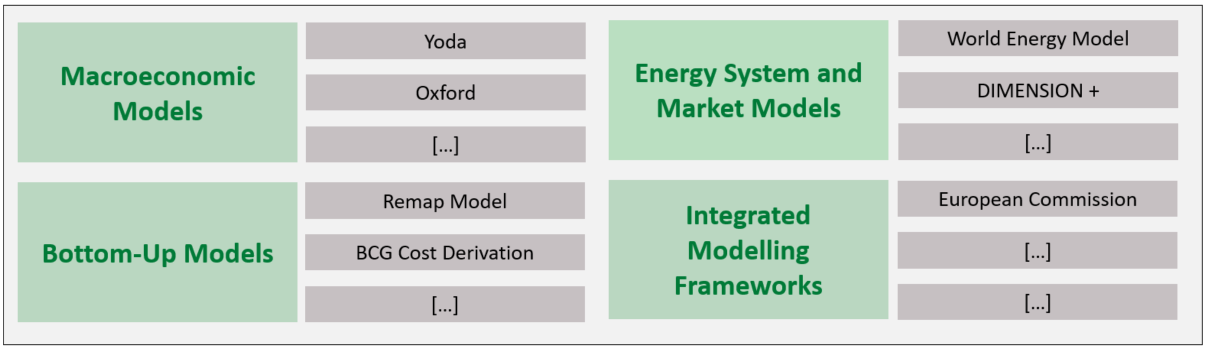

Figure 2: Model families

Macroeconomic models - capturing economic activity

The Oxford Global Economic Model is one example for an analytical tool widely used for macro-economic modelling with a special focus on trade and financial interlinkages. When employed to run a 2030-scenario, economic output is determined by a standard production function using capital flows, interest rates, technological progress, labour supply, trade volumes, exchange rates, and commodity prices as inputs. The comparative advantage of macro models includes their ability to capture “the big picture” in a coherent economy-encompassing manner, providing the economic context and important inputs or drivers of carbon and energy markets. The limitations of macro models (as compared to the energy system and market models discussed below) typically include a lower degree of precision, no or extremely limited sectoral disaggregation, as well as a very limited ability to capture issues changes in policy frameworks, social preferences, and institutional factors endogenously. Most modelling reports do not discuss these limitations or sensitivities of modelling outputs to these and other important factors.

Energy system and market models – demand and supply dynamics

The World Energy model, as one of the most widely employed models when it comes to scenario analysis of (global) energy market dynamics, is an iterative energy supply and demand model operated by the International Energy Agency. Main exogenous assumptions are economic growth, demographics, and technological developments, whereas the main output of interest in the context of our policy question, is the amount of investment required to meet the projected energy (service) demand. Advantages include very precise analysis of energy demand and supply based on expert know-how. Yet, its comparatively high degree of detail leads to a much higher complexity, which reduces transparency of how modelling outputs are derived and hides important sensitivities (which again, are generally not highlighted in respective modelling reports and publications).

Bottom-up models

Bottom-up cost derivation usually draws extensively on inputs from "industry" experts to assess the cost structure and dynamics of climate and energy technology. One flagship publication "BDI – Klimastudie" (2018), for instance, extracted and then aggregated know-how from companies, associations and economists (established through a major participatory effort, comprising 40 workshops) and used the resulting numbers to parametrise a technology-rich bottom-up model (by Prognos). The advantages include coverage of wide range of technologies, an easy-to-understand modelling structure and the ability to reflect social and political dimensions. Building bottom-up models is, however, very complex and yet again, also with regard to this model family, reports shy away from the discussion of sensitives.

Integrated modelling frameworks

To capture all possible interlinkages (e.g. between macroeconomic factors, agriculture, land use and energy processes), it is convenient to use the best models in their respective sphere and link their in- and outputs together. One important modelling framework used for analysing and providing insights for EU climate and energy policy making is the one adopted by the European Commission. The main advantage is that the comprehensive model includes "best individual models" into one integrated framework, where models are specifically geared to be more easily linked to each other, including interfaces specific to the other models included in the framework. The possibility to apply integrated modelling frameworks for daily work is very limited due to its complexity. For some policy applications it can be easier to focus on specific energy market models or technology models, without modelling explicitly all linkages included in integrated modelling frameworks.

4. Key Findings from reviewing the state of knowledge about climate and energy investment needs for Germany

4. 1 Building Sector

A number of studies have estimated Germany's investment needs to reach national climate goals (2030/2050) for the overall economy. As different time horizons, key questions and modelling scopes do not make a comparison straight-forward, we calculated the investment needs per year. Investment needs to achieve climate targets in Germany in 2030 and 2050 are in a range of EUR 20.0 – 58.3 billion per year – on the top of what will be invested in the reference case (see Figure 3). What explains the difference? (1) Different GHG reduction targets and/or different reference case (baseline), and (2) different model assumptions with regard to learning curves, oil/energy price development, etc. Conducting a sensitivity analysis (and first of all, being aware of the key sensitivities), is, therefore, crucial.

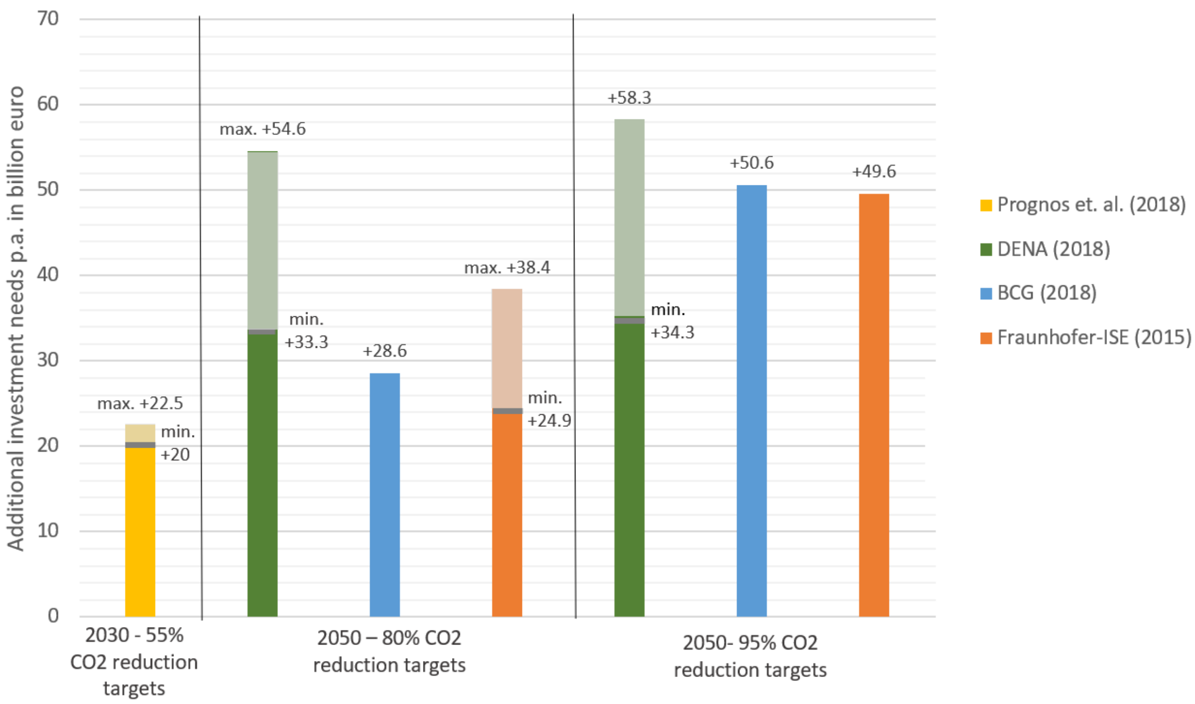

Figure 3: Summary of results for climate/energy investment needs for Germany[1]

Background information – sectoral targets will be missed

The building sector is responsible for 35% of final energy consumption in Germany (thereof 22.1% private households, 10.8% tertiary sector, 2.5% industry). According to Germany's sectoral targets, primary energy consumption shall fall by 80% till 2050 compared to 2008 levels (BMWi and BMU, 2010). The targets for 2020, however, will most probably be missed by a wide margin[2]. Significant additional action will be required.

The modelling framework needs to cover a complex structure and interlinkages

The final energy consumption of the building sector derives from complex interlinkages and the following aspects need to be included into the analysis of investment needs for the building sector: socioeconomic variables such as population growth, weather patterns, technological stock such as building characteristics, be-havioural patterns, ownership, and interest rates.

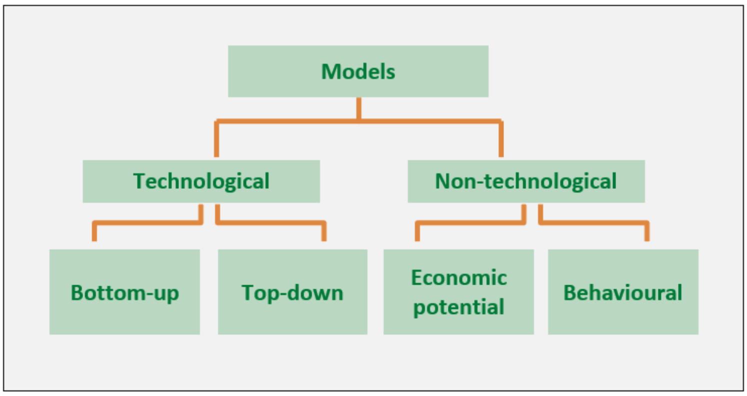

Figure 4: Building sector models

A brief possible classification on how to assess GHG mitigation potential and its costs in the building sector is depicted in Figure 4. Typically, for a detailed sector assessment bottom-up models are used rather than top-down

[1] A tabular representation with further details can be found in Annex I, Table 1.
[2] -6.3% in final energy consumption in 2016 opposed to -20% in 2020 (BMWi 2018b).

approaches. On the non-technological side, the economic potential through changes in energy use patterns is not very well researched. However, more and more decision models examine behavioural aspects such as rebound effects due to higher energy efficiency or lower prices.

Results from selected studies - building sector Germany

Figure 5 depicts the range of results from selected studies on investment needs in Germany in the building sector to achieve climate targets in 2030/2050. Overall, the estimated investment figures range between EUR 2.1 and 29.3 billion per year. What explains the variation? (1) Different GHG reduction targets and/or different reference case (baseline), (2) individual assumptions, e.g. some studies consider only renewable energy technologies as possibility to reduce CO2-emissions in the energy sector, others have different visions on learning curves and their impact on technology costs, among others.

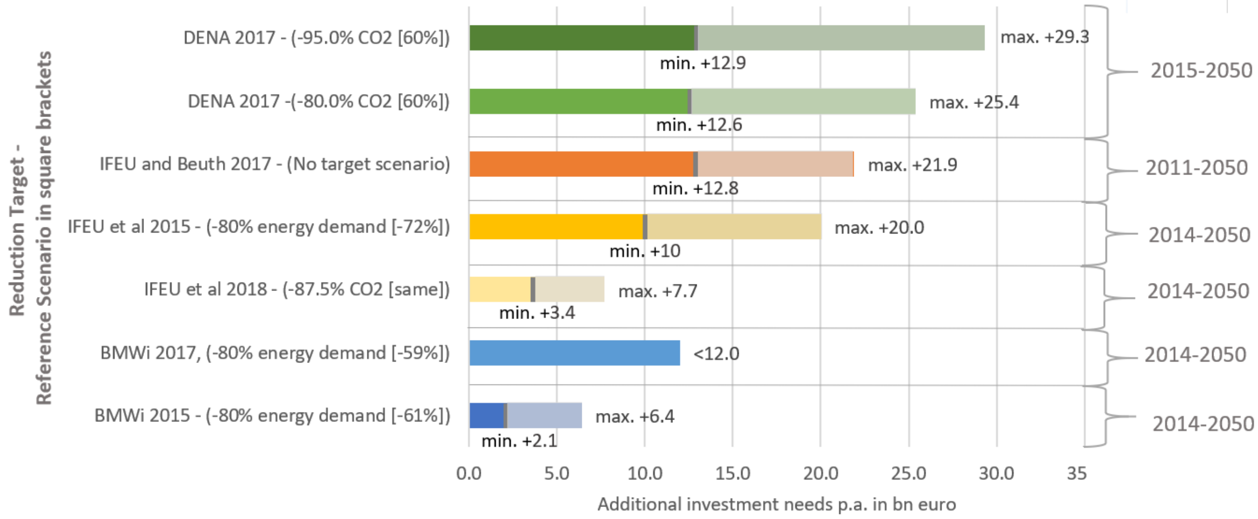

Figure 5: Selected studies in the renewable energy sector, Germany[3]

4.2 – Power Sector

Background information – renewable energy target will be missed

In 2016, the energy sector was responsible for 36.6% of Germany's GHG emissions (UBA, 2016). With 33.3% of produced electricity through renewables in 2018, Germany seems to reach the target of 35% by 2020 (BMWi, 2018a). However, Germany is likely to miss the target of 18% renewables in gross final energy consumption (European Renewable Energy Directive 2009), due to slower achievements in the heat and transport sector.

Power sector models – building blocks

For modelling the power sector, there is a trade-off between scope (i.e., the coverage of models – only electricity sector or also coupling with heat and transport) and resolution (i.e., the granularity of data – depending on considered time period or geographic coverage, among others), as both are very

[3] A tabular representation with further details can be found in Annex I, Table 2.

costly in terms of data collection and model maintenance. The stronger the focus on electricity production, system operation, and related technical details, the higher the temporal resolution and granularity necessary for modelling them. Vice versa, the stronger the focus on the electricity sector and the long-run development of the energy system, the more operational and macro-economic factors have to be considered. The dynamics are presented in Figure 4.

Macro Models	Energy System Models	Investment in Power Plants	Electricity Production	Grid Models
Economic Activities	Electricity Demand	Investment Potential	Commitment & Dispatch	Local Marginal Prices
Population	Electricity Supply	Decommission-ing potential	Zonal Power Prices	Load Flows
[...]	Sector Coupling	Optimal Capacity Mix	Electricity Flows	System Security

Figure 4 - Power sector models building blocks

Results from selected studies – power sector Germany

Figure 6 presents investment need estimations in the power and energy sector in Germany in order to achieve climate targets in 2030/2050[4]. Overall the investment figures range between EUR 4.2 and 12.8 billion per year. The variation can be explained with (1) different GHG reduction targets and/or different reference case (baseline), (2) different definition of what constitutes the energy sector (including (or not) heating and power, grid-expansion).

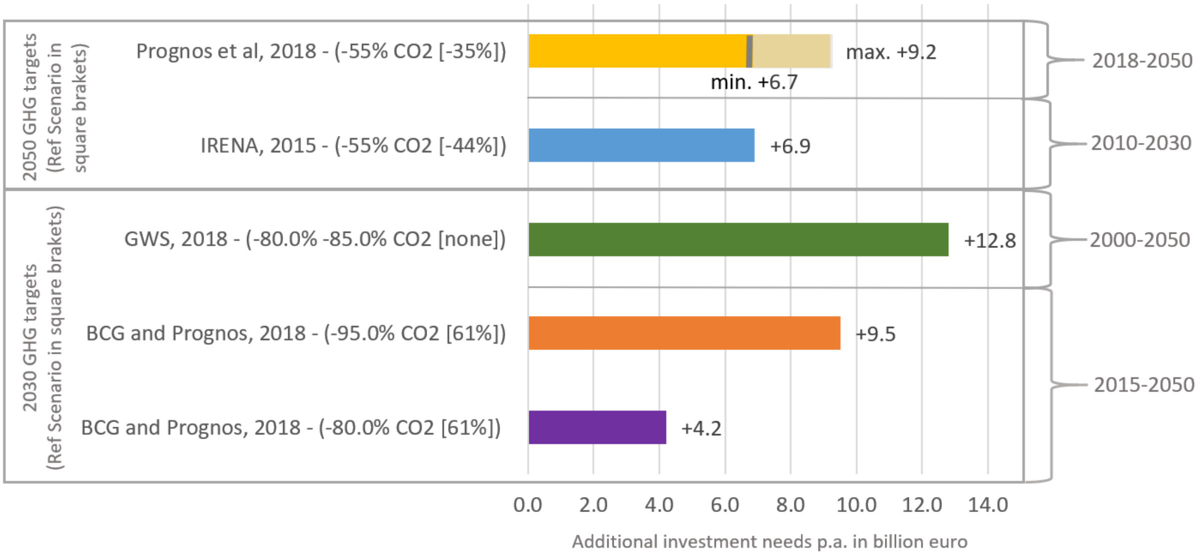

Figure 6: Findings power and energy sector[5]

[4] The terms "power sector" (only electricity production) and "energy sector" (can also include the heat and transport sector) are some commonly confused terms. In our figure, studies by BCG & Prognos, IRENA and GWS only deal with the power sector but the study by Prognos et al. also with the heating sector. The power sector covers "renewable energy investment" but also infrastructure related expenditure.
[5] A tabular representation with further details can be found in Annex I, Table 3.

5. Conclusion & Link to Climate Policy Process

Take-Home Messages

Pay attention to assumptions: estimates of investment needs depend on assumptions taken along the course of the modelling process. Important ones are price assumptions for fuel, carbon credits, technologies, learning curves and macroeconomic expectations.

Understand the scenarios used and especially what is and what is not included in the baseline. Our analysis shows that the single biggest factor causing variation comes from the definition of the baseline scenario, as studies are always comparing scenarios against a counterfactual case which assumes constant political ambitions. Moreover, results are stated as additional costs on top of the reference case.

Climate and energy investments are no ends in themselves: but are important means for reaching specific energy and climate policy objectives. Translating targets into respective investment needs and gaps, as required within the National Energy and Climate Plans, enhances our understanding of the necessary steps and their costs to achieve decarbonisation of our economies in the long run. However, investments alone will not reach the targets and a suite of additional measures will be required to successfully steer the climate and energy transition.

REFERENCES

BCG (Boston Consulting Group) and Prognos AG (2018). Philipp Gerbert, Patrick Herhold, Jens Burchardt, Stefan Schönberger, Florian Rechenmacher, Almut Kirchner, Andreas Kemmler and Marco Wünsch. Klimapfade für Deutschland. A study commissioned by the BDI. (link)

BMWi (2015). Energy Efficiency Strategy for Buildings - Methods for achieving a virtually climate-neutral building stock. (link)

BMWI (2017). Langfrist- und Klimaszenarien. Study carried out by Fraunhofer ISI, Consentec and IFEU. (link)

DENA (2018). Leitstudie Integrierte Energiewende – Impulse für die Gestaltung des Energiesystems bis 2050. (link)

DENA (2018a). dena-GEBÄUDEREPORT KOMPAKT 2018. Statistiken und Analysen zur Energieeffizienz im Gebäudebestand. Deutsche Energieagentur, 4/2018

EU High-Level Expert Group on Sustainable Finance (2018). Financing a Sustainable European Economy. (link)

Fraunhofer-ISE (2015). What will the Energy Transformation cost? – Pathways for transforming the German energy system by 2050. (link)

GWS, Fraunhofer ISI, DIW Berlin, DLR and Prognos AG (2018). Gesamtwirtschaftliche Effekte der Energiewende. Commissioned by BMWi. (link)

IFEU, IWU, Ecofys, Universität Bielefeld (2015). Weiterentwicklung des bestehenden Instrumentariums für den Klimaschutz im Gebäudebereich - Sanierungsfahrplan. Commssioned by BMWi. (link)

IFEU and Beuth Hochschule (2017). Anlagenpotenzial - Ableitung eines Korridors für den Ausbau der erneuerbaren Wärme im Gebäudebereich. (link)

IFEU, Fraunhofer IEE and Consentec (2018). Wert der Effizienz im Gebäudesektor in Zeiten der Sektorenkopplung. Studie im Auftrag von Agora Energiewende. (link)

IRENA (2015). Renewable Energy Prospects – Germany. *Part of REmap 2030 – A Renewable Energy Roadmap.* (link)

Prognos et. al. (2018). Folgenabschätzung zu den ökologischen, sozialen und wirtschaftlichen Folgewirkungen der Sektorziele für 2030 des Klimaschutzplans 2050 der Bundesregierung. (link)

UBA (2018a). German Environment Agency, National Inventory Reports for the German Greenhouse Gas Inventory 1990 to 2016 (as of 01/2018) and initial forecast for 2017 (UBA press release 08/2018). Retrieved from link, checked on 17/01/2019.

Annex I

Table 1 – Studies investigating total (additional) investment costs in relation to 2030 & 2050 GHG emission reduction targets.

ID	Study	Inv. Needs p.a.		Reference
	Authors	*Min. Bn €*	*Max. Bn €*	*GHG reduction*
2050 – 80 % targets				
1	DENA	+33.3	+54.6	-62%
2	BCG	+28.6		-61%
3	Fraunhofer-ISE	+24.9	+38.4	Not stated
2050 – 90/95% targets				
1	DENA	+34.3	+58.3	-62%
2	BCG	+50.6		-61%
3	Fraunhofer-ISE	+49.6		Not stated
2030 – 55% targets				
4	Prognos	+20.0	+22.5	-35%

Table 2 - Selected studies and their results on investment needs in the building sector

ID[6]	Study	Inv. needs p.a.		Reduction target
	Authors	Min bn€	Max bn€	*Ref Scenario in brackets*
1	IFEU (2018)	+3.4	+7.7	-87.5% CO_2 [same]
2	DENA	+12.6	+25.4	-80.0% CO_2 [-60%]
2	DENA	+12.9	+29.3	-95.0% CO_2 [-60%]
3	IFEU & Beuth	+12.8	+21.9	*no target scenario*
4	IFEU (2015)	+10[b]	+20[b]	-80% energy [-72%][C]
5	BMWi (2017)	<12[a]		-80% energy [-59%][C]
6	BMWi (2015)	+2.1	+6.4	-80% energy [-61%][C]
7	BDI	+ 12.3		-80% CO_2 [-61%]
7	BDI	+18.2		-95% CO_2 [-61%]

Notes:
"Investment needs p.a." state the additional investment needs on top of the reference scenario. "Reduction target" links to the target achievement scenario. The reduction in GHG emissions achieved by the BAU case is presented in square brackets.
a: Costs in this study are not stated in accumulated terms but only for every 10th year. Annual additional investment costs range from +1.1 bn € in 2020 to +12 bn € in 2050. **b:** As in note a, costs are not mentioned in cumulative terms. In the majority of years costs are 10-20 bn € higher than the reference case. **c**: compared to 2008.

[6] Footnotes on IDs: 1 – see IFEU et al, 2018, chapter 3.3.1); 2 –see DENA, 2017, figure 7; 3 – see IFEU and Beuth Hochschule, 2017, table 6.6 & 6.7; 4 – see IFEU et al, 2015, section 5.2.4 ; 5- see BMWI, 2017, module 3, table 41; 6 – see BMWi, 2015, table 24; 7 – see BCG and Prognos, 2018, figure 66

Table 3 - Overview of Selected Studies - RE Investment Needs

ID	Study	Investment p.a.		GHG reduction
	Authors	*Min. Bn €*	*Max. Bn €*	*Reference in []*
2050 GHG reduction targets				
1	BCG & Prognos	+4.2		-80.0% [-61%]
1	BCG & Prognos	+9.5		-95.0% [-61%]
2	GWS	+12.8		-80%-85% [none]
2030 GHG reduction targets				
3	IRENA	+6.9		-55% [-44%]
4	Prognos	+6.7	+9.2	-55% [-35%]

Notes:
Explanation Columns: “Investment needs p.a.” state the additional investment needs on top of the reference scenario. “GHG reduction target” links to the target achievement scenario. The reduction in GHG emissions achieved by the BAU case is presented in square brackets.
Footnotes on IDs: 1 – see BCG and Prognos, 2018, figure 75; 2 – see GWS, 2018, chapter 3.2.5, comparison to a counterfactual scenario!; 3- see IRENA, 2015, table 10, number stated in US dollars; 4- see Prognos et al, 2018, Summary file chapter 5.1 of the full report.