Economic barriers to energy services and energy efficiency improvement projects in German Industrial Sector – a multiple-case study

by

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Abstract

The member states of the European Union have committed themselves to the reduction of energy consumption in order to reduce the emission of greenhouse gases, to which global warming is attributed. The Federal Republic of Germany has announced its intention to increase energy efficiency by using Energy Services from Energy Service Companies.

Contrary to the assumptions about existing potentials, the development of this market – both globally and in relation to Germany – has so far been sub optimal, the existence of barriers is held responsible for this. Although there is a growing volume of papers on different aspects of these barriers, the area of economic barriers for the industry sector in Germany has not yet been examined.

This research filled this gap.

The multiple-case study strategy employing semi-structured interviews was used for this research, in order to understand the phenomenon in depth, identify the most important barriers on the basis of a conceptual barrier framework and develop recommendations to overcome these barriers. The use of the multiple-case study research strategy made it possible to obtain transferable results whose credibility was underpinned by carefully collected data.

Research participants came from the stakeholders Energy Service Company, customer organisations as well as third party financing organisations involved in energy efficiency improvement projects.

It was found that from the common point of view of the stakeholders involved, 'External Risks' and 'Low Capital Availability' were the most significant barriers.

Furthermore, it was found that additional barrier issues were not yet part of the existing barrier frameworks. The barrier 'Accounting Standards' was therefore added as a further barrier.

Recommendations were derived both for policy and practice of the Energy Service Company involved.

The safeguarding of the status of energy legislation was recognised as a major political contribution in order to create a sufficiently secure basis for decision-making on the necessary investments – at least for existing measures.

The Energy Service Company recognised the need to offer a comprehensive energy service scope in order not to lose ground to providers of specialised services.

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List of Abbreviations

BAT ..... Best Available Technology
ca. ..... circa
CCHP ..... Combined Cooling, Heat and Power (= Trigeneration)
CHP ..... Combined Heat and Power (= Cogeneration)
CO2 ..... Carbon Dioxide (= Greenhouse Gas)
DBA ..... Doctor of Business Administration
e.g. ..... *Latin: 'exempli gratia'* (= for example)
EC ..... European Commission
EE ..... Energy Efficiency
EED ..... Energy Efficiency Directive
EEG ..... *German: 'Erneuerbare Energien Gesetz*' (= German Renewable Energies Act)
EEI ..... Energy Efficiency Improvement
EPC ..... Energy Performance Contract
ES ..... Energy Service
ESC ..... Energy Supply Contract
ESCO ..... Energy Service Company
et al. ..... *Latin: 'et alii'* (= and others)
EU ..... European Union
EUR ..... Euro (= official Currency of the Eurozone)
FY ..... Fiscal Year
GAAP ..... General Accepted Accounting Principles
HGB ..... *German: 'Handelsgesetzbuch'* (= German Code of Commercial Law)
i.e. ..... *Latin: 'id est'* (= that is)
IAS ..... International Accounting Standards
IFRS ..... International Financial Reporting Standards
KfW ..... *German: 'Kreditanstalt für Wiederaufbau*' (= German National Development Bank)
KWKG ..... *German: 'Kraft-Wärme-Kopplungsgesetz'* (= German Combined Heat and Power Act)
LED ..... Light Emitting Diode
Max. ..... Maximum
Mio. ..... Million
N/A ..... not applicable
NACE ..... *French: 'Nomenclature statistique des Activités économique dans la Communauté Européenne*' ..... (= Statistical Classification of economic Activities in the European Community)
NEEAP ..... National Energy Efficiency Action Plan
p. ..... Page
pp. ..... Pages
TPF ..... Third Party Financing
UK ..... United Kingdom

List of Abbreviations

UN ..... United Nations

UNFCCC ..... United Nations Framework Convention on Climate Change

USA ..... United States of America

Glossary

This glossary contains essential terminology for this research. In addition to those taken from the Energy Efficiency Directive (EED) of 2006 (European Parliament, 2006), further key terms are added and defined below, cross references are highlighted in bold. For reasons of systematic presentation, the definitions of the key terms are not sorted alphabetically, but are grouped together thematically in five clusters:

- 'Energy, Efficiency and corresponding Legislation';
- 'Stakeholder System';
- 'Financing Methods';
- 'Energy Service Contracts';
- 'Accounting Standards'.

Table G-1 – Key Terms: Energy, Efficiency and corresponding Legislation

The following definitions are based on the Energy Efficiency Directive (EED) of 2006 (European Parliament, 2006); further terms relevant in this context, whose definitions are not provided by the EED, have been added accordingly.

Energy	*"All forms of commercially available energy, including electricity, natural gas (…), liquefied petroleum gas, any fuel for heating and cooling (including district heating and cooling), coal and lignite, peat, transport fuels (excluding aviation and maritime bunker fuels) and biomass (…)"* (European Parliament, 2006). Covered by the definition provided by the EED are only types and sources of primary energy (non-renewable/fossil like natural gas, crude oil, coal; renewable like sunlight, wind, hydropower, geothermal heat) or final energy (like heating oil) respectively. In a wider sense the term energy also can subsume useful energy streams. Examples of useful energy streams include steam, cooling or hot water, compressed air and electricity, or final services like thermal comfort (i.e. heating and cooling) and illumination (Nolden et al., 2016, p. 421), as well as ventilation, process heat and motive power (Sorrell, 2007, p. 509). Reducing useful energy consumption leads to a reduction in final energy use and hence primary energy demand. In the context of this research, final energy as well as useful energy streams are integrated in the term 'Energy'.
Energy Efficiency *(EE)*	*"A ratio between an output of performance, service, goods or **Energy**, and an input of **Energy**"* (European Parliament, 2006). The definition provided by the EED will be used in this research.
Energy Efficiency Improvement *(EEI)*	*"An increase in **Energy** end-use efficiency as a result of technological, behavioural and/or economic changes"* (European Parliament, 2006). EED's definition of EEI does not distinguish between EEI and **Energy** saving – the latter is subsumed to EEI. In this research, the following distinction is used: **Energy** saving refers to a change in consumer behaviour using existing technology, while EEI refers to lowering **Energy** use without changing consumer behaviour, but with the application of specific – best available – technologies (BAT) that reduce **Energy** consumption (Oikonomou et al., 2009, p. 4787). So, EEI in general is an effect of technological but not behavioural and/or economic changes. BAT are technologies, that are already developed and successfully applied (Cagno and Trianni, 2012, p. 2). Furthermore, all activities within the meaning of improving **EE** are referred to as (EEI) measures, they are physically and organisationally implemented via (EEI) projects. In certain contexts of this research, nevertheless, the terms 'Measure' and 'Project' may be used synonymously. EEI projects consist of three main phases – the design, implementation and operation phases. These phases may be subdivided in several process steps. Summing up, in the context of this research EEI can be reached via measures in the area of **ES**, provided by an **Energy Service Company** (normally in the form of an **Energy Service Contract**), correspondent investments in BAT to be financed up-front may be funded by a **stakeholder** other than the **Customer**, in general a **Third Party Financing** organisation using one of the **Financing Method**s – or the **Energy Service Company** as well, as the case may be.

Energy Service *(ES)*	*"The physical benefit, utility or good derived from a combination of **Energy** with **Energy** efficient technology and/or with action, which may include the operations, maintenance and control necessary to deliver the service, which is delivered on the basis of a contract and in normal circumstances has proven to lead to verifiable and measurable or estimable **Energy Efficiency Improvement** and/or primary **Energy** savings"* (European Parliament, 2006). Within the definition of EED, the term ES is defined in a narrow sense, in which a contribution from a provider, which does not necessarily have to be an **Energy Service Company**, is already enclosed. In his conceptual review, Fell (2017, p. 132) identified 173 (slightly differing) variations of the term ES. In this research, the definition above from EED will be used in the amended form of Duplessis et al. (2012, p. 268), where services offered by an **Energy Service Company**, such as implementation engineering as well as financial services may be included in ES. As a subset of ES, Duplessis et al. (2012), used the so-called **Energy** Efficiency Services (EES). These are additionally characterised by contractually agreed performance criteria. This additional distinction is not relevant for the purpose of this research. So EES is subsumed and referred to as ES. In the literature, ES is also sometimes referred to as **Energy** contracting service. Both terms are synonymous, in the following, only ES is used.
German Renewable Energy Sources Act – Gesetz für den Ausbau erneuerbarer Energien (Erneuerbare Energien Gesetz, EEG, 2017)	The purpose of the German 'Gesetz für den Ausbau erneuerbarer Energien' (2017) is, above all in the interest of climate and environmental protection, to enable the sustainable development of energy supply, to reduce the costs of energy supply for the German economy, to conserve fossil energy resources and to promote the further development of technologies for the generation of electricity from renewable energies. Another goal is to increase the share of electricity generated from renewable energies in gross electricity consumption. The original version of the act dates from 2000 and was amended in 2004, 2009, 2012, 2014 and for the last time in 2017. With significance for this research, the act regulates above all... • ...feed-in tariffs granted for self-generated electricity (the act below – KWKG – regulates the situation for electricity generated in CHP plants). • ...levies charged by utility organisation in connection with energy consumption of all consumers (as well as exemptions from these levies for energy-intensive organisations, when certain conditions are met), which in turn are used to cover the feed-in tariffs granted by this act.
German Combined Heat and Power Act – Gesetz für die Erhaltung, die Modernisierung und den Ausbau der Kraft-Wärme-Kopplung (Kraft-Wärme-Kopplungsgesetz, KWKG, 2018)	The purpose of the German 'Gesetz für die Erhaltung, die Modernisierung und den Ausbau der Kraft-Wärme-Kopplung' (2018) is to increase net electricity generation from combined heat and power plants in the interest of saving energy and protecting the environment and climate. The original version of the act dates from 2002 and was amended in 2004, 2009, 2012, 2015 and for the last time in 2018. With significance for this research, the act regulates above all... • ...feed-in tariffs as well as surcharges for electricity from CHP plants. • ...payment of bonifications by grid operators for CHP plants. • ...allocation of costs.

Table G-2 – Key Terms: Stakeholder System

Basic **EEI** measures can be executed without advanced support from specialised organisations. In contrast, complex **EEI** measures typically require the expertise of specialised and experienced organisations and normally involve significant investments, so several (at least two) stakeholders participate in these projects. Funding of investments can be provided by each of the two compulsory stakeholders of **EEI** projects or an optional third stakeholder. Some of the following definitions again are provided by the EED.

Customer	As the initial stakeholder and compulsory to an **EEI** project, the Customer organisation is set. The consumption of **Energy** attributable to this organisation is to be reduced by an **EEI** measure, implementing BAT. Customer organisations come from private households, public/ municipal sector, real estate/residential sector as well as the industrial sector. Hence, **ES** provided by **Energy Service Companies** are seen as an unsuitable option for private households. This Customer sector is therefore omitted in all further considerations in this research. The public/municipal sector is a major Customer for **ES** with **Energy Performance Contracts**. However, the focus of this research is primarily on the field of industrial Customers and **Energy Supply Contracts**.
Energy Service Company *(ESCO)*	*"A natural or legal person that delivers **Energy Services** and/or other **Energy Efficiency Improvement** measures in a user's [= the **Customer**] facility or premises and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of **Energy Efficiency Improvements** and on the meeting of the other agreed performance criteria"* (European Parliament, 2006). The definition provided by the EED will be used in this research. Components of a complex **EEI** measure can be bundled together in **ES**. For the purposes of this research ESCOs are seen as providers of **ES**, so ESCOs are treated as the second compulsory stakeholder in an **EEI** project. **EEI** can be seen as the strategy to reduce **Energy** consumption through technology (on the **Customer** side), as well as the business model for ESCOs, the providers of technology and services combined in **ES**. In Germany, ESCOs offer comprehensive **Energy Service Contracts** with a typical payback time of between five and 15 years (Bertoldi et al., 2007, p. 29), that may include **Energy** analysis, audit, management and control systems, project design, implementation of **Energy** conversion, distribution and control equipment, operation and maintenance of equipment, facility management, primary **Energy** (and/or final **Energy**) purchase, the supply of useful **Energy** streams, monitoring and evaluation of savings as well as financing of EEI investments. The business model of an ESCO includes billing for services instead of billing directly for (primary or final) **Energy** used (Fell, 2017, p. 132), By contracting an ESCO, the **Customer** can reduce **Energy** costs and transfer technical and financial risks. Through the opportunity for the **Customer** to refocus on its core activities, this model has strong parallels to other forms of outsourcing (Sorrell, 2007, p. 507; Nolden et al., 2016, p. 421). Risks for the business of ESCOs may emerge from volatile primary **Energy** and dependent final **Energy** prices during the long **Energy Service Contract** term. In the context of guaranteed savings in **EPC** these are to be covered and borne by the ESCO because of performance and billing mechanisms. The remuneration of the ESCO can be linked directly to the achievement of **EEI** and on reaching specific performance criteria (Marino et al., 2011, p. 6191).
Third Party Financing *(TPF)*	*"A contractual arrangement involving a third party – in addition to the **Energy** supplier [the **ESCO**] and the beneficiary of the **Energy Efficiency Improvement** measure [the Customer] – that provides the capital for that measure and charges the beneficiary a fee equivalent to a part of the **Energy** savings achieved as a result of the **Energy Efficiency Improvement** measure. That third party may or may not be an **ESCO** [in the positive case it is therefore not the third but also the second party]"* (European Parliament, 2006). The definition provided by the EED will be used in this research, however, in the context of this research **ESCO** and TPF are distinct parties. As optional further party and hence third stakeholder, the TPF organisation is required to finance those **EEI** measures by TPF, which cannot be covered by the **Customer**'s or the **ESCO**'s internal funds. Various **Financing Method**s are used, depending on a) the type of **Energy Service Contract**, b) underlying policies concerning investments in fixed assets in relation to the **Accounting Standards** applied and c) available forms of collateral on the part of the first two stakeholders. According to Labanca (2010, p. 50), the TPF can act as contractual partner for one of the compulsory two stakeholders, which results in the following two conceptually different TPF arrangement options: a) The **Customer** borrows the financial resources necessary for the **EEI** project, or b) The **ESCO** borrows the financial resources necessary for the **EEI** project. As a collateral in option b), the credit may be backed by contracting rates from the **Energy Service Contract** between the **Customer** and the **ESCO** showing that the payments contracted will cover the debt. The TPF organisation can also take over the rights on **Energy** savings or the invested fixed assets as collateral in options a) and b). Governmental funding schemes such as subsidies and tax deductions reduce the net investment required and hence can be seen as a supplement to TPF (Labanca, 2010, p. 51). Hence, important aspects of TPF are collateralisation and accounting issues (capitalisation of fixed assets).

Further Stakeholders	Depending on the type of **Energy Service Contract**, two or all three of the above stakeholders may be contractually connected. In addition, other parties may be directly or indirectly involved in an EEI project, such as utility organisations, **Energy** consultants, manufacturers of **EE** technology (BAT) and (handcraft) installers. These may act as... • ...supplier to an **ESCO** as the second compulsory stakeholder – as such outside the **EEI** stakeholder system, or • ...provider of specific **ES** on their own – as such in the role of the second stakeholder (= the **ESCO**) in this context. **EEI**, with its inherent objective of reducing **Energy** consumption, is at odds with utility organisations' business model, which is based on meeting the (primary and final) **Energy** needs of their **Customers** - the higher the consumption, the better. However, in **ESCO** literature utility organisations are treated as **EEI** stakeholders. Beyond these (potential) parties in an **EEI** project, other stakeholders are indirectly involved, such as (governmental) authorities – as well as academics, energy consultants and experts and energy agencies. Thus, in the scope of this research the stakeholder system does not include any other parties besides those three stakeholders defined as key terms above.

Table G-3 – Key Terms: Financing Methods

Especially in the area of **EEI** projects in the industrial sector significant investments have to be financed.

As optional third stakeholder, a TPF organisation may be required to finance those measures, which cannot be covered by the **Customer**'s or the **ESCO**'s internal funds.

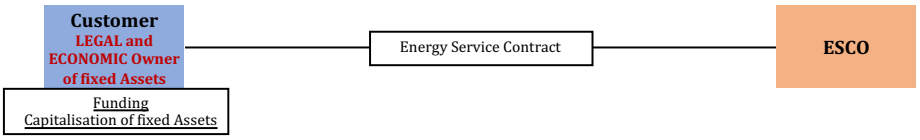
In connection with the chosen financing method, the **Accounting Standards** to be applied result in different effects for the **Stakeholders**. These mainly relate to the capitalisation of **EEI** equipment and are also further examined below.

The underlying contract structure is presented specifically for each of the main financing methods described.

Customer Financing (own Funds)

The easiest way to finance EEI measures is to use the Customer's own resources. The transaction cost situation of the measure also benefits from such 'streamlined' contract design.

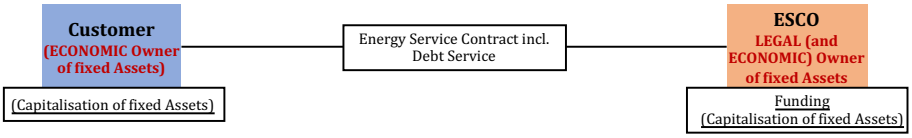
Figure G-1 – Financing by Customer: Contract Structure



ESCO Financing (own Funds)

EEI measures may also be financed by the ESCO, using own funds.

Figure G-2 – Financing by ESCO: Contract Structure



For the financing, the ESCO charges a debt service that forms part of the remuneration and is paid over the contract term. Customer or ESCO can achieve economic ownership with this financing method.

Financing of **EEI** investments provided by the ESCO may also involve funding through other (external) instruments – as described in the financing methods below by using TPF with the ESCO as contractual partner of the TPF organisation.

ESCOs can use guaranteed savings streams to secure the financing and serve as market aggregators by opening **EEI** project portfolios to **TPF** (Sarkar and Singh, 2010, p. 5565). Furthermore, ESCOs introduce a way to facilitate access to commercial financing and to private financing of public/municipal sector infrastructure.

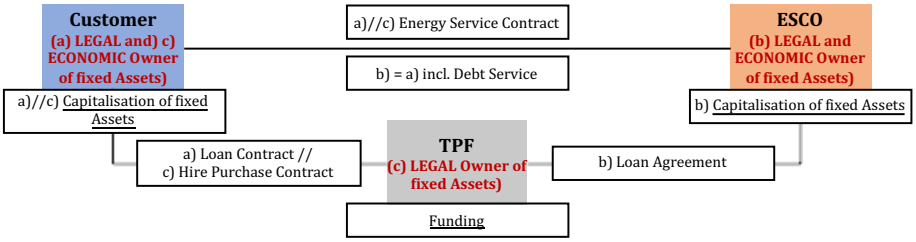
Loan Financing // Hire Purchasing

In the case of loan financing, a **TPF** organisation provides the borrowing **Stakeholder** (the **Customer** – case a)) or the **ESCO** – case b)) with capital for the **EEI** investment. In cases a) and c) financing is used to pay the purchase price for the equipment to the **ESCO**. In case (c), the **ESCO** uses the funds received to refinance its investment. Depending on the case, **Customer** or **ESCO** respectively gain legal as well as economic ownership of the fixed assets invested.

In the case of hire purchase (case c)), the **TPF** organisation finances the EEI measure and gains legal ownership on the fixed assets, while the economic ownership of the EEI equipment is transferred – in general – to the **Customer**. At the end of the hire purchase term, the legal ownership is also transferred to the **Customer**.

Figure G-3 – Financing by TPF Organisation: Method of Loan as well as Hire Purchase Financing; Contract Structure in three cases

Based on (Bleyl-Androschin and Schinnerl, 2010, pp. 19-35)



The loan in cases a) and b) (or the hire purchase in case c)) is settled over a fixed period of time, with a scheduled number of instalments (= debt service). These instalments have to cover the total of the amount borrowed (or the purchase price respectively) and resulting interest rates.

Concerning capitalisation of assets, in the case of loan financing as well as hire purchasing no substantial differences can be seen between the **Accounting Standards** considered.

Lease

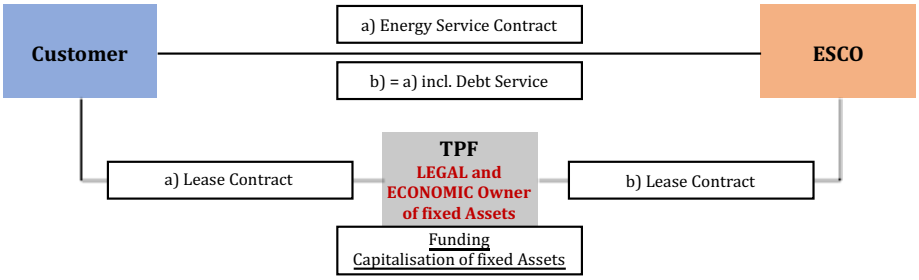
Lease is another way of obtaining the usage right of an asset from an **EEI** measure, hence the economic but not the legal ownership. In a first step, the equipment invested is sold from the **ESCO** to the TPF organisation, that pays for the purchase price. Then, the user (the **Customer** or the **ESCO**) only has to pay for the use of the asset in form of lease instalments (= debt service), while exclusive rights to this use are granted by the (legal) owner. Lease is based on a contract between the owner (**TPF** organisation = the lessor), and the user (**Customer** or **ESCO** = the lessee).

Two basic lease types can be distinguished: operate lease and finance lease. The distinction is relevant with regard to capitalisation aspects resulting from **Accounting Standards**.

Beyond that there are also more complicated lease models which distinguish between full- and part-amortisation (with residual value) contracts as well as contracts including advance payments or not, all of which are applicable to **ES** financing. Their details will not be further investigated.

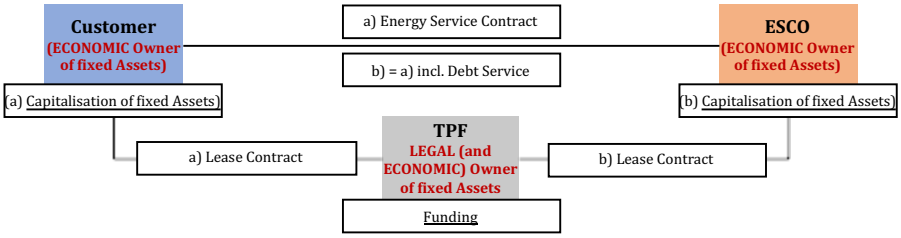
In the case of operate lease, the lessor holds both legal and economic ownership of the invested fixed assets. This enables an off-balance solution for both the **Customer** (case a)) and/or the **ESCO** (case b)), i.e. the operate lease does not require disclosure in one of the balance sheet items of one of these two stakeholders.

Figure G-4 – Financing by TPF Organisation: Method of Lease Financing (Operate Lease); Contract Structure in two Cases
Based on Bleyl-Androschin and Schinnerl (2010, pp. 36-58)



On the contrary, in the course of the finance lease the lessee (i.e. the **Customer**, case a) or **ESCO**, case b)) receives the economic ownership of the fixed assets invested, which on the one hand leads to their capitalisation and on the other hand to the recognition of corresponding liabilities in the balance sheet.

Figure G-5 – Financing by TPF Organisation: Method of Lease Financing (Finance Lease); Contract Structure in two Cases
Based on Bleyl-Androschin and Schinnerl (2010, pp. 36-58)



Up to now, there have been no significant differences concerning lease accounting between the **Accounting Standards** considered.

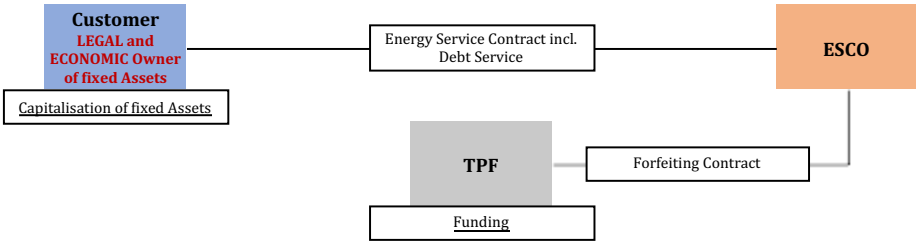
The new **IFRS** 16 standard has now resulted in changes in the accounting treatment of finance lease – on the part of both the **Customer** and **ESCO**.

Forfeiting

With forfeiting, in a first step, the **Customer** acquires the implemented **EEI** equipment from the **ESCO** and thereby becomes the legal and economic owner. The associated purchase price is not paid immediately but over the term and as a part of the **Energy Service Contract** to the **ESCO**.

The **ESCO** as the original creditor cedes its claims in future receivables from the **Energy Service Contract** to the **TPF** organisation, that, as the new creditor gains the right to claim future instalments from the **Customer** as the debtor. The **TPF** organisation buys this portion of future contracting rates from the **ESCO** and on return pays a discounted present value. Finally, the **Customer** has to pay contracting rates to the **ESCO**, that has to forward the ceded instalments to the **TPF** organisation.

Figure G-6 – Financing by TPF Organisation: Method of Forfeiting; Contract Structure
Based on Bleyl-Androschin and Schinnerl (2010, pp. 59-72)



Concerning capitalisation, in the case of forfeiting no substantial differences can be seen between the **Accounting Standards** considered.

Collateralisation

In general, TPF requires a collateral in return for the grant of funds, either from the **Customer** or the **ESCO**. In the context of **ES**, there are various forms of collateralisation (Bleyl-Androschin and Schinnerl, 2010).

Depending on the debtor (**Customer** or **ESCO**), essential forms of collateral are...

- ...project based, e.g.:
  - Waiver of the objection on debt service, i.e. the waiver of paying certain portions of the remuneration from the **ES** contract in the event of default in order to cover the debt service
  - Cession of receivables, i.e. the **ESCO** as debtor cedes future contracting rates or feed-in tariffs from the **Customer**
- ...financial, e.g.:
  - Guarantee, i.e. a bank or e.g. the parent company warrants for the **Customer** organisation
- ...tangible, e.g.:
  - Easement, i.e. reservation of property rights
  - Mortgage, i.e. registration of debt in a land register
  - Pledge, blanket assignment
  - Legal ownership on fixed assets invested

Table G-4 – Key Terms: Energy Service Contracts

ES are delivered on the basis of distinguishable **ES** contract types. In these contracts (concluded between **Customer** and **ESCO**), details and technical aspects of the equipment and **Energy** streams, financing, decision rights and rights of ownership, saving guarantees and payments as well as diversification of risks (performance, **Energy** prices, credit) typically are documented.

General Aspects	In his paper, Sorrell (2007) developed a framework of these different types. So, typical **ES** contracts in common have the incentivising of the **ESCO** to maintain and improve the performance of the measure over time. In addition, the contracts cover content such as...
	• ...implementation of measure, i.e. BAT for **Energy** conversion, distribution and control,
	• ...funding of the investment or provision (by **TPF**),
	• ...assumption of rights on...
	  o ...decision over useful **Energy** streams and final services as well as over organisational activities to provide these within the site of the **Customer**,
	  o ...ownership on the fixed assets necessary to provide these **ES**,
	• ...guarantee of reductions of **Energy** consumption and hence corresponding costs,
	• ...coverage of risks related to the provision of **ES** like...
	  o ...(technology) performance risk,
	  o ...**Energy** price risk,
	  o ...credit risk.
	Following Sorrell (2007, p. 508), all **ES** contracts can be described by the following three variables:
	• Scope – may be defined as the amount and degree to which useful **Energy** streams as well as final services are under the control of the **ESCO**; scope may range from a single useful **Energy** stream or a single final service to all useful **Energy** streams and all final services for the entire site of the **Customer**.
	• Depth – can be seen as the amount of organisational activities under control of the **ESCO** required to provide the useful **Energy** stream or the final service – set by the scope of the contract; depth may vary from one stream or service to another, hence it is likely to be relatively homogeneous over the streams and the services; the provision of each useful **Energy** stream or final service involves several organisational activities, including purchase of primary and final **Energy**, design engineering and financing of the project; specification, purchasing, implementation and maintenance of equipment; operation and control, monitoring and verification of performance of measure.
	• Source of funding – refers to the **Financing Method** for the investment in the **EEI** measure; in general, **ES** contracts involve investment.
	In the maximum value of scope and depth, all **Energy** systems and services and corresponding activities for the entire site of the **Customer** of this **ES** may be outsourced to the **ESCO**.
	According from their characteristics from the variable depth a main pair of contract types can be contrasted:
	• **Energy Supply Contract (ESC)**;
	• **Energy Performance Contract (EPC).**
	Main differentiators are the assignment of the control over final **Energy** use and the possibility of reducing final **Energy** consumption, hence, the assignment of performance risks of the measurement (Pätäri and Sinkkonen, 2014, p. 265).
	These two main contract types are described in more detail below.

Energy Supply Contract *(ESC)*	ESC – also known as **Energy** delivery contracts – are focused on the supply of one or a set of useful **Energy** streams or final services via outsourcing of the supply to an **ESCO** as service provider. The **ESCO** may also take over the purchase of fuel and electricity. Remunerations normally are calculated on the basis of the available **Energy** bills of the **Customer**, reduced by certain levels of savings as price per unit of **Energy** type or service (Nolden and Sorrell, 2016, p. 1407), or per square metre respectively, where applicable (Bertoldi et al., 2014, p. 7), and may include a surcharge for the service as well as for availability guarantees. The **ESCO** gets control over **Energy** conversion equipment (from primary and final **Energy** to useful **Energy** streams and final services) but has little or no control over the demand for delivered **Energy** (Sorrell, 2007, p. 510). Hence, **EEI** measures in the area of **ESCO**'s responsibility are aimed solely on conversion equipment. So, the **ESCO** has to cover less performance risk than characterised by **Energy Performance Contracts** (Pätäri and Sinkkonen, 2014, p. 265) and rather no energy price risks.
Energy Performance Contract *(EPC)*	*"A contractual arrangement between the beneficiary and the provider (normally an **ESCO**) of an **Energy Efficiency Improvement** measure, where investments in that measure are paid for in relation to a contractually agreed level of **Energy Efficiency Improvement**"* (European Parliament, 2006). The definition provided by the EED will be used in this research. EPCs are focused upon the delivery of final services like heating, lighting, refrigeration at an agreed annual **Energy** cost below a defined baseline (Nolden and Sorrell, 2016, p. 1407). In contrast to the **ESC**, in an EPC the **ESCO** not only guarantees for the availability of the **Energy** demanded but also for a previously agreed level of savings from **Energy** costs (Bertoldi and Rezessy, 2005, p. 18) – thus the overall performance of the **EEI** measure. In the most comprehensive contracts, the **ESCO** has control over the demand for final **Energy** services and therefore over the demand for useful and delivered **energy**, and hence the complete useful **Energy** streams and final services for the

Customer's site (Sorrell, 2007, p. 511). So, the **ESCO** has overall control of both the demand for delivered **Energy** and the total cost of providing final **ES**.

The remuneration for this service is based on and connected to the demonstration of the performance of the measure (Pätäri and Sinkkonen, 2014, p. 265).

EPC may be an instrument to deliver **EEI** to **Customer**s that lack skills, manpower, funding and understanding of risk or technology. Credit-worthy but cash-poor organisations therefore are potentially good **Customer**s for EPC, as **EEI** measures may solely funded from cost reductions (Bertoldi and Rezessy, 2005, p. 18).

From the mode of risk diversification – or funding respectively, two subtypes of EPC are distinct. According to Limaye and Limaye (2011, p. 137) and Bertoldi et al. (2006, pp. 1821-1822), the main criterion is the source of funding – provided by the **Customer** (from internal funds or **TPF**), or by the **ESCO** (also from internal funds or **TPF**):

- Shared savings: In this subtype, funding in general is provided on the part of the **ESCO**, which assumes the credit risk and in turn gets a share of the savings realised by the **EEI** measure, so that the **ESCO** can recover its implementation costs and obtain the required return on its investment (Bertoldi et al., 2014, p. 6). At the end of the contract, the equipment invested passes to the **Customer**, as well as all following savings. Performance and **Energy** price risk in this subtype are covered by the **ESCO** (Qin et al., 2017, p. 424).
- Guaranteed savings: In this subtype, the **Customer** takes the credit risk by financing the **EEI** measure internally or by **TPF**. In return, the **ESCO** takes the performance risk by guaranteeing a certain level of **Energy** savings. Any breach of the guaranty shall be borne by the **ESCO** by reimbursing the remaining amount to the **Customer**, any excess of the guarantee shall be distributed between **Customer** and **ESCO** according to the quotas agreed upon (Qin et al., 2017, p. 424).

Table G-5 – Key Terms: Accounting Standards

Accounting Standards define the principles according to which companies must prepare their annual financial statements. In the context of this research, the regulations described below as well as differences between these standards, according to which the balance sheet reporting of fixed assets (i.e. their capitalisation) from investments in **EEI** measures in connection with the various **Financing Methods** are regulated, are of particular importance.

In addition to local accounting standards, in Germany the application of international standards is also permitted under certain circumstances. This is important for internationally active organisations as well as for those involved in the capital markets.

German Commercial Code (German GAAP) – Handelsgesetzbuch ***(HGB, 2018)***	The HGB contains the core of commercial law in Germany. It regulates the legal relations of the merchants, in its 3. book (§§ 238-342e HGB) the trading books are treated. In § 246 HGB it is regulated that fixed assets (property, plant and equipment) are to be included in the owner's balance sheet. If economic and legal owner differ, the asset must be accounted for by the economic owner, measured at acquisition cost. The **Financing Method** used in the **ES** has an impact on which stakeholder assumes the role of economic owner. In the case of **Loan Financing**, the borrower (**Customer** or **ESCO**) and in the case of **Forfeiting**, the **Customer** is the economic (and also the legal) owner. In the case of a **Hire Purchase**, the **Customer** is the economic owner right from the start and also assumes legal ownership at the end of the contract term. In the case of **Lease Financing**, economic ownership depends on its specific form, two forms are distinct: 'Finance lease' and 'Operate lease'. In the first case, economic ownership is allocated to the lessee (the **Customer** or the **ESCO**, in the second to the lessor. Capitalisation of **Lease Financing** is governed by decrees of the German Federal Ministry of Finance. Among other things, lease is regarded as finance lease, hence the lessee is regarded as the economic owner, if... • ...the lease is a full amortisation lease for movable assets, • ...the lease term is between 40 % and 90 % of the useful life of the fixed asset and the lessee has a bargain purchase option, • ...the lease term is less than 40 % or more than 90 % of the economic life of the asset without a bargain purchase option; or • ...the leased asset is of a specialised nature, so that only the lessee can use it without significant modifications. Lease under HGB therefore basically offers the possibility to structure an off-balance solution for both **Customer** and **ESCO**, as long as the requirements for an operate lease are met. An off-balance solution is advantageous for certain balance sheet ratios, which are used, among other things, to assess credit-worthiness or are regulated in covenants of existing credit agreements. An example of this is the debt-equity ratio on the liabilities side, which would be worsened by an on-balance solution. The same applies to the investment intensity, a ratio on the assets side of the balance sheet.
International Financial Reporting Standards ***(IFRS, 2019)***	The International Financial Reporting Standards Foundation (IFRS Foundation) was established to develop consistent and globally recognised accounting standards and to promote the adoption of these standards (The International Financial Reporting Standards Foundation, 2019). The International Accounting Standards Board (IASB) is the independent, accounting standard-setting body of the IFRS Foundation. Initially, the 'International Financial Reporting Standards' (IFRS) were published by this board under the name 'International Accounting Standards' (IAS). The standard IAS 16 regulates the accounting treatment of fixed assets (property, plant and equipment). Fixed assets must be capitalised if it is probable that future economic benefits will flow to the organisation and the costs can be determined. So, analogous to HGB in Germany, IAS 16 requires the economic owner to capitalise the fixed asset, measured at fair value. With regard to the different **Financing Methods**, comparable treatment methods were therefore applied for these two accounting standards at the time of IAS 16. With regard to **Lease Financing**, IAS 17 distinguished between finance and operating leases – also in analogy to HGB – and provides for corresponding accounting for these leases. With the standard IFRS 16, the IFRS Foundation has introduced a new standard on leases that is to be applied from 01/01/2019 at the latest. A distinction between operating and finance leases continues to be made within this standard, but this alone affects the balance sheet item within which both the lessor and the lessee are required to report. This standard no longer permits an off-balance solution for the lessee, as the lessee has to account for either a fixed asset or a right of use and also a liability as an obligation to pay lease payments. This is to be applied for all leases with a term of more than 12 months unless the underlying asset is of limited value. Existing lease situations at the time of introduction are also affected and must be treated accordingly. According to the new standard IFRS 16, lease contracts can no longer be designed as off-balance solutions for the **Customer** and the **ESCO**, so that the treatment of lease contracts according to HGB and IFRS is clearly different.

Chapter 1: Introduction

The world's energy demand has been rising continuously for decades (Abdelaziz et al., 2011, p. 152). A correlated increase in energy production based on fossil energy resources (Suganthi and Samuel, 2012, p. 1224) led and is still leading to an increasing release of the greenhouse gas carbon dioxide (CO2), to which global warming is attributed (Ürge-Vorsatz and Metz, 2009, p. 87). The organisation of the United Nations (UN) attached extraordinary importance to this issue for humankind, hence the Kyoto Protocol signed on 11/12/1997 (UNFCCC, 1998), as an additional protocol to the United Nations Framework Convention on Climate Change (UNFCCC), set binding targets under international law for the reduction of CO2 emissions in industrialised countries. For many of these countries, a reduction in energy consumption has therefore been on the political agenda ever since, to pursue these targets the European Union (EU) subsequently generated papers and plans for the member states.

On 05/04/2006, the European Parliament and the Council of the European Union imposed the directive 2006/32/EC (European Parliament, 2006) on energy efficiency and energy services (the 'Energy Efficiency Directive', EED). The target of the EED was an improvement in energy efficiency (EE) within the EU. The EU member states committed themselves to a reduction of energy consumption of 9% by 2016 in relation to the average primary energy consumption of the base period of 2001 to 2005. This proposed reduction in energy consumption was to be achieved through corporate energy services (ES) and other measures on the demand side. Through the stimulation of the ES market and an increase in EE in all consumer sectors within the EU member states, the efficient use of energy and so a reduction of primary energy consumption should be obtained. Each of the EU member states was free in the design of its individual measures and instruments. From 2007, circa every three years (2007, 2011 and 2014), every EU member state has had to evaluate its own realisation of the EED in the form of a National Energy Efficiency Action Plan (NEEAP), and to report to the European Commission (EC).

On 04/12/2012 – after adoption by the European Parliament and the Council of the EU – the directive 2012/27/EU (European Parliament, 2012) came into effect replacing the directive 2006/32/EC. It incorporated many measures of the preceding EED with the aim of reducing the primary energy consumption of the EU member states until 2020 by 20% in comparison with projections without measures. The focus was set on energy efficiency improvement (EEI) obligations of the EU member states. Each had to ensure the reduction of annual energy consumption between 2014 and 2020 by 1.5% of the average annual energy consumption of the base period of 2010 to 2012. Again, each of the EU member states was free in the design of its individual measures and instruments. The obligation to document the achievement of targets via NEEAPs continued.

Recommendations of the EU Commission from 2014 for further EEDs have scheduled a reduction of CO2 emissions by 40% in comparison with the situation of 1990 – to be reached through further reductions of primary energy consumption, as well as the extension of energy generation from renewable resources.

With Directive (EU) 2018/2002 (European Parliament, 2018) of the European Parliament and of the Council of 11/12/2018, the previous EED from 2012 was amended and supplemented. Among other

things, the EU laid down new rules on EE for its member states. The previously existing target of reducing overall primary energy consumption by 20% in comparison with projections without measures was extended to 2030, and the reductions in primary energy consumption to be achieved were fixed at 32.5%.

The substantiation of these targets by appropriate measures again was the task to the EU member states, to be documented in their NEEAPs.

After 2007 with the first (First National Energy Efficiency Action Plan (NEEAP) of the Federal Republic of Germany, 2007) and 2011 with the second (Second National Energy Efficiency Action Plan (NEEAP) of the Federal Republic of Germany, 2011), in 2014, the government of the Federal Republic of Germany published the third NEEAP (Third National Energy Efficiency Action Plan (NEEAP) for the Federal Republic of Germany, 2014). In the first NEEAP, the overall strategy and important measures were outlined. In addition to governmental measures, it also included contributions through actions of other actors. With the second NEEAP, the degree of achievement of reduction of energy consumption targets and provided information about the conditions, the status and the success of EE measures and instruments, and their respective reduction of energy consumption for the EU Commission was documented.

Common to all previous NEEAPs was the assignment of a key role to energy service companies (ESCOs, for definitions and details of key terms regarding the stakeholder system of EEI projects refer to glossary, p. 9 and following) for achieving the consumption reduction targets by means of the dissemination and increase of EE. The market for ES was explicitly identified as a growth market in the industrial, real estate and in the public/municipal sector. The requirement for these organisations' success was the creation of an appropriate environment. The third NEEAP in 2014 added an overview of the current and expected future development of the market for ES in Germany.

The government of the Federal Republic of Germany has not yet submitted an update of the NEEAP based on the revised EED from 2018. The definition of further measures appears necessary in order to achieve the objectives set.

1.1 Background of the Research and Rationale

It can currently be assumed that the savings targets set by the EEDs for the Federal Republic of Germany for 2020 will not be achieved.

Due to the complexity of the issue, the causes are manifold, but it can be expected that developments in the area of EE and ES were also below the targeted magnitude, the forecasts and the existing potential. This research will focus on the background to this situation.

From October 2010 to February 2017, the researcher was himself employed in a commercial management function at an ESCO and thus had direct insights into this market and already had in-depth knowledge of the interrelationships and essential factors of this branch of business. Working with colleagues, Customers and TPF organisations, the researcher gained an immediate impression of the existence of barriers that affected the implementation of EEI measures.

Not least with this practical background of experience, the researcher was convinced that...

- ...climate protection and the achievement of the above-mentioned UN as well as the EU targets derived from them had to be accorded the highest priority,
- ...existing resources were to be secured in the best possible way for future generations and therefore had to be handled responsibly – this applied in particular to the use of fossil energy resources,
- ...EE and its dissemination was of great importance in this context,
- ...ES and ESCOs, that pursued EE through ES as a business purpose had a useful tool to achieve these targets – although they had not yet achieved the success they could.

Due to the existing access to potential research participants and the knowledge about the local NEEAP as well as the related legislation, this research concentrated on the industrial sector in addition to the regional focus on Germany due to the comparatively large potential in connection with significant investment volume from respective measures. Considering the thematic breadth of the various barrier aspects and the need to enable a well-founded investigation of a clearly defined subject, this research was limited to the area of economic barriers. For this purpose, a research approach was chosen that has not previously been applied, at least for ES in the industrial sector in Germany.

The researcher was particularly interested in developing recommendations for stakeholders and policy-makers, thereby making an important contribution to overcoming these economic barriers.

1.2 Research Objectives

The aim of this research was to gain deeper understanding of the...

- ...significance of economic barriers for ES and EEI projects for Customers from industrial sector in Germany, as well as
- ...influencing factors from specific stakeholder situations (e.g. with regard to their requirements and prerequisites for financing, capitalisation of fixed assets and collateralisation) and corresponding stakeholder constellations with regard to economic barriers,

in order to develop...

- ...recommendations for policy and practice to overcome these barriers and thus to reduce the so-called energy efficiency gap and to promote the development of ESCO's German business, and where appropriate,
- ...further the existing conceptual frameworks in the area of economic barriers on the basis of the data collected, provided that gaps in literature are identified.

1.3 Research Questions

Based on the objectives above, the following three research questions were formed:

a) *Which economic barriers for ES and EEI projects for Customers from industrial sector in Germany can be identified as significant?*

b) *How do specific stakeholder situations and stakeholder constellations influence the emergence and significance of economic barriers?*

c) *What prevents ESCOs from avoiding or removing these economic barriers that inhibit the realisation and development of their business and which measures (e.g. policy, business practice) could help to overcome these barriers?*

This research aimed to attain sound answers for the questions. These were formed via empirical study, that was carried out as a multiple-case study.

1.4 Structure of the Research

This research is structured linear-analytically. It is built up on six chapters (including this introductory part).

After this introduction in Chapter 1, it is organised in two main parts as followed:

In the first part, consisting of Chapter 2 and Chapter 3, the theoretical background of the research is introduced:

- In Chapter 2, the relevant literature in this area is reviewed to examine the environment of the object of investigation and identify gaps for this research, and the selection of an appropriate theoretical framework is presented.
- In Chapter 3, the theoretical and methodological foundations of this research are described, how its quality is to be guaranteed is explained.

The second part, composed of Chapter 4 to Chapter 6, consists of the empirical content of this research:

- Chapter 4 deals with data collection and analysis. Following a description of the underlying process and discussion of ethical issues, the specific Cases of the multiple-case study and differing situations of the stakeholders involved are contrasted.
- In Chapter 5, analyses and findings derived are presented.
- Chapter 6 summarises and concludes. The results are discussed, reference to the research objectives and questions is made and contributions to knowledge, limitations as well as emerging opportunities for future research are pointed out.

Definitions of important terms of this research are provided in the Glossary (refer to p. 7 and following). Details on the theoretical frameworks from which the relevant one applied for this research is selected in Chapter 2 can be found in Annex A.1 – A.9.

Chapter 2: Literature Review

The core element of this chapter is a critical overview of the literature on EEI, the ES and ESCO market, barrier issues and their empirical evidence.

Gaps in the literature not yet covered are identified and form the starting point for this research. Furthermore, a barrier framework as the theoretical basis is selected from literature.

Within the context of this research, the literature on the specific situation of the market in Germany is particularly taken into account.

2.1 Energy Efficiency Improvement Measures and Energy Services

Today energy is used in all areas of human life, on the level of energy consumers every single entity is a potential target of EEI, where measures to reduce energy consumption can be implemented. Estimates of the effects feasible through EEI vary in the literature but do show significant potential in general.

The share of global public and buildings lighting is assumed to reach about 20% of the total (final) energy consumption. In this area, an efficiency potential of at least 50% is estimated (Sarkar and Singh, 2010, p. 5561). In the case of municipal street lighting, a savings potential of up to 90%, through the use of efficient light-emitting diodes (LED – as best available technology (BAT) in this area) instead of conventional technology seems to be feasible (Polzin et al., 2016a, p. 133).

Representing a major source of cost for the public/municipal sector, energy use can be seen as an important point for EEI measures. Furthermore, EEI measures in public facilities can also serve as a stimulus to the ES market, as it fosters the awareness of EE programs and policies in general and provides benchmarking data for the development of new programs and policies as well as a comprehensive data record of EEI measures as a calculation base for future measures (Hopper et al., 2005, p. 83).

More important, however, is the industrial sector: The share of global (final) energy consumption ascribed to it ranges from almost one third (Chai and Yeo, 2012, p. 460; Fleiter et al., 2011, p. 3100) to 50% (Cagno et al., 2013, p. 291; Catarino et al., 2015, p. 995; Trianni et al., 2013, p. 444). Estimates show an efficiency potential of 30-40% on this consumption across many industrial sectors, using BAT (Sarkar and Singh, 2010, p. 5561). So, the industrial sector can be seen as an even more important point for EEI measures with significant potential to reduce energy consumption in comparison to the public/municipal sector and buildings lighting area.

Price levels of energy (primary as well as final) play a crucial role in the evaluation, implementation and profitability of an EEI measure (Bertoldi and Boza-Kiss, 2017, p. 352): Rational actors make decisions under an economic perspective to maximise their utility. A measure in which the utility exceeds the cost is advantageous. The utility (i.e. the return on investment) of an EEI measure is the savings that are generated by reducing energy consumption and hence corresponding energy costs. The demand for EE therefore depends on the price of primary and final energy in relation to the price of a specific EEI

measure. High prices of primary and final energy enable high economic savings from EEI. Hence, an increase in these prices raises the demand for EEI.

So, on a corporate level the implementation of EEI measures can positively affect financial performance (Fan et al., 2017). By reducing the use of energy and without changing the user behaviour a cost reduction, and by this an improved corporate competitiveness can be realised (Chai and Yeo, 2012, p. 460). To reach significant effects, investments in BAT focus on replacing major energy using technologies.

ESCOs are the providers of ES within which EEI measures are realised. A significant influence on the reduction of energy consumption through the activities of ESCOs was already demonstrated from a comprehensive perspective in the paper of Fang et al. (2012). In a quantitative empirical model based on panel data from the period 1981 to 2007 from a total of 94 countries (including Germany), short-term reductions of energy consumption of 3.8% and long-term reductions of 39.7% were shown.

Several papers tried to gain an overview of the ES market, its hitherto development and actual status in different countries or regions. The ES markets in Europe (Bertoldi and Rezessy, 2005; Bertoldi et al., 2006; Bertoldi et al., 2007; Marino et al., 2010; Bertoldi et al., 2014) and in a total of 38 countries outside the USA (Vine, 2005) were covered. In the paper of Okay and Akman (2010), selected country indicators were included to assess ES development in comparison with macroeconomic development.

Among others, the ES market in Germany was covered by all of these investigations. According to Vine (2005, p. 693), the first ESCOs were established in Germany between 1990 and 1995 – later than in several other European countries (e.g. Hungary, Italy, Sweden and the UK, where first participants entered the market in the early 1980s). However, after a strong development, the current German ES market is rated as the largest and most advanced in Europe (Marino et al., 2010, p. 8).

Concerning its revenues, published values for German market are inconsistent but do seem to indicate an increasing volume over the last 15 years: Bertoldi and Rezessy (2005, p. 45), as well as Bertoldi et al. (2006, p. 1825) stated an annual turnover of even EUR 3,000 Million (Mio.) in 2003, while an assessment of Marino et al. (2010, p. 26) for 2008 amounted to an annual turnover of only between EUR 1,700 and EUR 2,400 Mio. Latest assumptions on 2013 market size by Bertoldi et al. (2014, p. 78) amounted to a span between EUR 3,500 and 5,000 Mio. Retrospectively, the annual turnover in 2013 was valued at EUR 3,000 to 4,000 Mio. (Bertoldi and Boza-Kiss, 2017, p. 350).

Obviously, accurate figures cannot be derived for this specific market sector, nevertheless a growth over the last 15 years seems to be recognisable and is to be assumed.

It is also unclear to what extent the above-mentioned turnover figures include revenues of energy passed through (if primary and final energy is purchased by the ESCO and then sold to the Customer directly or even in a refined form) as well as investments in BAT sold by the ESCO to the Customer or a TPF after implementation.

Okay and Akman (2010) statistically evaluated perspectives on ES market growth in different countries in relation to each countries' sophistication. This resulted in comparatively lower opportunities in the German market (as an already overdeveloped market) than in economically and socially less developed countries such as Turkey. Nevertheless, from the latest estimates, since 2010 the market potential in

Germany constantly amounted to EUR 20,000 to 30,000 Mio. (Bertoldi et al., 2014, p. 79; Bertoldi and Boza-Kiss, 2017, p. 350). These figures suggested that sustained stable growth was possible. At the same time, they showed that only a small portion of the German market potential has been tapped to date.

All of these reports in common had the evaluation of EPC as the subordinate contracting type (for definitions and details of key terms regarding ES contracts and their scope refer to glossary, p. 14 and following). In Germany, too, where EPC was comparatively popular, EPC accounted for only 8-10% of total ES contract volume in 2013 (Bertoldi and Boza-Kiss, 2017, p. 349). In matters of EPC, most widely used was shared savings contracting, where financing of investments is provided by the ESCO or a TPF organisation (Bertoldi et al., 2014, p. 83).

Existing Customers of ES in Germany originated from all sectors, most broadly represented was the public/municipal sector (with heating as the most frequently contracted service). Commonly requested ES in the industrial sector were heating, hot water supply and combined heat and power (CHP) (Bertoldi et al., 2014, p. 86).

The situation of ESCOs in Germany was seen as matured, derived from the large number of organisations offering ES with a total of at least 500 already active for several years (Vine, 2005, p. 693; Bertoldi and Boza-Kiss, 2017, p. 350).

On the other hand, the number of ESCOs providing EPC – with more than one project in their track record in Germany – seemed to be very small, for 2010 only 10 to 15 organisations out of the total of 500 organisations were identified (Bunse and Irrek, 2010, p. 11).

Besides this small group of 'advanced' ESCOs, offering comprehensive ES nationwide and non-sector-specific, other service provider groups were distinct, namely energy agencies, retail energy and energy distribution companies, energy consultants, manufacturers of EE technology (BAT) and (handcraft) installers.

In general, the other service providers only offered ES with a selected scope – mainly in the real estate/residential area or for private households, some were specialised in non-residential buildings or offered special EE consultancy for municipalities or certain industrial Customers – often at a regional level (Bunse and Irrek, 2010, p. 12). Due to their specialisation, these providers were able to compete in their niche with established ESCOs.

Although financing by TPF organisations was increasingly used in EEI projects, only one out of 10 projects in Europe was externally funded. In all other cases, ESCOs in particular and, to some extent, the Customers, provided the necessary funds to finance the investment (Bertoldi et al., 2014, p. 267).

Since the beginning of this century, forfeiting (for definitions and details of key terms regarding financing methods refer to glossary, p. 11 and following) became increasingly important for EPC projects, especially in public/municipal sector projects. Off-balance financing solutions – for example to be achieved through operate lease – were sought, where applicable (Marino et al., 2010, p. 27).

Financing in the form of TPF was mainly provided by private banks (Bertoldi et al., 2014, p. 83), preferential loans were not offered in Germany (Bertoldi and Boza-Kiss, 2017, p. 351). In matters of subsidies, the entire financing of the German Federal Government was managed by the Kreditanstalt für

Wiederaufbau (KfW), a non-profit banking group owned by the German Federal Government (80%) and the Federal States (20%) that was the world's largest national development bank. KfW Bank did not grant loans or other financial products directly to the investor, but to other banks (generally the house bank of the subsidy recipient). To this end, it raised funds from the financial markets and transferred this capital via commercial banks to applicants in the form of low-interest loans or similar forms of subsidies. KfW Bank promoted residential construction and the modernisation and reduction of energy consumption of private organisations and municipalities (Marino et al., 2010, pp. 27-28), as well as private households.

2.2 The 'Energy Efficiency Gap'

Although the use of the existing EE potential was necessary to achieve the target values on primary energy consumption and CO2 reduction – agreed upon European level and defined by EED – in practice, it was apparent that this potential was not used to the appropriate extent. The reasons for even lagging behind forecasted growth rates or the non-introduction of appropriate measures, obtained their own term – the so-called 'Energy efficiency gap'. This term was already created by Jaffe and Stavins (1994) to explain why organisations fail to implement explicitly profitable EEI measures (in their terms this meant capital spending with relatively short payback periods through cost reduction resulting from lower energy use). In their paper, Jaffe and Stavins (1994) essentially focused on neoclassical economic theory, based on rational actors.

In other words, measures implemented did not include all potential measures. This paradox was mainly explained by the presence of barriers. Backlund and Thollander (2011) aggravated this situation explicitly as 'Energy Service gap' due to high transaction costs overcompensating effects from EE. Accordingly, in certain situations or constellations, the activity of ESCOs could even be seen as counterproductive, in addition to a basically supportive effect on the way to reducing energy consumption.

In this context, a barrier was seen as a determining factor that prevents or inhibits investment in technologies that are energy efficient as well as cost-effective for those who invest in these technologies (O'Malley et al., 2003, p. 4).

The existence of these barriers was seen as the reason for the incomplete exploitation of existing EEI potentials on the one hand and for the delayed development of the ESCO business on the other.

2.3 Previous Research on Barriers to Energy Efficiency

Numerous academic papers dealt with EE, many of these papers related to the situation of (potential) users of such technologies (BAT), a significant part of these papers had to do with barriers and drivers – not least because of the obviously only slowly progressing use of EEI potentials.

Barriers that arose within an EEI project from EE as a service and a project with different stakeholders have so far only been investigated in very few papers. The perspective of the ESCO or the TPF organisation as (potential) stakeholders of EEI projects has rarely been addressed so far.

Papers dealing with barriers from the Customer's perspective exclusively were not relevant for this research. With the focus on ES, only papers that explicitly captured at least the central perspective of ESCOs as the provider of ES and, if the case arose, included the perspective of the Customer and of a TPF organisation as further stakeholders from EEI projects were considered as relevant.

Some of the papers corresponding to the above conditions dealt with untapped ESCO markets, e.g. in developing countries (Köhn (2012), Limaye and Limaye (2011), Yang (2016)). The Indian and Chinese markets had an important role in this (Da-li (2009), Li et al. (2014), Liu et al. (2017), Painuly (2009), Xu et al. (2011)). Some of the papers focused on markets in regions with fundamental differences from European countries in general and Germany in particular regarding climatic conditions or user behaviour and energy consumption (Canada: Ribeiro (2011); Hong Kong/Taiwan: Lee et al. (2014); Singapore: Chai and Yeo (2012); Russia: Garbuzova and Madlener (2012), Garbuzova-Schlifter and Madlener (2013), Roshchanka and Evans (2016); USA: Manoukian et al. (2015), Nandivada (2014), Shonder (2010), Smith (2010), Stuart et al. (2018)).

The results and findings obtained in these papers were therefore not fundamentally applicable to the context of this research. Due to the specific situation in Europe with regard to the policy framework created by the EED in 2006 and the NEEAPs in the EU member states, of which ES and ESCO were an important component, this research therefore focused on literature from 2006 onwards on the conditions in these European countries.

Much of the relevant research was done in the form of grey literature. Since the launch of the EED in 2006, several projects initiated, funded and monitored by the EU were carried out to support the dissemination and impact of the EED across Europe. In addition to their supportive character for the EED, three of these projects together had a comprehensive empirical part in which they examined, among other things, the barriers to ES business. As a result, national reports have been published. Of particular importance for this research were those papers dealing with the German market in the industrial sector ('ChangeBest' (Bunse and Irrek, 2010), 'Transparense' (Busch, 2013) and 'EESI 2020' (Busch and Lagunes Diaz, 2013)).

Further grey literature on European EE situation and ESCO business regularly was published by the Joint Research Centre, Institute for Energy and Transport – a Directorate General of the EC. Each of these reports described the situation in the EU member states and from an overarching perspective. These papers also comprised an empirical part in which they examined, among other things, the barriers to ES business. These comprehensive surveys were published in reports in 2007 (Bertoldi et al., 2007), 2010 (Marino et al., 2010) and the most recent in 2013 (Bertoldi et al., 2014).

The relevant academic papers in turn covered specific market situations in the European countries – so also Germany among others. The subject matter was the economic situation of the stakeholders, the respective services against the background of the climatic situation, the size of the businesses and the duration of their projects. In an effort to find effective drivers for overcoming barriers to ES, these papers tried to better understand these barriers and derived a ranking of the significance of those identified.

The following table gives an overview of the results and main barriers (in order of significance, economic barriers are highlighted in capital letters) identified both in the latest relevant...

a) ...grey literature, as well as

b) ...academic literature,

to EEI and ES (for barrier categorisations refer to section 2.4, p. 34 and following). Regional focus as well as the market sectors considered are also included:

Table 2-6 – Overview of grey and academic Literature concerning Barriers to ESCO Business

Source	Region // Market Sector	Top 3 as well as all Economic Barriers identified (especially for German Market, if applicable)
a) Grey Literature		
Bertoldi et al. (2007) JRC Science and Policy Report	Europe (here: specifically **GERMANY**) // Comprehensive	• **UNWILLINGNESS OF CLIENTS TO ENGAGE IN CONTRACTS WITH PAY-BACK TIMES LONGER THAN A FEW YEARS** • Reluctance to use ESCOs when the core production process is affected • Lack of trust between ESCO and Customer • Lack of Customer's willingness to co-operate with the ESCO (no evaluation of ranking order)
Bertoldi et al. (2014) JRC Science and Policy Report	Europe (here: specifically **GERMANY**) // Comprehensive	1. **NO ESCO LEGISLATION** (complexity of procurement regulations, Renewable Energy Act, Tender specifications for public/municipal sector projects) 2. Competition with in-house solutions (on Customer side) **3. SPLIT INCENTIVES** ... **7. PROBLEMS WITH FINANCING**
Bunse and Irrek (2010) Project 'ChangeBest'	**GERMANY //** Comprehensive	• **FINANCIAL SUPPORT FOR CLIMATE PROTECTION ACTIVITIES** • Lack of information • User/investor dilemma • **LOW IMPORTANCE OF ENERGY COSTS** • **RISK AVERSION (I.E. REQUIREMENT OF SHORT PAYBACK RATES)** (no evaluation of ranking order)
Busch (2013) Project 'Transparense – Increasing Transparency of Energy Service Markets'	**GERMANY //** Comprehensive	1. Complexity of concept 2. Lack of trust in the ESCO industry 3. Lack of standardised measurement and verification practices ... **10. RAISING AFFORDABLE FINANCE** ... **13. COMPLEX ACCOUNTING/BOOK KEEPING**
Busch and Lagunes Diaz (2013) Project 'European Energy Service Initiative 2020 (EESI)'	**GERMANY //** Comprehensive	• **LEGISLATIVE AND REGULATORY** • Awareness and knowledge • **FINANCIAL** (no evaluation of ranking order)
Marino et al. (2011) JRC Science and Policy Report	Europe (here: specifically **GERMANY**) // Comprehensive	1. Mistrust from Customers, scepticism and **PERCEPTION OF** (technical and **BUSINESS**) **RISK** 2. Low awareness 3. Lack of information ... **5. HIGH TRANSACTION COSTS**
b) Academic Research		
Hannon et al. (2015)	UK // Comprehensive	1. Lack of awareness of the ESCO model (external) **2. LACK OF PRIVATE SECTOR FINANCE AND INVESTMENT IN ESCO PROJECTS** (internal) 3. Lack of Local Authority willingness to engage with and support ESCO projects (external) ... **7. ACCESS TO CAPITAL (DUE TO THE DECLINE OF CAPITAL GRANT SCHEMES FOR START-UPS)**
Kamenders et al. (2018)	15 European Countries (Austria, Belgium, Bulgaria, Czech Republic, France, **GERMANY**, Greece, Italy, Latvia, The	**1. SUBSIDY/POLICY UNCERTAINTY** 2. Lack of support from the government **3. LOW ENERGY PRICES** **4. RAISING AFFORDABLE FINANCE** ...

Source	Region // Market Sector	Top 3 as well as all Economic Barriers identified (especially for German Market, if applicable)
	Netherlands, Portugal, Slovakia, Slovenia, Spain, UK) // Real estate/residential	**6. HIGH COSTS OF PROJECT DEVELOPMENT AND PROCUREMENT** …. **9. STAFF COSTS** … **11. COMPLEX ACCOUNTING/BOOK-KEEPING RULES** **11. SPLIT INCENTIVES** **11. PRESSURE TO REDUCE COSTS**
Kangas et al. (2018)	Finland // Real estate/residential	1. Regulatory Problems 2. Imperfect Information 3. Inertia … • **PRINCIPAL-AGENT RELATIONSHIPS** • **RISK** • **UNPRICED EXTERNALITIES** • **ADVERSE SELECTION** • **SPLIT INCENTIVES** • **HETEROGENEITY** • **ACCESS TO CAPITAL**
Kindström et al. (2016)	Sweden // **INDUSTRIAL**	1. Lack of clear strategic direction from top management (internal) 2. Lack of an internal will to change (internal) 3. Lack of knowledge regarding energy efficiency (external) **4. LACK OF FINANCIAL RESOURCES** (external) … **10. LACK OF FINANCIAL RESOURCES** (internal)
Nolden and Sorrell (2016)	UK // Public/municipal	• Information • **SPLIT INCENTIVES** • **RISK** • **TRANSACTION COSTS RELATIVE TO ENERGY COST SAVINGS** (no evaluation of ranking order)
Pätäri and Sinkkonen (2014)	Finland // Comprehensive	**1. RAISING FUNDING FOR ESCO PROJECTS IS NOT STRAIGHTFORWARD** 2. Customers regard with suspicion calculations and estimates presented by ESCOs 3. Companies are not willing enough to make energy-efficiency investments 4. Not enough technical and business knowledge to market, design and implement ESCO projects successfully in Finland 5. …
Pätäri et al. (2016)	Finland // Comprehensive	• Lack of awareness of opportunities and benefits that are related to the ESCO projects (external) • **CURRENT FINANCIAL SITUATION SETTING BACK ALL KINDS OF INVESTMENTS** (external) • **HIGH TRANSACTION COSTS IN RELATION TO POTENTIAL SAVINGS** (external) (no evaluation of ranking order)
Polzin et al. (2016a)	**GERMANY //** Public/municipal	• Technological barriers • Institutional barriers • **ECONOMIC AND FINANCIAL BARRIERS** • **VOLATILE ENERGY PRICES** • **ADVERSE INCENTIVES** • **HIGH FINANCING COSTS** (no evaluation of ranking order)
Polzin et al. (2016b)	**GERMANY //** Public/municipal	1. Existing legal partnerships 2. Lack of personnel for the management of an EPC 3. Perceived unfair balance of interests
Stede (2017)	Italy // **INDUSTRIAL**	**1. REGULATORY UNCERTAINTY** **2. LACK OF ACCESS TO FINANCE** **3. OTHER INVESTMENT PRIORITIES** …
Soroye and Nilsson (2010)	Sweden // Real estate/residential	• Lack of knowledge • Timescale of projects and 'trust' issues • Requirements for public market EPC, procurement laws (no evaluation of ranking order)
Virtanen et al. (2014)	Italy, Belgium, Finland // Comprehensive	1. Reluctance of the present players in energy business to change conventional business models 2. Lack of experience and knowledge of smart systems 3. Political awareness …

Source	Region // Market Sector	Top 3 as well as all Economic Barriers identified (especially for German Market, if applicable)
		5. **LACK OF AFFORDABLE CAPITAL**
Winther and Gurigard (2017)	Norway // Real estate/residential	**Customer perspective** 1. Lack of interest in energy savings 2. Lack of willingness to change practices and reduce user flexibility 3. Main focus on comfort and convenience … **5. HIGH TRANSACTION COSTS** … **8. LACK OF FINANCING CAPITAL** **ESCO perspective** 1. Individual needs and behaviours vary and are difficult to control 2. High fragmentation of market **3. HIGH TRANSACTION COSTS, LIMITED ENERGY COSTS** … **9. LACK OF PUBLIC SUBSIDIES AND FINANCING CAPITAL**

From the preceding table it can be seen that...

- ...specific market sectors only were covered by academic literature;
- ...the main barriers identified in literature varied widely between regions and market sectors studied, mainly resulting from different project or stakeholder constellations in the different papers;
- ...key barriers explicitly identified for German market varied between the papers, also in the longitudinal perspective taken from grey literature, mainly resulting from different project or stakeholder constellations in the different papers;
- ...the possible influence of accounting standards was not investigated and mentioned as a barrier in any of the relevant papers, mainly resulting from barrier frameworks that did not cover accounting-related barriers.

In the following subsections, grey and academic literature is reviewed separately and discussed in depth.

2.3.1 Grey Literature

Grey literature from 'ChangeBest', 'Transparense' and 'EESI 2020' projects were carried out by national organisations that were involved in the field of ES. In Germany, this included the 'Wuppertal Institute für Klima, Umwelt, Energie gGmbH' (engaged in the 'ChangeBest' project), a non-profit research institution, and the 'Berliner Energieagentur GmbH' (engaged in 'Transparense' as well as 'EESI 2020' project), an independent operator of renewable energy power plants and also provider of ES (contracting and energy consulting). Shareholders of the Berliner Energieagentur GmbH were the Federal State of Berlin, two private energy supply groups and KfW Bank in equal shares.

The objective pursued in the project 'ChangeBest' was "Promoting the development of an energy efficiency service (EES) market – good practice examples of changes in energy service business, strategies, and supportive policies and measures in the course of the implementation of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", with the project goal to contribute to the market, assist stakeholders and develop best practices (Bunse and Irrek, 2010).

The project 'Transparense' aimed "Increasing Transparency of Energy Services Markets", with the project goal to promote trustworthiness of ES and increase transparency of this market (Busch, 2013). The main focus was set on EPC.

The project 'EESI 2020' was created as "European Energy Service Initiative towards the EU 2020 energy saving targets" with the project goal to foster EPC as specific ES in selected European cities and metropolitan regions (Busch and Lagunes Diaz, 2013).

Primary data were collected in all of these three German sub-projects. The data sample was documented for 'ChangeBest' and 'Transparense' (in the first case, there were a total of five participants interviewed, including two ESCO representatives, one representative of an ESCO association, one representative of Berliner Energieagentur GmbH and one Customer representative; in the second case there were nine survey participants, seven of them ESCO representatives and two TPF representatives, the respective organisations were not mentioned.

The author of the 'Transparense' project originally intended to carry out a quantitative analysis of the data collected, but it was not possible to create a representative database. The basis for the analyses of the 'EESI 2020' project was not documented at all. Overall, the database for the respective country report on EU-wide projects was very small. At least for the projects 'ChangeBest' and 'Transparense' it was documented that besides ESCO also the perspective of another stakeholder in an EEI project was examined – in one case the perspective of a Customer, in a second case the perspective of a TPF organisation. Whether they were involved in an EEI project jointly with the ESCOs participating is not documented.

The comprehensive papers of the Joint Research Centre, Institute for Energy and Transport were also based on primary data. In these papers, the two author organisations of the aforementioned papers, Berliner Energieagentur GmbH and Wuppertal Institute für Klima, Umwelt, Energie gGmbH were involved as participants in 2007 (Bertoldi et al., 2007) and 2013 (Bertoldi et al., 2014), Berliner Energieagentur GmbH also in 2010 (Marino et al., 2010). Three ESCOs were also involved in the study in 2007, only one ESCO in 2010 and four ESCOs in 2013, each of which was listed by name. The perspective of Customers or TPF organisations was not represented at all in these papers.

While the papers of the years 2007 and 2010 obtained their findings regarding the barriers from primary data, the study of 2013 referred solely to the previous 'ChangeBest' and 'EESI 2020' projects.

In summary, only a small amount of evidence can be tested for grey literature with regard to the findings on barriers. Many papers were not based on primary but only secondary data regarding the content of barriers – in principle, even for European ESCO markets only a small amount of data was available in some cases, access to further data was seen as difficult, this was also documented in the academic as well as grey literature (Soroye and Nilsson (2010), Bertoldi et al. (2014)).

Instead, the papers related to each other. The Berliner Energieagentur GmbH played an important role in the investigations of the German market. It acted alternately as a research organisation and as a research participant – a biased attitude can therefore be assumed. With regard to barriers, the perspectives of other stakeholders from EEI projects (Customer and TPF organisation) played a completely subordinate role in the relevant grey literature.

All selected papers of grey literature used surveys as a research strategy for obtaining research data. Most of the reviewed papers pursued their survey strategy in the form of questionnaires with follow-up interviews.

With regard to the barrier categories (refer to section 2.4, p. 34 and following), there was no focus at all. The semi-structured data collection provided a comprehensive picture of the existing or perceived barriers from the perspective of each participant and, though the significance of the barrier categories and the barriers varied.

The paper of Bertoldi et al. (2014) had the largest population with a total of 217 participants – from 43 countries, which meant an average of solely almost five participants per country. A total of 13 experts were interviewed on the German market.

Due to the research strategy used, these papers could not provide information about the situation and the corresponding barriers for different stakeholders in a concrete EEI project, but merely a compilation of the barriers of the respective stakeholders.

2.3.2 Academic Literature

The academic literature covering barriers to ESCOs, ES and EE each focused on one European country – in the following labelled as 'Single focus', or in the case of Virtanen et al. (2014) six, in the case of Kamenders et al. (2018) 15 countries with a special focus on Latvia – in the following labelled as 'Multi focus'.

Concerning market sectors, the academic literature covered one – also labelled 'Single focus', or in the case of Virtanen et al. (2014) three sectors (including private households) – also labelled as 'Multi focus'.

The following table shows the regional as well as market sector coverage of each of the academic papers:

Table 2-7 – Coverage of European Countries by academic Literature

Region covered	Market Sector covered	Source	
		Single focus	Multi focus
Austria	Real estate/residential		Kamenders et al. (2018)
Belgium	Real estate/residential		Kamenders et al. (2018)
	Public/municipal Real estate/residential *(Private households)*		Virtanen et al. (2014)
Bulgaria	Real estate/residential		Kamenders et al. (2018)
Czech Republic	Real estate/residential		Kamenders et al. (2018)
Finland	Real estate/residential	**Kangas et al. (2018)**	
	(no sector)	**Pätäri and Sinkkonen (2014)**	
	(no sector)	**Pätäri et al. (2016)**	
	Public/municipal Real estate/residential *(Private households)*		Virtanen et al. (2014)
France	Real estate/residential		Kamenders et al. (2018)
GERMANY	Public/municipal	**Polzin et al. (2016a)**	
	Public/municipal	**Polzin et al. (2016b)**	
	Real estate/residential		Kamenders et al. (2018)
Greece	Real estate/residential		Kamenders et al. (2018)
Italy	**INDUSTRIAL**	**Stede (2017)**	
	Real estate/residential		Kamenders et al. (2018)
	Public/municipal Real estate/residential *(Private households)*		Virtanen et al. (2014)
Latvia	Real estate/residential		Kamenders et al. (2018)
The Netherlands	Real estate/residential		Kamenders et al. (2018)
	Public/municipal Real estate/residential *(Private households)*		Virtanen et al. (2014)
Norway	Real estate/residential	**Winther and Gurigard (2017)**	
Poland	Public/municipal Real estate/residential *(Private households)*		Virtanen et al. (2014)
Portugal	Real estate/residential		Kamenders et al. (2018)
Slovakia	Real estate/residential		Kamenders et al. (2018)
Slovenia	Real estate/residential		Kamenders et al. (2018)
Spain	Real estate/residential		Kamenders et al. (2018)
	Public/municipal Real estate/residential *(Private households)*		Virtanen et al. (2014)
Sweden	Real estate/residential	**Soroye and Nilsson (2010)**	
	INDUSTRIAL	**Kindström et al. (2016)**	
UK	*(no sector)*	**Hannon et al. (2015)**	
	Public/municipal	**Nolden and Sorrell (2016)**	
	Real estate/residential		Kamenders et al. (2018)

In the two papers labelled as 'Multi focus' (Kamenders et al. (2018), Virtanen et al. (2014)), no separate evaluation of the data collected was carried out with regard to individual countries or individual sectors.

To gain a condensed overview with a clearer focus on specifics of single countries and market sectors, the 'Multi focus' literature was left out in the following:

Table 2-8 – Coverage of European Countries by Market Sectors

Country covered	Market Sector			
	INDUSTRIAL	**Real Estate/ Residential**	**Public/ Municipal**	*(No Sector)*
Finland		x		x
GERMANY			**X**	
Italy	**X**			
Norway		x		
Sweden	**X**	x		
UK			x	x

From the preceding tables it can be seen that...

- ...although it was considered the most developed ES market in Europe, barriers to ES in Germany was the subject explicitly of the papers only of Polzin et al. (2016a), and Polzin et al. (2016b). In these cases, the public/municipal sector was examined. In addition, these two papers only dealt with a small area of ES, as the subject was the retrofitting of municipal street lighting and the introduction of LED as BAT;
- ...the industrial sector throughout the European countries is examined explicitly only by the papers of Kindström et al. (2016) and Stede (2017);
- ...academic research on barriers to ESCOs in the industrial sector in Germany have not yet been carried out – at least not since the publication of the EED in 2006.

As outlined in Table 2-6 above, all papers were based on barrier frameworks, which included economic barriers. However, economic barriers were not recognised as significant in these papers at all. In papers in which a ranking order was determined, the economic barriers had quite differing significance: In the paper of Pätäri and Sinkkonen (2014), for example, they were identified as essential barriers, in the case of Stede (2017) they were within the first three ranks; they were of medium significance in the investigations of Hannon et al. (2015) and Winther and Gurigard (2017), of subordinate significance in the case of Kindström et al. (2016) and Virtanen et al. (2014) and insignificant in the case of Polzin et al. (2016b).

In the papers without evaluation of a ranking order, economic barriers were not relevant except in the paper of Soroye and Nilsson (2010).

The papers also showed completely different results with regard to the significance of the barriers within the area of economic barriers: Frequently identified barrier were 'Low capital availability'

(alternatively 'Access to capital', 'Lack of financial resources', 'Lack of affordable capital' or 'Raising affordable finance') and 'Hidden costs'.

The significance attached in the various papers to economic barriers to ES and ESCOs was therefore completely inconsistent. One reason for this may lie in the constellation of the stakeholders involved.

The following table provides an overview of which stakeholders were involved in the relevant academic literature:

Table 2-9 – Overview of the Stakeholders involved in the Literature reviewed

Author	Stakeholders involved			
	ESCO	Customer	TPF	*(Further)*
Hannon et al. (2015)	X		X	• Academics • Authorities • Energy Experts
Kamenders et al. (2018)	X	X	X	-,-
Kangas et al. (2018)	X			-,-
Kindström et al. (2016)	X	X		• Energy Consultants
Nolden and Sorrell (2016)	X	X	X	• Energy Experts
Pätäri and Sinkkonen (2014)	X			• Academics • Energy Consultants • Energy Experts
Pätäri et al. (2016)	X			• Academics • Energy Consultants • Energy Experts
Polzin et al. (2016a)	X	X	X	• Manufacturer of BAT • Facilitators
Polzin et al. (2016b)	X	X		-,-
Soroye and Nilsson (2010)	X	X		• Authorities • Energy Agencies
Stede (2017)	X	(X)		• Academics • Authorities
Virtanen et al. (2014)	X	X		• Authorities • Energy Experts
Winther and Gurigard (2017)	X	X		-,-

From the preceding table it can be seen that...

- ...in the majority of the academic literature, only the perspective of the ESCO and the Customer or even only the ESCO were subject. On the other hand, the perspectives of further stakeholders such as academics, (governmental) authorities, energy consultants and further energy experts and energy agencies (that in some cases may act as facilitators) as well as manufacturers of BAT were included;
- ...only in the papers of Kamenders et al. (2018), Nolden and Sorrell (2016) and Polzin et al. (2016a) the perspectives of all three stakeholders relevant for this research were considered. The extent to which the participants were representatives of commercial or technical fields in their respective organisations was not apparent, but a technical character in connection with technical equipment was to be assumed in principle.

The paper of Virtanen et al. (2014) was the only one in which a purely quantitative research method came to use. It was therefore the only one in which primary data were collected solely by means of an online survey, with a total of 933 participants. However, these participants mainly were private households.

Mixed methods were used in the paper of Polzin et al. (2016b). In the quantitative part, primary data were collected by a survey with 1,298 participants.

The qualitative data collection of primary data in the other papers was done through interviews – usually in a semi-structured form. Pätäri and Sinkkonen (2014) and Pätäri et al. (2016) used a Delphi study (for specifics of this research strategy refer to subsection 3.4.2, p. 58) to collect primary data.

The papers thus systematically did not refer to a common project, but to different projects. What these papers were unable to consider were the influencing factors from particular stakeholder constellations for the respective projects – a comprehensive picture of the existing or perceived barriers was collected, information about the situation and the corresponding barriers related to the stakeholders in a concrete EEI project could not be provided.

An exception was made by the paper of Winther and Gurigard (2017). Here a single-case study was used, the respective perspectives of the stakeholders involved were examined in depth.

With regard to barrier categories (see also the following section), there has been no particular focus in previous research (i.e. economic barriers were not addressed explicitly). Rather, all barrier categories were recorded and examined in the various papers.

Finally, it is to be summarised and emphasised once again that the German ES market has not yet been examined by the academic literature in the sense of this research with regard to economic barriers for the industrial sector, taking into account the perspectives of the respective stakeholders involved.

2.4 Previous Research on Barrier Frameworks

As Cagno et al. (2013) explained, a categorisation of barriers in frameworks (also called 'Taxonomies') is crucial to obtain a comprehensive picture of a complex problem, which incorporates barriers into energy models facilitating the formulation of effective policy responses to reduce the impact of these barriers.

Some of the barriers and corresponding frameworks were identified and arranged from the perspective of the user (in the context of this research the Customer of ES) of an EEI measure. Nevertheless, they are also applicable – albeit not exhaustively – from the perspective of the other stakeholders of EEI projects (i.e. the ESCO as provider of ES as well as the TPF organisation as financier) and were therefore also used in this way in corresponding academic as well as grey literature.

Following Weber (1997), the methodological question of how to determine a barrier model is: 'What is a barrier to whom in reaching what?' So, a barrier framework specifies three features:

- The objective barrier: 'What is a barrier...': economic interests, financial incentives, regulations, technical standards, organisations, people, patterns of behaviour, attitudes, needs, preferences, social norms, habits, cultural patterns, etc.
- The subject hindered: '...is a barrier to whom...': organisations, managers, workers, consumers, tenants, clerks, voters, politicians, local administrations, parties, trade unions, households, NGOs, etc.
- The action hindered: '...reaching what': buying more efficient equipment, retrofitting, improving operating practices, decreeing an energy tax, establishing a public traffic network, etc.

In the following subsections nine barrier frameworks identified from literature are described in detail in chronological order, with a focus on the approach chosen, the results achieved and the relevance – especially in the context of this research. A tabular illustration of each of these frameworks can be found in the Annex, part A, A.1 – A.9.

2.4.1 Barrier Framework 1

Hirst and Brown (1990)

The early paper of Hirst and Brown (1990) was one of the first which qualitatively examined possible systematisations of barriers related to EE – even before the concept of the energy efficiency gap (refer to section 2.2, p. 24 and following) was established by Jaffe and Stavins (1994).

- Approach: The paper was based on a literature overview of the EE situation in the USA, whereby only barriers (e.g. social, institutional, behavioural, market-related) were examined in the respective sources.
- Results: A compilation and systematisation of a total of 10 barriers was provided. The barriers identified have been condensed into two groups ('Structural', 'Behavioural'). They were labelled as 'Types'.
- Relevance: Several of the barriers identified fell into the economic area and were therefore fundamentally relevant to this research. However, from today's perspective and almost 30 years later, some of these barriers have since become obsolete or have in fact been eliminated (e.g. 'Supply infrastructure limitations') or were not sufficiently precise in the 'Action hindered' as one of the required features of a barrier, as they focused on energy saving and not on EE (e.g. 'Attitudes towards EE') or addressed the specific and not generalisable situation in the USA (e.g. 'Codes and standards'). Some of the barriers identified in this paper were subsumed in subsequent frameworks on other barriers.

2.4.2 Barrier Framework 2

Weber (1997)

The paper of Weber (1997) qualitatively examined the methodological background of barrier frameworks as well as a break down for the structure of barriers. Neither certain barriers were analysed, nor a comprehensive theory of barriers was given. Rather, the basics of barrier frameworks in general were shown.

- Approach: The paper was based on a literature review paper and a separate literature overview.
- Results: Four barrier categories ('Institutional'; 'Market'; 'Organisational'; 'Behavioural'), labelled as 'Types', were contrasted. In addition, the three features as requirements for a barrier framework as already described in the introduction were worked out.
- Relevance: In his paper, Weber (1997) provided a methodological background of barrier frameworks that was used and deepened in following research projects. Some of the defined types were used as structural elements in proceeding frameworks.

2.4.3 Barrier Framework 3

Sorrell et al. (2000)

The fundamental paper of Sorrell et al. (2000) qualitatively examined the nature, functioning and determinants of barriers to the use of EE technologies in industrial sector with the aim of developing a comprehensive framework.

- Approach: The paper was based on a vast literature review and was empirically reassured by case studies on 46 organisations from the mechanical engineering, brewing and higher education areas in the UK, Germany and Ireland.
- Results: A compilation and systematisation of overall 15 barriers was provided. The barriers were condensed into three categories ('Economic'; 'Behavioural'; 'Organisational'), labelled as 'Perspectives'. These perspectives differed according to the underlying theories (neo-classical economics theory; transaction cost economics theory; decision theory; organisation theory).
- Relevance: The framework of Sorrell et al. (2000) was certainly the most influential and widespread on which most of the following barrier frameworks and barrier papers on EEI and ESCOs were based – or at least they included specific excerpts from this framework. The framework comprised economic barriers, which, however, were assigned to different theory buildings and thus to a range of categories.

  This comprehensive and ground-breaking framework served as a reference for the classification of the frameworks that followed chronologically and are thus presented below.

2.4.4 Barrier Framework 4

De Groot et al. (2001)

The paper of De Groot et al. (2001) quantitatively examined the differences in investment behaviour, attitudes and responsiveness to economic policy and the barriers to the introduction of EEI.

- Approach: The paper was based on a survey of 135 companies from nine industries in the Netherlands in May 1998. Companies were asked about their investment behaviour and the factors that prevented them from investing in energy-saving technologies. A list of 15 barriers was provided to be rated with a score between '1' (= totally unimportant) and '5' (= very important). The origin or selection as well as the categorisation procedure of the barriers surveyed was not documented.

- Results: A ranking upon a compilation and systematisation of overall 15 barriers was provided. The barriers were condensed into three 'Categories' ('General'; 'Financial'; 'Uncertainty'). The barriers qualified as the most important by the survey participants came from the area 'General'.
- Relevance: According to the approach, it was actually more an empirical examination of a list of barriers than a barrier framework. The majority of these barriers could be seen as economic barriers. Some of the barriers from the 'General' category ('Technology can only be implemented after existing technology has been replaced', 'Current Installations are sufficiently efficient' and 'Currently introducing a new Technology') mentioned in the survey and classified by the participants as relatively significant cannot be qualified as barriers with regard to the framework specifics of Weber (1997), since no 'Action hindered' can be determined. Overall, the paper of De Groot et al. (2001) did not make a significant contribution in terms of theoretical barrier frameworks; rather, it was an empirical study of the significance of barriers in specific sectors.

2.4.5 Barrier Framework 5

Thollander et al. (2010)

The paper of Thollander et al. (2010) qualitatively examined social practices in companies and existing routines in decision-making and industrial processes to develop a categorisation for barriers that took this perspective.

- Approach: The paper was based on the theoretical model of socio-technical change from the work on science and technology, in which technological and social change are interrelated and the dynamics of change processes are on focus. In socio-technical regimes, the actors are embedded in structures that shape their preferences, goals and strategies. Depending on the system complexity three hierarchy levels were defined:
  a) Micro – Technical system, development of technological innovations in niches
  b) Meso – Technological regime, routines, knowledge and problem definitions
  c) Macro – Socio-technical regime, superstructure, which guides technical design and shapes market development.

  Following Thollander et al. (2010), new technologies can hardly break through established regimes. To successfully establish a new technology – e.g. BAT in the area of EE – all three levels must be interconnected.
- Results: A new systematisation of the 15 barriers compiled by Sorrell et al. (2000) was provided by rearrangement into three areas according to their assignment to one of the three levels. The first area (connected to the 'Micro' level) focused on barriers to technology and related costs. The second area (connected to the 'Meso' level) identified barriers that, coupled to technology, were influenced by human factors. The third area (connected to 'Macro' level) concerned barriers that were influenced by human factors and hardly by technology.
- Relevance: Compared to the framework of Sorrell et al. (2000), the structure of barriers from a socio-technical perspective meant a solution-oriented approach to barriers for the implementation of EEI measures, as different approaches were required depending on the area from which the barrier

originated. Aspects such as corporate culture and established internal values were problematised and emphasised. By applying this categorisation, a stronger focus on social practices in companies and existing routines in industrial processes was set. The socio-technical perspective of Thollander et al. (2010) was only of secondary importance in this research, as neither social nor technical aspects were to be examined in detail.

2.4.6 Barrier Framework 6

Cagno et al. (2013)

The paper of Cagno et al. (2013) qualitatively examined the impact of barriers on decision-making processes and the interactions between them.

- Approach: The paper was based on a review of literature. Cagno et al. (2013) deduced the need for an advanced framework and pursued the enhancement of the framework of Sorrell et al. (2000): In addition to missing elements (i.e. technical), links between barriers were taken into account, in order to avoid overlaps and implicit interactions. The features of their framework were empirically tested through a preliminary investigation by a set of organisations in Italy.
- Results: A new systematisation of the 15 barriers compiled by Sorrell et al. (2000) was provided by rearranging into seven areas, according to the origin of the barrier ('Technologic'; 'Informational'; 'Economic'; 'Behavioural'; 'Organisational'; 'Competences'; 'Awareness'), labelled as 'Areas'.
  The compilation of barriers was enlarged by adding technology-related barriers, barriers related to competences and to awareness, so that the framework finally comprised 27 barriers. Of the nominal 12 additional barriers in comparison to Sorrell et al. (2000), only five did not correspond to the original 15 barriers, the others were further differentiations of already defined barriers. The framework took a Customer perspective to examine how barriers affect decisions and investments.
  In contrast to the underlying framework of Sorrell et al. (2000), a distinction was made between the internal and external origin of barriers from the perspective of the Customer organisation and a connection to its decision-making process was established.
- Relevance: In this framework, an area was established in which economic barriers were bundled. The compilation and refinement of barriers in this area is of particular importance in the context of this research.

2.4.7 Barrier Framework 7

Reddy (2013)

The paper of Reddy (2013) qualitatively examined barrier (and also the driver) structures that affect investments in EE from an actor-oriented concept.

- Approach: The paper was based on a review of literature. Reddy (2013) first tried to identify the drivers and barriers that influenced the success or failure of EEI, and then to determine the entities that were responsible for the establishment of these drivers and barriers. So, not the barriers themselves, but their categorisation and their hierarchical structure depending on the actor were the focus of this paper.

- Results: A new systematisation of barrier areas was provided by establishing seven areas ('Technological'; 'Financial'; 'Legal'; 'Market-related'; 'Institutional/Organisational'; 'Informative'; 'Behavioural') – similar to Cagno et al. (2013). Depending on the area of influence three hierarchy levels – similar to Thollander et al. (2010) – were defined:

  a) Micro – Customer

  b) Meso – ESCO, TPF organisation, equipment manufacturer, industrial and commercial organisations and utilities.

  c) Macro – EE agencies, and governmental as well as international organisations.

  The decisive criterion for the assignment of a barrier to one of these levels was the actor, according to the framework of Weber (1997), the 'Subject hindered' – or the subject in a position to remove the barrier. Similar to Thollander et al. (2010), this barrier framework used a hierarchical structure of the barrier system, in this case from the perspective of the actors. This system also followed a solution-oriented approach for the implementation of EEI measures, as each barrier addresses a different actor.

- Relevance: The paper complemented a hierarchical structure to the categorisation of barriers.

2.4.8 Barrier Framework 8

Vogel et al. (2015)

The paper of Vogel et al. (2015) qualitatively examined barriers to EEI measures in the building industry and their origins in the context of the Swedish building area, which was investigated as a socio-technical system – similar to the paper of Thollander et al. (2010).

- Approach: The paper was based on a catalogue of 38 barriers developed in a previous interview study carried out by the authors on the Swedish building industry. There was no further information available about the approach or the empirical basis of this prior paper, no details could be researched.

- Results: The paper developed a framework for categorising barriers according to their structural origin. The barriers were divided into three analytical decision levels:

  a) Project – Building projects

  b) Sector – Organisations and institutions involved in building projects

  c) Context – Institutional framework for previous levels; contained rules and regulations

  Most barriers had their origin at the contextual level. The paper of Vogel et al. (2015) followed the same theoretical approach as the paper of Thollander et al. (2010) on socio-technical systems. While the latter was based on the barriers of the framework of Sorrell et al. (2000), the barrier catalogue of the framework of Vogel et al. (2015) originated from a separate empirical study. The paper of Thollander et al. (2010) thus remained generally applicable in its results, whereas the paper of Vogel et al. (2015) was only partially applicable to the industrial segment.

- Relevance: From the perspective of this research, the framework of Vogel et al. (2015) was not of great importance due to the focus on the building industry and the specific barrier catalogue empirically collected for this field.

2.4.9 Barrier Framework 9

Stede (2017)

The paper of Stede (2017) qualitatively examined the elements of the white certificate system in Italy and evaluated possibilities to overcome various barriers to industrial EE.

The white certificate system was a tool developed under the Italian NEEAP to bridge the energy efficiency gap. Commitments obliged market participants to satisfy binding EEI targets over a certain period of time. The reductions in energy consumption achieved were then credited via certificates, which in turn could be traded on an official market or used directly bilaterally. Non-compliance of targets was sanctioned.

- Approach: The paper was based on a survey of 16 participants from different organisations (academics and experts from ESCOs, authorities and industry associations) in Italy in 2015. Drivers incentivising industrial EEI within the white certificate scheme, as well as any remaining barriers were investigated. A list of six barriers (the so-called 'Taxonomy') was provided to the participating experts. Respondents were asked to identify the three main barriers. For a ranking, the barriers were rated with a falling score from '3' to '1'. An average score was then calculated for each barrier.
- Results: A compilation and ranking of finally 10 barriers was derived, three areas were contrasted ('Financial', 'Informational/Behavioural/Institutional', 'External'). The origin or selection procedure of the barriers was not documented, nor was the classification or subdivision of the barriers into areas. The most significant barriers empirically identified were: 'Regulatory uncertainty', 'Access to finance' and 'Other investment priorities'.
- Relevance: According to the approach, it was not actually a barrier framework but an empirical examination of a list of barriers. Many of these barriers could be seen as economic barriers. The paper of Stede (2017) did not make a significant contribution in terms of barrier frameworks; rather, it was an empirical study of the significance of barriers in the context of a specific measure – the white certificates – to overcome the energy efficiency gap in Italy. Some of the barriers identified in this paper were subsumed in previous frameworks into other barrier areas.

2.4.10 Comparison, Evaluation and Selection of appropriate Barrier Framework

In the following, the barrier frameworks discussed above are compared and evaluated in order to select a suitable barrier framework to be used for guiding the systematic and structured data analysis process of this research. The focus is therefore on barriers related to the economic area.

It is clear that the nine frameworks described above have both similarities and differences, the following main aspects of the frameworks can be contrasted:

- While Weber (1997, refer to Framework 2, subsection 2.4.2 above) laid important foundations, Sorrell et al. (2000, refer to Framework 3, subsection 2.4.3 above) made a significant contribution to the development of barrier frameworks. Many papers on barriers to EE used this framework or excerpts from it, many of the subsequently developed frameworks were based on these fundamentals. One of them, Cagno et al. (2013, refer to Framework 6, subsection 2.4.6 above) has further developed the framework of Sorrell et al. (2000) with valuable additions for further

empirical use. Thollander et al. (2010, refer to Framework 5, subsection 2.4.5 above) proceeded similarly but their paper focused mainly on the development of a framework structure from the socio-technical perspective.

- Thollander et al. (2010), Cagno et al. (2013), Reddy (2013, refer to Framework 7, subsection 2.4.7 above) and Vogel et al. (2015, refer to Framework 8, subsection 2.4.8 above) added a hierarchical component to the barrier systems. While the framework of Vogel et al. (2015) considered building projects very specifically, the frameworks of Thollander et al. (2010) and Reddy (2013) were of general applicability.
- The frameworks of Vogel et al. (2015) and Stede (2017, refer to Framework 9, subsection 2.4.9 above) have been developed for a specific market sector (real estate/residential sector in the prior, white certificates in the industrial sector in the latter). Single barriers from their paper represented a meaningful extension of the already established catalogue, which has so far been mainly influenced by Sorrell et al. (2000).
- The frameworks of De Groot et al. (2001, refer to Framework 4, subsection 2.4.4 above) and Stede (2017) were less concerned with the theoretical (further) development of barrier systems than with an empirical investigation with the aim of deriving rankings concerning the significance of barriers.

The main developments and contributions of these nine frameworks are summarised in the following table. A distinction is made between a contribution to the identification and definition of barriers, the categorisation of barriers and the structuring of barriers within the framework, for example in the sense of establishing different levels depending on the area of influence or decision:

Table 2-10 – Overview of Barrier Frameworks from Literature

Framework	Development of...			Comment
	...Barriers	...Barrier areas	...Framework structure	
Hirst and Brown (1990) – Barrier Framework 1	**YES**	**YES**	*N/A*	Provided a definition of a series of barriers and an initial categorisation of these into areas
Weber (1997) – Barrier Framework 2	*no*	**YES**	*N/A*	Developed methodological background for frameworks and defined barrier areas
Sorrell et al. (2000) – Barrier Framework 3	**YES**	**YES**	*N/A*	Systematised barriers as well as barrier areas
De Groot et al. (2001) – Barrier Framework 4	**Based on Framework 3**	**YES**	*N/A*	Provided empirical relevance of (economic) barriers, divided into new area system
Thollander et al. (2010) – Barrier Framework 5	*(Identical to Framework 3)*	**YES**	**YES**	Established hierarchical structure of barriers, taken from a socio-technical perspective
Cagno et al. (2013) – Barrier Framework 6	**Based on Framework 3**	**YES**	**YES**	Established the area of economic barriers, further detailing of several barriers
Reddy (2013) – Barrier Framework 7	*no*	*no*	**YES**	Established hierarchical structure of barriers, taken from an actor-related perspective
Vogel et al. (2015) – Barrier Framework 8	**YES**	*no*	**YES**	Specific to building area, added several barriers relevant to economic area
Stede (2017) – Barrier Framework 9	**YES**	**YES**	*N/A*	Specific to white certificates in industry, added several barriers relevant to economic area

From the preceding table it can be seen that...

- ...the barriers arranged in the framework of Sorrell et al. (2000) were used in several of the succeeding frameworks,
- ...most of the frameworks provided contributions to the categorisation of barriers into areas.

In order to select the most suitable barrier framework for the purpose of this research, an evaluation of the frameworks discussed above is carried out in the following. A total of five evaluation criteria were defined on the basis of which the selection was to be made. The frameworks were evaluated based on following criteria, considered relevant by the researcher:

a) Detailedness – The barrier framework should consist of a catalogue of several different barriers.

b) Structure – The barrier framework should clearly distinguish one area of economic barriers from other barrier areas.

c) Empiricism – The barrier Framework should be a system of empirically determined barriers.

d) Applicability – The barrier framework should not be sector-specific or at least directly applicable to the industry sector.

e) Differentiability – The barrier framework should enable a level formation, hierarchisation or evaluation according to stakeholders engaged.

The fulfilment of the criteria is assessed for each of the frameworks as follows:

- 'Fully met' = ✓
- 'Partially met' = ---
- 'Not met', N/A = X

Table 2-11 – Barrier Framework Evaluation based on a Criteria System

Framework	Evaluation Criteria				
	a) Detailedness	**b) Structure**	**c) Empiricism**	**d) Applicability**	**e) Differentiability**
Hirst and Brown (1990) – Barrier Framework 1	---	X	---	✓	X
Weber (1997) – Barrier Framework 2	X	X	X	X	X
Sorrell et al. (2000) – Barrier Framework 3	**This framework is not part of the evaluation process, as it forms the basis for other frameworks evaluated.**				
De Groot et al. (2001) – Barrier Framework 4	---	X	✓	✓	X
Thollander et al. (2010) – Barrier Framework 5	---	X	---	✓	---
CAGNO ET AL. (2013) – Barrier Framework 6	---	✓	✓	✓	✓
Reddy (2013) – Barrier Framework 7	X	X	X	X	✓
Vogel et al. (2015) – Barrier Framework 8	---	X	*unknown*	---	✓
Stede (2017) – Barrier Framework 9	---	X	✓	✓	---

From the preceding table it can be seen that...

- ...the framework of Cagno et al. (2013) had the lowest deficits compared to the evaluation criteria and is thus ahead of the framework of Stede (2017).
- ...the framework of Stede (2017) was not rated on any of the criteria as being better than that of Cagno et al. (2013).
- ...the only criterion that was not fully met by the framework of Cagno et al. (2013) ('a) Detailedness') was also not met by any other framework.

For this reason, the barrier framework of Cagno et al. (2013) was selected. The table below shows the barriers assigned to the economic area, and their more detailed specifics of this framework, which henceforth was used in this research:

Table 2-12 – Selected Barrier Framework 6 – Excerpt of economic Barrier Area
Based on Cagno et al. (2013)

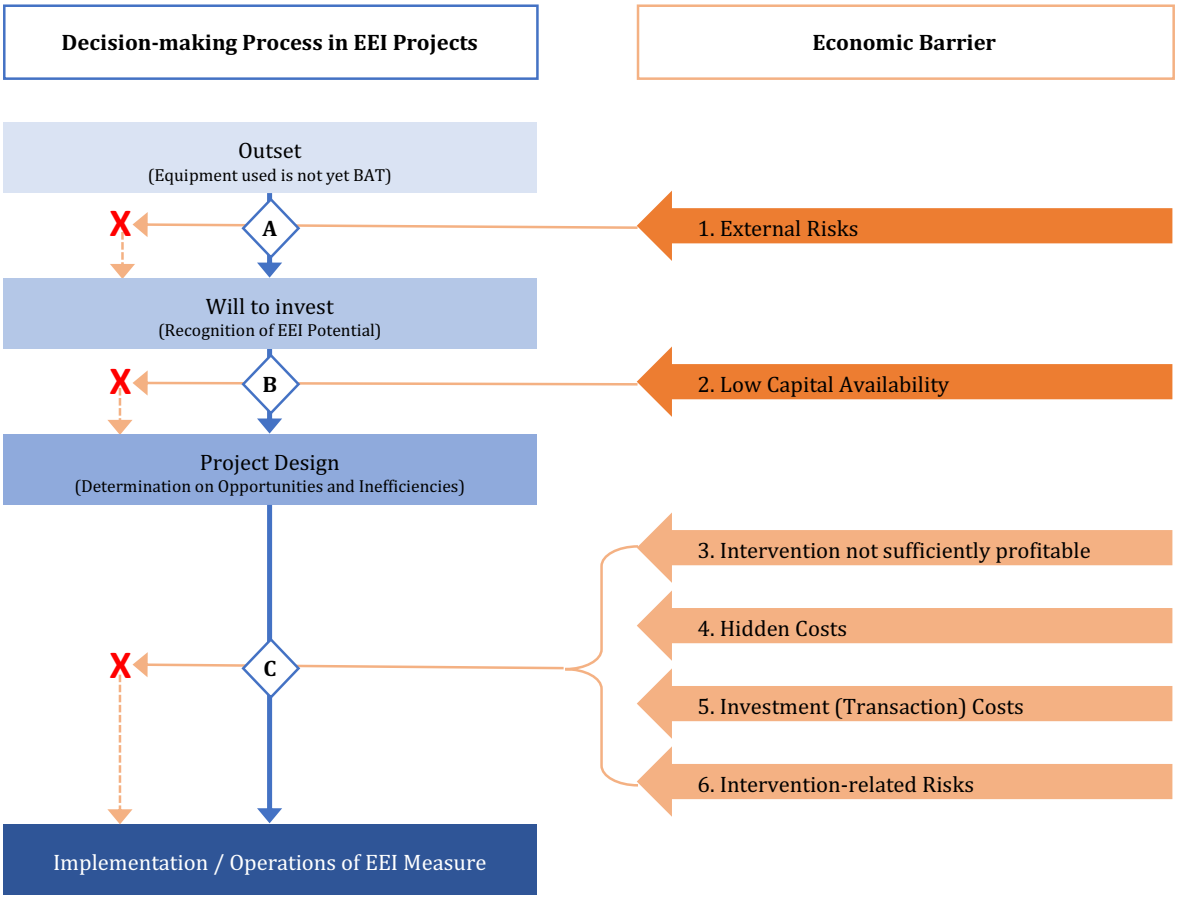
Area	Barrier	Origin	This barrier implies, that an EEI measure can be inhibited or prevented ...
ECONOMIC	**1. External Risks**	External	...by highly volatile energy prices, which create a high degree of uncertainty in the estimation of future or long-term operating costs; this may lead to BAT investments being avoided compared to conventional technologies due to higher investment needs – and uncertainty about the price of energy produced from fossil fuels, which does not reflect all the environmental and social costs associated with production, conversion, transport and use; this means that EEI measures are less profitable than would be socially optimal, and price signals are therefore an barrier to investment in the purchase of EE technology.
	2. Low Capital Availability	Internal	...by insufficient capital from own resources and difficulties in borrowing or raising equity, or internal investment planning procedures and investment evaluation related to higher investment needs for BAT systems compared to conventional technology; in manufacturing, EEI measures are hindered by the preference of investments that increase production over EEI investments that reduce operating costs; often a two-tier system of investment criteria is also used, where product-independent investments, such as energy cost reductions or savings, must achieve a significantly higher return than product-related investments; the resulting very high discount rates then lead to a situation known as the 'Payback gap'; often a two-tier system of investment criteria is also used, where product-independent investments, such as energy savings, must achieve a significantly higher rate of return than product-related investments; the resulting higher discount interest rates then lead to a situation known as the 'Payback gap'.
	3. Intervention not sufficiently profitable	Internal/ External	...by solutions that are in principle, but not necessarily cost-effective in all cases and organisations.
	4. Hidden Costs	Internal/ External	...by costs, which are not included in the original estimate of the investment planning (e.g. transaction costs for the collection, analysis and application of the measures, in addition, costs of the information procurement and analysis as well as the personnel training) and eliminate thereby the originally calculated cost efficiency.
	5. Investment (Transaction) Costs	External	...by initially high design and manufacturing costs for providing an energy efficient technology.
	6. Intervention-related Risks	Internal/ External	...by uncertainties in investments in EEI measures, which always entail risks of operational failure; uncertainties also exist with regard to the duration and availability of EE technologies and the long-term availability of calculated energy cost savings, especially if the discount rates for future costs and benefits are either lower than the available return on investments with comparable risk or higher than the financing rate of the measure.

Part of this framework was also the origin of the barrier, i.e. the distinction between external and internal with respect to the Customer organisation. The origin of some barriers was seen either clearly

internal or external, however, in some cases both options were possible. External sources included the stakeholders ESCO and TPF organisation, but also further actors such as (governmental) authorities.

Furthermore, the framework contained an assignment of the barriers to stages of a decision-making process to an EEI project. The following figure shows this process (with decision levels 'A' – 'C') as well as the integration of the six economic barriers into it:

Figure 2-7 – Selected Barrier Framework 6: Decision-making Process – economic Barriers potentially preventing or inhibiting the Progress
Based on Cagno et al. (2013, p. 302)

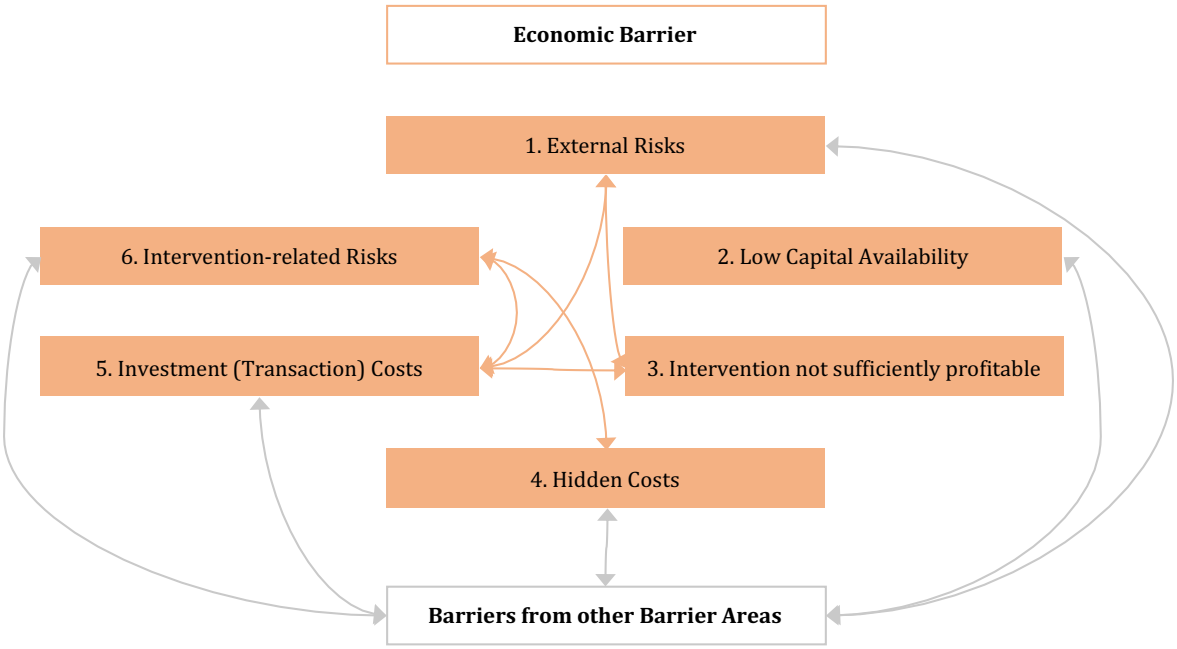


From the preceding figure it can be seen that...

- ...the appearance or existence of economic barriers could lead to inhibition or termination of the decision-making process on Customer side during its different stages;
- ...the first two economic barriers of the framework ('1. External Risks' and '2. Low Capital Availability') were of fundamental significance for EEI projects irrespective of the concrete intended measure, while the other barriers were directly related to the (technical and organisational) content of the measure.

A further result of the paper of Cagno et al. (2013, p. 304) was the identification of relationships between single barriers. These are shown in the figure bellow:

Figure 2-8 – Selected Barrier Framework 6: Connections between economic Barriers and Barriers from other Areas Based on Cagno et al. (2013, p. 304)



From the preceding figure it can be seen that...

- ...especially the economic barriers '5. Investment (Transaction) Costs' and '6. Intervention-related Risks' could have a negative impact on the barrier '3. Intervention not sufficiently profitable' through a possible accumulation of corresponding effects, even if the performance of the EEI measure appeared to be fundamentally positive.

2.5 Conclusions from Literature Review

After an introductory description of the importance attached to policy in the EU to achieving the climate targets and the contribution ES and ESCOs were intended to provide, this chapter continued with an overview of the ES market in general and in Germany in particular.

The existence of potentials for reducing energy consumption on the consumer side through EEI measures has been demonstrated in the literature. The positive influence of ESCOs on the use of these potentials has also already been shown. An existing, approximate market volume for their activity was quantified for Germany. The incomplete use of this available market volume by ESCO was explained by the presence of barriers.

Comparatively little academic research dealing with this complex of issues, the causes and possible solutions was identified. The existing academic literature covered only certain regions and market sectors, the comprehensive grey literature with cross-sectional and longitudinal data obviously suffered from very small data bases and general methodological weaknesses for the situations (regions and market sectors) under study.

The focus of these papers was on EEI – from the Customer's perspective as the user of BAT and the barriers on its situation. Papers concerning ES from the perspective of ESCOs focused primarily on the Customer sectors real estate/residential (mainly outside Germany) and public/municipal (including

Germany). The industrial sector as another important energy consumer segment has so far only been covered by a few papers, the situation in Germany not yet at all.

Although the barriers to ES projects were examined from the perspective of the stakeholders Customer as well as ESCO, influencing factors from constellations of stakeholders could not be taken into account – the research strategies applied in the corresponding papers (mainly the survey strategy) systematically could not capture these different perspectives in a joint EEI project. The research strategy of the case study, with which this could be achieved, has so far only been used in a paper covering the real estate/residential sector in Norway.

Furthermore, economic barriers as part of a comprehensive barrier framework were not the subject of explicit qualitative research in these papers. This was particularly applicable to the German ESCO and ES market. Barriers that could arise from accounting standards (i.e. International Financial Reporting Standards) have also not yet been investigated.

With reference to the research questions posed in the introductory chapter, this research aims to close these gaps identified in the existing literature.

The selection of a conceptual framework on which analyses could be based has also been presented above. The one of Cagno et al. (2013) was selected as the most suitable system. This framework also did not fully meet all the evaluation criteria – with regard to the criterion 'a) Detailedness'. It was one of the objectives of this research to further develop the existing conceptual frameworks in the area of economic barriers.

The research methodology applied as well as the approaches and concepts for ensuring the quality of this research will be described in the next chapter.

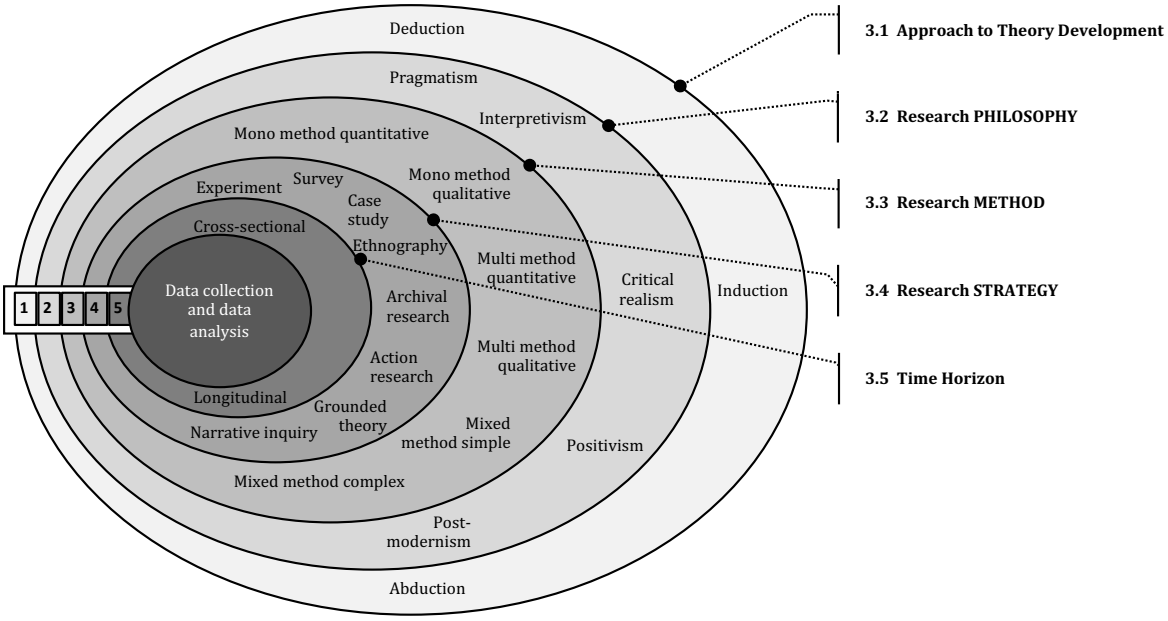
Chapter 3: Methodology

This chapter deals with the philosophical foundations on which this research was based, following Saunders et al. (2016, pp. 127-202).

The choice of the theoretical structure is introduced by the approach to theory development, which results from the nature and the subject of the research questions posed in Chapter 1. This in turn is the basis for the associated research philosophy, which also includes the corresponding research methods. Accordingly, various research strategies are available which – depending on the chosen time horizon – require their own procedures of data collection and analyses.

Following Saunders et al. (2016, p. 124), the different elements of the research methodology are structured in layers of the so-called 'Research onion':

Figure 3-9 – 'Research Onion': Layers of Research Methodology
Based on Saunders et al. (2016, p. 124)



In the sections below, the elements of the layers of the 'Research onion' are briefly described and the appropriate philosophical foundation for this research is selected – element by element from each of these layers. Subsequently, the criteria for assessing the quality of this research will be considered.

3.1 Approach to Theory Development – First Layer of the 'Research Onion'

In the first layer of the 'Research onion' of Saunders et al. (2016, pp. 146-149), the method of reasoning is to be defined. Three different approaches are distinct:

- Deduction,
- Induction, and
- Abduction.

3.1.1 Deduction

The deductive approach is the development of a theory, which is then subjected to a rigorous examination through a series of propositions. Laws form the basis of explanations that make it possible to anticipate phenomena, predict their occurrence and thus enable them to be controlled. This makes it the dominant research approach in the natural sciences.

Starting from a hypothesis, its argumentative logic is tested, and the hypothesis is compared with existing theories. The hypothesis is tested by collecting appropriate data to measure and analyse variables. If the results of the analyses match the hypothesis, the theory is confirmed.

The deductive approach includes several important features by which the quality of quantitative research can be assessed:

- Reliability – a highly structured approach is followed to enable replication by searching for causal relationships between concepts and variables;
- Validity/generalisability – a careful selection and sufficiently large dimensioning of the sample is a prerequisite;
- Operationalisation – the principle of reductionism is followed, i.e. problems are reduced to the simplest elements so that facts can be measured quantitatively.

In short, the aim of the deductive approach is 'explain' (Gill and Johnson, 2002, p. 10).

3.1.2 Induction

The inductive approach aims to better understand the nature of a problem. The result of the analysis of the collected research data is the formulation of a theory, which is often expressed in the form of a conceptual framework.

In this approach – and contrary to the deductive approach – theory follows data. As explained in the previous subsection, the deductive approach has its origin in scientific research. The social sciences criticise deduction for having an argumentative approach that makes it possible to establish a cause-and-effect relationship between certain variables without understanding people's interpretation of the social world. The development of such an understanding is the object of the inductive approach.

In an inductive approach, people are treated not as 'mechanically' reacting research objects but as people whose behaviour is a consequence of the way they perceive the social world. Researchers in the inductive approach also criticise the deductive approach for its tendency to follow a rigid methodology that does not allow for alternative explanations of a situation. On the other hand, researchers criticise the use of small samples in the inductive approach and question its ability to provide generalisable und reliable contributions to knowledge.

Therefore, alternative concepts to assess the quality of inductive research were established (refer to section 3.7, p. 63 and following).

Research with an inductive approach to reasoning is particularly concerned with the context in which such situations take place. Therefore, the examination of a small sample of subjects is more suitable than

that of a large number of subjects, as in the deductive approach. Researchers in this approach tend to work with qualitative data and use a variety of methods to collect this data to gain different views of phenomena.

In short, the aim of the inductive process is 'understand' (Gill and Johnson, 2002, p. 43).

3.1.3 Abduction

The abductive approach moves back and forth, combining the deductive and the inductive approach instead of switching from theory to data (as in the deductive approach) or from data to theory (as in the inductive approach). The abductive approach begins with the observation of a 'surprising fact' and then develops a plausible theory of how this could happen. Some plausible theories can explain better than others what is observed, and these theories help to uncover further 'surprising facts'. These 'surprises' can occur at any stage of the research process. Sufficiently detailed data are used to explore the phenomenon and to identify and explain topics and patterns.

The deductive and the inductive approach thus complement the abductive approach as a method for testing plausible theories.

3.1.4 Selection of appropriate Approach to Theory Development

The objectives of this research are described in section 1.2 (refer to p. 19). The central aim is to understand in depth the significance of economic barriers for ES and EEI projects. The objective is therefore not the examination of existing theories but a better understanding of the nature of a problem.

This corresponds to the inductive approach. Hence, as explained above, this is selected as the appropriate approach to theory development in the first layer of the 'Research onion'.

3.2 Research Philosophy – Second Layer of the 'Research Onion'

In the second layer of the 'Research onion' of Saunders et al. (2016, p. 124), research philosophies relevant for social science research are considered in the following subsections. Five main research philosophies can be distinguished (Saunders et al., 2016, pp. 135-144):

- Positivism,
- Critical Realism,
- Interpretivism,
- Postmodernism, and
- Pragmatism.

As Saunders et al. (2016, pp. 127-128) explain, the different research philosophical perspectives in the area of social sciences differ in three dimensions: Ontology, epistemology and axiology.

- Ontology: As the first of the three dimensions in the research philosophy framework, ontology can be described as the essence of phenomena and their existence, following the question 'What is the nature of reality' (Creswell, 2012, p. 21).

- Epistemology: As the second of the three dimensions in the research philosophy framework, epistemology can be summarised as a set of assumptions about ways of enquiring into the nature of the world, following the questions 'What counts as knowledge' and 'How this knowledge is known' (Creswell, 2012, pp. 20-21).
- Axiology: As the third of the three dimensions in the research philosophy framework, axiology refers to values and ethics in the research process, following the question 'What are values' (Creswell, 2012, p. 21), distinguishing how researchers deal with their own values and those of the research participants. The choice of research topic, philosophy and data acquisition techniques are seen as an expression of the values of the researcher.

An overview of the most important philosophical perspectives is necessary to justify the research method and research strategy to be chosen in the following steps and to highlight the underlying assumptions of the researcher.

3.2.1 Positivism

Positivism refers to the philosophical attitude that reality is observable, observations are taken from an independent, value free position to providing pure data and facts that are not influenced by human interpretation or prejudice.

From a positivist position, organisations and other social units are regarded as real objects and natural phenomena. The complexity of the social world is reduced to the simplest terms to uncover the structures of social relations (Easterby-Smith et al., 2015, p. 52).

Causal relationships in the data generate law-like generalisations to explain and predict human behaviour. Based on a theory, in a system of cause and effect, facts can be derived from hypotheses as a result of research. These hypotheses are tested and then fully or partially confirmed – or refused, leading to a further development of a theory, which can then be tested by further research.

In the positivist research philosophy, the world is seen as concrete from the ontological dimension. There is a single reality as a concrete structure and a single, unique truth. Facts exist and can be disclosed directly.

From the epistemological dimension, positivist research follows the scientific method. Facts are observable and measurable. Generalisations are made in the form of laws, research is based on numbers. The contribution of positivist research to knowledge is causal explanations and predictions.

From the axiological dimension, positivist research is value-free. The researcher is neutral and independent of what he is researching. Positivist research strives for a neutral approach, in order to not influence the results. Against this background, positivist research is strongly linked to the inductive approach to theory development.

3.2.2 Critical Realism

The philosophy of critical realism focuses on explaining what we see and experience in terms of the underlying structures of reality that shape observable events. Critical realism claims that there are two

steps to understanding the world. First there are sensations and events that one experiences. Second, there is the mental processing that takes place some time after the experience.

For critical realism, observations (the 'Empirical') are only a small part of everything – a fraction of the sum of the 'actual' events that occur at a given time. One can only understand what is happening in the social world if one understands the social structures that led to the phenomena. The 'real' domain, on the other hand, comprises events and actions that take place independently of observation (Easterby-Smith et al., 2015, p. 59). The research into the philosophy of critical realism focuses on the explanation of observable organisational events through the search for the underlying causes and mechanisms by which deep social structures shape everyday organisational life.

In the ontological dimension of critical realism, reality is thus external and independent, but not directly accessible through observation and knowledge.

The epistemological dimension of critical realism recognises that knowledge is a product of its time and specific to it, and that social facts are social constructions that people agree on rather than exist independently. This means that the notions of causality cannot be reduced to statistical relationships and quantitative methods.

The axiological dimension of critical realism arises from the realisation that knowledge of reality is a result of social conditioning and cannot be understood independently of the social actors involved. This means that research according to critical realism tries to be aware that the socio-cultural background and experience of the researcher can influence the research, and therefore aims to minimise such distortions. The role of the researcher is as objective as possible.

Due to the historically founded analysis of already existing structures and emerging effects, critical realistic research is linked to the deductive approach. Research in the social sciences is often based on this position and tends to uncover underlying structures of social relations.

3.2.3 Interpretivism

What interpretivism has in common with critical realism is criticism of positivism, but from a purely subjectivist perspective. Interpretivism emphasises that people differ from physical phenomena because they create meanings. Humans and their social world cannot be studied in the same way as physical phenomena, so social science research must differ from scientific research instead of trying to imitate it.

Since different people with different cultural backgrounds, under different circumstances and at different times create and experience different social realities, interpretivism criticises the aspiration of positivism to discover universal 'laws' by reducing complexity to a series of generalisations. The aim of interpretivist research is to create new, richer insights and interpretations of social worlds and contexts. As the social world is complex, the setup to be studied embraces the whole complexity, and no reduction can take place to preserve the richness of the insights. The interpretations of what looks the same on the surface can differ from the context.

In the field of interpretivism the social world is seen as individually constructed by social actors, and is therefore not observable independently and value free, as the researcher is part of the social world and

brings his own background. Actions of others lead to adjustments of the researcher's own actions and meanings. A theory is not the starting point, but the result of interpretivist research.

With its focus on complexity, rich, multiple interpretations and the formation of meaning, interpretivism is explicitly subjectivist.

From the perspective of interpretivism on the ontological dimension, reality is complex, rich and socially constructed through culture and language. Meanings are manifold and interpretable.

From the epistemological dimension of interpretivism, theories and concepts are considered too simple. Knowledge contributions of interpretive research are new insights and world views.

The consequence for the axiological dimension of interpretivism is that the values and convictions of the researcher play an important role in the research process. The decisive factor for the interpretivist research philosophy is that the researcher must adopt a sensitive attitude. The challenge is to enter the social world of research participants and understand it from their perspective. The researcher's role is reflexive.

Research from interpretational philosophy is typically inductive. It is based on small sample sizes, the data of which are examined in detail. Qualitative analysis methods are used to interpret series of data.

3.2.4 Postmodernism

Postmodernism emphasises the role of language and power relations and tries to question accepted ways of thinking and give voice to alternative, marginalised views. Postmodernism goes even further than interpretivism in its criticism of positivism and objectivism and attaches greatest importance to the role of language. The objectivist ontology of a concrete world is rejected.

Order is considered provisional and unfounded, as it is only achieved through language with its categories and classifications. Language is considered inadequate because it marginalises, suppresses and excludes aspects of what it claims to describe, while it privileges and emphasises other aspects. This expresses power relations and ideologies that dominate the context. Postmodernism tries to uncover and question these power relations. This is done in the form of 'deconstructing' what is considered reality.

From the ontological dimension, reality is considered nominally complex and rich. It is socially constructed by power relations, certain meanings, interpretations and realities are dominated and suppressed by others.

With regard to the epistemological dimension, dominant ideologies decide what counts as truth and knowledge. Therefore, the focus of postmodernist research is on the absent, silenced and suppressed meanings and interpretations.

From the axiological dimension, postmodernist research is value-oriented. The postmodernist researcher and his research are embedded in power relations, the balance of power between researcher and research object shapes the knowledge created by research. At the expenses of others, certain research narratives are suppressed and silenced. These are investigated in detail.

In general, qualitative analysis methods are used for this inductive purpose. The researcher's view of his role is radically reflective.

3.2.5 Pragmatism

Two opposing main fields of the ontological dimension can be distinguished: Objectivism and subjectivism. The research philosophy of pragmatism can be seen as a compromise between these two extremes (Easterby-Smith et al., 2015, p. 60).

In pragmatism, concepts of research philosophy are only relevant where they support the approach. Since pragmatic research is more interested in practical results than in abstract differences, it can cover the entire spectrum between objectivist and subjectivist research.

In the field of pragmatism, research does not face concepts like truth and reality and attempts at these concepts are seen as pointless.

The most important determinant of pragmatism is the research problem and the research question, which includes the pragmatic emphasis on practical results. Pragmatism is of the opinion that there are many different ways of interpreting and exploring the world and that no single perspective can ever convey the whole picture. Pragmatic research does not use several methods, but the one that enables credible, sound, reliable and relevant data to be collected in order to advance research.

According to the ontological dimension of pragmatism, reality is seen as complex, rich and external. Reality is the practical consequence of ideas, there can be several realities.

From the epistemological dimension of pragmatism, knowledge gains practical meaning in specific contexts. Those who make successful action possible are regarded as true theories. Pragmatic research begins with a problem and aims to find practical solutions that improve future practice.

From the perspective of the axiological dimension of pragmatism, research is value-oriented. Research is initiated and supported by doubts and convictions of the researcher. The values of the researcher drive the reflexive process of investigation. The researcher's view of his role in general is reflective.

Pragmatic research follows research problems and research questions in its methods. The wide spectrum ranges from mixed, multiple and qualitative to quantitative methods. The focus is always on achieving practical solutions and results.

3.2.6 Selection of appropriate Research Philosophy

In the following selection of the research philosophy, in a first step certain research philosophies were excluded in a negative selection on the basis of their specific characteristics:

- Positivism: Based on the approach to theory development chosen in the previous subsection – the inductive approach – it can be excluded directly on the basis of its inherent deductive approach.
- Critical realism: The same exclusion criterion applies to this research philosophy.
- Postmodernism: Due to the focus on power relations and the underlying approach from the ontological perspective of uncovering reality through ‘deconstruction’, this research philosophy is excluded.

In a second step, a positive selection of the remaining two of the five research philosophies identified as relevant for social science research (i.e. interpretivism and pragmatism) will be used to select the most suitable in the context of the research questions, emerging from the three dimensions:

Concerning ontology, the research questions assume a complex, rich reality, resulting from the perspectives of the stakeholders of the EEI projects and their respective constellations.

In epistemology, the research questions aim to gain new insights and thereby contribute to a deeper understanding of ES and the ESCO market as well as barrier issues.

Regarding axiology, it can be assumed that the researcher contributes to interpretations of the collected data; the researcher is part of what is being investigated. The role of the researcher is expected to be reflexive.

Both the research philosophy of interpretivism and that of pragmatism correspond in principle to the research approach resulting from the research questions regarding these three dimensions. With the research objective of developing further the existing conceptual frameworks in the area of economic barriers, this corresponds to the interpretivist research philosophy.

The research objectives of this research thus go beyond the pragmatic philosophy, since pragmatic research means the pragmatic orientation towards practical or practice-relevant results.

So, interpretivism is selected as the appropriate research philosophy in the second layer of the 'Research onion'.

3.3 Research Method – Third Layer of the 'Research Onion'

In the third layer of the 'Research onion' of Saunders et al. (2016, pp. 165-173), the term research method is used to distinguish between quantitative and qualitative approaches and combinations (so called mixed methods) thereof. Thereafter, the related research purpose is to be determined.

3.3.1 Quantitative vs. Qualitative vs. Mixed Methods

Quantitative and qualitative methods can be interpreted through their association to philosophical assumptions and also to research approaches and strategies, each with the aim of answering the research question. Quantitative and qualitative research can be seen as two ends of a continuum, but in practice they are often mixed. This can be done in different ways. By selecting interpretivism as relevant research philosophy, purely quantitative as well as mixed methods are directly excluded from a selection in this layer of the 'Research onion'. In order to emphasise the specifics of the remaining methods more clearly, the distinct features of the research methods are nevertheless listed briefly below.

- Quantitative research deals with quantification, reproducibility, objectivity and causality. The use of large amounts of data in quantitative research makes sense for the use of statistical methods to analyse research results. Quantitative research…
    - …is usually associated with a deductive approach that focuses on the use of data to verify a theory; it is therefore generally linked to the research philosophy of positivism, especially in

connection with highly structured data acquisition techniques in accordance with the research strategy, but may also be used in critical realism and pragmatism;

- …investigates relationships between variables that are measured numerically and analysed using various statistical and graphical methods; the data are collected uniformly, and probability sampling procedures are often used to ensure generalisability;
- …may use a single data collection technique and an appropriate quantitative analysis method according to the research strategy; a quantitative research design can also use more than one quantitative data collection technique and one appropriate analysis method;
- …is primarily connected with experimental and survey strategies; in quantitative research, a survey is usually conducted with the help of questionnaires or structured interviews or structured observations.

- Qualitative research attaches importance to seeing the social world from the perspective of the actors, in contrast to quantitative research, that focuses on facts and not on judgements. Qualitative research therefore aims to develop a comprehensive understanding of the problem under study by collecting data in a natural environment – the place where the actors experience the problem under study. Qualitative research…
  - …begins with an inductive approach to build a theory or develop a richer theoretical perspective than already existent in literature; often, strategies begin with a deductive approach to test a theory with qualitative methods;
  - …is often linked to the interpretative research philosophy; this aims to understand subjective meanings of the phenomenon under study; just like quantitative research, qualitative research can also be used in research philosophies of critical realism and pragmatism;
  - …examines the meaning of research participants and the relationships between them, using a variety of data collection techniques and analytical methods to develop a conceptual framework as theoretical contribution;
  - …does not have a standardised data collection procedure, a previous selection may change during the research process;
  - …is connected with a variety of research strategies; these share the ontological and epistemological basis, but each have specific priorities, scope and procedures;
  - …may use a single data collection technique and an appropriate qualitative analysis method according to the research strategy; a qualitative research design can also use more than one qualitative data collection techniques and analysis methods.
- Mixed methods research…
  - …can use a deductive, inductive or abductive approach;
  - … combines the use of quantitative and qualitative data acquisition techniques and analytical methods;
  - …is used in connection with the research philosophy of critical realism, since it assumes that there is an external, objective reality, but the way in which this is interpreted and understood is influenced by social conditioning; further qualitative research methods can be used based on

quantitative data analysis in order to take this realistic ontology and interpretative epistemology into account;

- …is also used in connection with the research philosophy of pragmatism, as it does not consider the exclusive assumption of a philosophical position to be helpful and instead, depending on the research question and the context, the most suitable research method is determined.

3.3.2 Research Purpose

The respective purpose is derived from the type and content of the research questions. Research may be designed to serve one of the four research purposes:

- Exploratory,
- Descriptive,
- Explanatory,
- Evaluative,

or a combination thereof.

- Exploratory Purpose…
  - ...is pursued to gain insights and to understand a topic, or if a phenomenon or problem is to be clarified; research questions that pursue an exploratory purpose usually begin with 'what' or 'how';
  - ...can be followed in various ways, e.g. by interviewing 'experts' on the topic, conducting interviews or focus group interviews, which due to their explorative character are unstructured and depend on the quality of the contributions of the research participants;
  - ...has the attribute of being flexible and adaptable; it can start with a broad focus and become narrower as research progresses.
- Descriptive Purpose…
  - ...is pursued to obtain an accurate profile of events, persons or situations; research questions that pursue a descriptive purpose usually begin with 'who', 'what', 'where', 'when' or 'how';
  - ...may be extension for an exploratory purpose or precursor for an explanatory purpose.
- Explanatory Purpose…
  - ...is pursued to establish the causal relationships between variables; research questions that pursue an explanatory purpose usually begin with 'why' or 'how';
  - ...is tracked to investigate a situation or problem by explaining the relationships between the variables.
- Evaluative Purpose…
  - ...is pursued to investigate the effectiveness of measures; research questions that pursue an evaluative purpose usually begin with 'how' or 'what' in the form of 'to what extent'';

- ...can provide a theoretical contribution in which the emphasis is not only placed on 'how effective' something is, but also 'why', and then this explanation is compared with the existing theory.

3.3.3 Selection of appropriate Research Method

The qualitative research method belongs to the inductive approach to theory development (selected in section 3.1, p. 47 and following). Accordingly, the interpretivist research philosophy (selected in section 3.2, p. 49 and following) is linked to the qualitative research method. As already mentioned, both the quantitative and the mixed method approach can therefore be excluded as applicable research methods for this research.

With regard to the determination of a mono or multi method approach, reference is made to the next element of the 'Research onion' – the research strategy – in section 3.4 (p. 57 and following).

With regard to the determination of the research purpose, a positive selection is to be made once again: Based on the research objectives (i.e. to gain a deeper understanding of the topic), accordance can be found with the specifics of the exploratory purpose that is applied when an understanding of a topic is to be created or a phenomenon or problem is to be clarified. This selection is also supported by the research questions – in an exploratory purpose, open questions beginning with 'what' or 'how' are asked to find out what is happening and to gain insights into a topic.

So, the qualitative research method is already determined by the interpretive research philosophy, carried out in an exploratory purpose in the third layer of the 'Research onion'.

Research strategies in connection with the explorative purpose are primarily literature research or (unstructured or semi-structured) interviews with 'experts'. These and other research strategies are discussed further in the next section.

3.4 Research Strategy – Fourth Layer of the 'Research Onion'

According to Saunders et al. (2016, p. 177), a strategy in general can be seen as an action plan to achieve an objective. A research strategy can therefore be described as the plan to find an answer to the research question. It is the methodical link between the research philosophy and the operational procedures for data collection and analysis.

In the fourth layer of the 'Research onion' of Saunders et al. (2016, pp. 177-200), the following eight research strategies are distinct:

- Experiment,
- Survey,
- Archival and Documentary Research,
- Case Study,
- Ethnography,
- Action Research,

- Grounded Theory, and
- Narrative Inquiry.

The selection of the appropriate research strategy again depends on the research questions and the research objectives and is therefore a consequence of the coherence with which they are connected with the research philosophy and the research method already selected in the previous sections.

Certain research strategies can be connected with any of the research philosophies and with both a deductive and an inductive approach. Boundaries between research philosophies, research approaches and research strategies are permeable: The first two of the research strategies described in detail below (experiment and survey) are generally or exclusively linked to a quantitative research design – and so already can be excluded from selection. The two following research strategies (archival and documentary research and case study) can be used in quantitative or qualitative research or in a mixed design. The last four research strategies (ethnography, action research, grounded theory and narrative inquiry) are generally linked to a qualitative research design.

3.4.1 Experiment

The purpose of an experiment is to investigate the likelihood that a change in one independent variable will cause a change in a dependent variable. An experiment uses predictions (hypotheses) – rather than research questions.

In an experiment in general two types of (opposing) hypotheses are formulated: the null hypothesis and the alternate hypothesis. The null hypothesis predicts that there will be no significant difference or relationship between the variables, the alternate hypothesis assumes the opposite. In an experiment this null hypothesis is then statistically tested and – depending on the result accepted or rejected.

The experiment is connected exclusively with a deductive research approach and can therefore directly be excluded as strategy for this research.

3.4.2 Survey

A survey strategy using a questionnaire makes it possible to collect and compare standardised data from a large population in an economic way and to collect quantitative data that can be quantitatively analysed. The data collected tend not to be as far-reaching as those from other research strategies, as the number of questions that can be expected to be answered by the participants is limited.

According to Easterby-Smith et al. (2015, p. 75), the dominant epistemology underlying the survey strategy is positivism. It is assumed that there are regular, verifiable patterns in human and organisational behaviour, but these are often difficult to identify and to explain due to the number of factors and variables that could lead to the observed result.

A special case of this strategy is the Delphi study, in which carefully selected experts are consulted at least twice on the same topic according to their expertise and receive feedback between these two rounds. This can refine statements and deepen certain topics. The number of responses is limited in this process, but the quality is usually better than in a simple survey. The survey is usually linked to a deductive research approach and is excluded as a relevant research strategy for this research.

3.4.3 Archival and Documentary Research

The archival and documentary research strategy is an approach that uses text, image and sound sources from archives. This data can be used for quantitative, qualitative or mixed methods. Typically, this strategy is not used alone but as support of other strategies in a multi-method approach.

3.4.4 Case Study

According to Yin (2014), a case study is an in-depth investigation of a topic or phenomenon in its real environment. By this the case study research strategy is distinct from others. Case study research is often used when the boundaries between the phenomenon being studied and the context in which it is being studied are not always obvious. A case study strategy has the ability to gain insights from intensive and in-depth research into the study of a phenomenon in its real context, leading to rich empirical descriptions.

Yin (2014) distinguishes between four case study strategies based on the following two dimensions:

- Single case versus multiple cases;
- Holistic case versus embedded case.

For the first dimension, a single case is used if it is a critical, extreme or unique case or because it is typical. A multiple-case study includes several cases. The rationale for using multiple cases focuses on 'replicability' across cases (in the sense of transferability of the findings derived from analyses). The cases are carefully selected for this purpose. Due to this comparability, the multiple-case strategy is preferred to the single-case strategy.

The second dimension of case study strategies refers to the unit of analysis. If the research relates to an object such as an organisation as a whole, then it is a holistic case study. For example, in relation to logical subunits within an organisation, a case study is referred to as an embedded case study.

Case studies are used by both deductive and inductive, and for explorative, descriptive or explanatory purposes.

3.4.5 Ethnography

The research strategy of ethnography is used to study the culture and social world of a specific group. Ethnography literally means a written representation of a people or an ethnic group. It examines the interaction of those involved.

According to Easterby-Smith et al. (2015, p. 86), the key principle of ethnography is to immerse the researcher in the environment and become part of the group under study to understand the meanings that people give to their behaviour and that of others and that are not understandable to outsiders. The breakdown of these meanings opens up possibilities for exploring the meaning systems of groups.

Ethnography solely is used with an inductive research approach.

3.4.6 Action Research

The aim of the action research strategy is to promote organisational learning to develop solutions to real organisational problems and to achieve practical results by identifying topics, planning, taking and evaluating measures.

The strategy of action research begins in a certain context and with research questions. As it goes through several iterations, the focus of the questions may change with the development of research.

In this way, action research differs from other research strategies in that it explicitly focuses on multi-stage measures to research and evaluate solutions for organisational questions and to promote changes within the organisation. The researcher works in a social process with the members of an organisation as moderator and teacher to improve the situation for these participants and their organisation.

According to Easterby-Smith et al. (2015, p. 85), action research assumes that social phenomena are not static but constantly changing. Action research solely is used with an inductive research approach.

3.4.7 Grounded Theory

The strategy of Grounded Theory refers to the data collection techniques and analysis methods used. These are incorporated into a theory developed inductively to analyse, interpret and explain meanings constructed by social actors in order to make meaningful use of their everyday experiences in specific situations.

Grounded Theory is used to develop theoretical explanations of social interactions and processes in a wide range of contexts. It offers a systematic approach to the collection and analysis of qualitative data.

The analyses are based on codes, developed in a process of continuous comparison of the collected data with already collected data, as well as with the codes that have so far been used to categorise this data. If necessary, new codes are created and existing codes are analysed again. Grounded Theory is generally regarded as an inductive approach. Due to the constant change between induction and deduction, Grounded Theory can also be classified as an abductive approach.

3.4.8 Narrative Inquiry

The research strategy of Narrative Inquiry is used in certain research contexts in which the experiences of the research participant(s) are best accessible by collecting and analysing them as complete stories instead of gaining them through interview questions. The participant acts as narrator, the researcher as listener, who facilitates the process of narration.

The purpose of narrative inquiry is to derive theoretical explanations from narratives while maintaining their integrity. The aim is to preserve chronological relationships and the sequence of events as told by the research participant in order to enrich understanding and analysis.

Through the narration, the research participant also provides his interpretation of the events.

Narrative inquiry is mainly used when research questions and goals suggest the use of an interpretative and qualitative strategy in an inductive research approach.

3.4.9 Selection of appropriate Research Strategy

Based on the qualitative research method (selected in section 3.3, p. 54 and following) and its corresponding basis, the fourth layer of the 'Research onion' is to determine the research strategy appropriate to the research objectives and questions of this research. The central aim is to understand in depth the significance of economic barriers for ES and EEI projects, hence a qualitative research method is to be used.

Due to their connection to the quantitative research method, the two research strategies experiment and survey can be excluded directly in a negative selection.

Ethnography is used to study the culture and social world of a particular group. The aim of narrative inquiry is to obtain chronological contexts and the order of events given by the research participant in order to enrich understanding and analysis. Action Research strategy, in turn, aims to promote organisational learning and develop solutions to real organisational problems through the development of measures. Grounded theory is used to develop theoretical explanations of social interactions and processes. Archival and documentary research was classified as a strategy within a mixed- or multi-method approach and thus as a complement to another research strategy. Finally, the case study strategy allows an in-depth investigation of a topic or phenomenon in its real environment or context, leading to rich empirical descriptions and the development of a theory.

This setup as exploratory case study corresponds most closely to the requirements. Since due to the rather complicated structure of EEI projects neither a critical, extreme nor unique or typical case can be identified, the multiple-case study setup is the approach to select for this research. In this context, attempts are made to achieve transferable findings across cases.

As the research deals with the Customer, ESCO and TPF organisations as a whole (even as it relates to economic aspects), a holistic multiple case study research strategy is selected.

With reference to the selection of the appropriate research method from the previous layer, the mono method research method, which only pursues one research strategy, is considered to be effective in this context.

3.5 Time Horizon – Fifth Layer of the 'Research Onion'

When designing a research project, it is important to ask whether it is a snapshot at a certain point in time or whether it is a representation of events over a period of time. The decisive factor once again are the research questions.

In the fifth layer of the 'Research onion' of Saunders et al. (2016, pp. 200-201), two time horizons are distinct:

- Cross-Sectional, and
- Longitudinal.

3.5.1 Cross-Sectional Time Horizon

In general, research is carried out in a cross-sectional horizon, in which a certain phenomenon is examined at a certain point in time. The subject can be the description of the frequency of the phenomenon or the explanation of the interrelationships of the factors in different situations. Case studies are usually based on interviews conducted over a short period of time in a cross-sectional horizon.

3.5.2 Longitudinal Time Horizon

The greatest strength of longitudinal research is its ability to investigate changes and developments and to understand change processes over time. Hence, following Easterby-Smith et al. (2015, p. 70), quasi-experimental methods are mainly used in the longitudinal horizon, as repeated measurements have to be carried out over time.

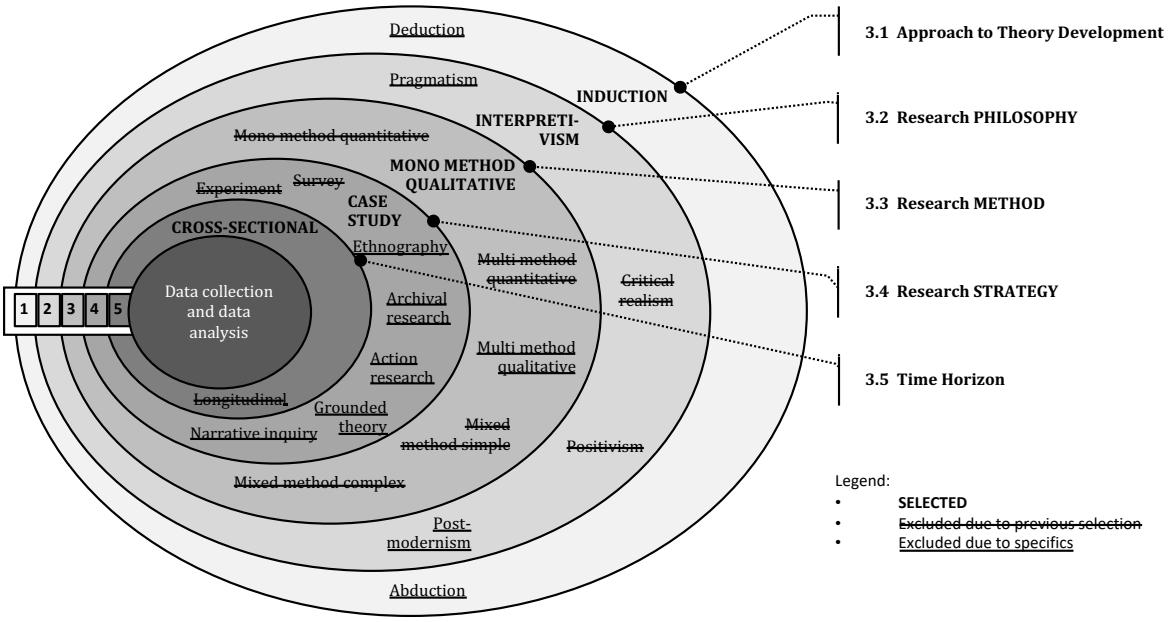
3.5.3 Selection of appropriate Time Horizon

The cross-sectional time horizon is used in conjunction with the research strategy of the multiple-case study selected for this research project in the previous section.

3.6 Conclusion from Selection of Methodology

The elements selected in each of the layers of the 'Research onion' are shown in the following figure; the elements excluded in the respective layers are marked according to the reason for exclusion:

Figure 3-10 – 'Research Onion': Selected Elements in Layers of Research Methodology
Based on Saunders et al. (2016, p. 124)



The research methodology chosen can therefore be summarised as follows:

This research pursues an interpretive research philosophy with an exploratory purpose in an inductive approach to theory development. It is conducted as mono method qualitative research with the strategy of a holistic multiple-case study in a cross-sectional time horizon. By doing so, the researcher pursues a reflexive role in order to enter the social world of the research participants to understand it from their perspective.

The element in the centre of the 'Research onion' (the research design for 'Data collection and data analysis') is subject of section 4.1, p. 66 and following in the next chapter.

3.7 Quality of Research

Reliability and validity are central elements to assessing the quality of deductive, quantitative research (refer to subsection 3.1.1, p. 48 and following). Alternative criteria have become established for assessing the quality of qualitative research. According to Saunders et al. (2016, pp. 206 and 398-401) these criteria are...

- ...'dependability' instead of 'reliability': The assumption behind interpretivist research based on qualitative, semi-structured interviews is that the phenomena under study are complex and dynamic. The value of using this methodology derives from the flexibility with which this complexity can be explored. The attempt to ensure that such non-standardised research can be replicated is therefore excluded in order not to undermine the strength of this type of research. To make the research process and the results understandable and comprehensible, the researcher's reasons for choosing the strategy and methods and the way in which the data was obtained should be explained. A detailed description of the research design and the data collection process must demonstrate that accurate results were derived.

  This requirement was responded to in this research with the very detailed description of the selection of methodology (refer to sections 3.1 to 3.5, p. 47 and following, concluded in section 3.6, p. 62 and following) as well as the description of the research design applied for the empirical work (refer to section 4.1, p. 66 and following).

- ...'transferability' instead of external validity/generalisability: The transferability of the results of qualitative research with the research strategy of the multiple-case study is made possible, e.g. in comparison to a single-case study, by the comparison of the findings between the cases – nevertheless, replication in the sense of statistical generalisability is not given. The transferability furthermore is made possible by a complete description of the research questions, the context, the results and the conclusions of the research, so that a similar project can be conceived in the context of future research and used in a suitable environment.

  This requirement was responded to in this research with the very detailed description of 'Empirical Work' (refer to Chapter 4, p. 66 and following) as well as of 'Analyses and Findings' (refer to Chapter 5, p. 92 and following). Findings were examined with regard to their transferability between the Cases of the multiple-case study.

- ...'credibility' instead of 'internal validity': The accurate demonstration of causal relationships between two variables to reach internal validity is systematically not given in qualitative research. In comparison, credibility from this approach can be gained through carefully conducted, semi-structured interviews with clarifying questions, investigating meanings and examining answers from different perspectives.

  This requirement was responded to in this research in the context of a corresponding, accurate conducting of semi-structured interviews (refer to subsection 4.1.3, p. 69 and following).

The researcher was aware of the particular importance of maintaining objectivity in the phases of data collection, analysis and reporting in order to ensure the credibility of the research. These requirements have been met by conscious action in the constant effort to collect data correctly and completely and to avoid any form of bias, error as well as selectivity:

- Participant error (negative influencing of the participant's performance) and participant bias (invoking incorrect answers from the participant) was attempted to be prevented by careful preparation and handling of the interviews (refer to subsection 4.1.1, p. 66 and following).
- Researcher error (negative influencing of the researcher's disposition on the interpretation of the answers) and researcher bias (misinterpretation of the answers by subjective views of the researcher) were attempted to be prevented by the researcher himself becoming sensitive of these factors in the preliminary stages of conducting the interviews.

At the same time, the researcher was aware of his reflexive role according to the axiology of the research philosophy of interpretivism (refer to subsection 3.2.3, p. 51 and following), according to which research is value bound and the researcher, as part of what is being researched, makes his contribution to knowledge through his subjective interpretations.

Another factor to consider was the role as an 'Internal researcher' (Saunders et al., 2016, pp. 207-209) due to the affiliation (at least at the time of data collection) to the ESCO as the central organisation of the multiple-case study. On the one hand, this role already provided knowledge of the organisations involved, the complexity of the problem and the context, furthermore unrestricted access to the research object was made possible. On the other hand, this 'Closeness' required a special awareness of the already existing assumptions and prejudices in the person of the researcher (such closeness may prevent the investigation of certain topics that would enrich the research).

The researcher was conscious at all times of the possible effects on the research and therefore tried to identify and prevent possible negative influences on research at an early stage by reflecting on his role as an internal researcher.

3.8 Summary of Chapter 3

Methodology is an essential part of any research. On this basis, it enables the researcher to justify the choice of the concrete approach on the way to achieving the stated research objectives. How the researcher intended to achieve this in this research has been shown in this chapter.

The researcher justified the use of the chosen methodology, i.e. research philosophy of interpretivism, that was essential in order to provide the researcher with a holistic view of the participants' views in the context of EEI projects, as well as the research strategy in the form of the multiple-case study method as a means of collecting meaningful data to answer the research questions.

The approaches and concepts for ensuring the quality of this research were explained.

In the next chapter data collection and analysis process are described, ethical issues are discussed. Then, the specific Cases of the multiple-case study and differing situations of the stakeholders involved are contrasted.

Chapter 4: Empirical Work

In the preceding chapters the empirical conditions of earlier research as well as the theoretical and methodological conditions of this research were presented, this chapter now deals with its empirical dimension.

The procedures for data collection and analysis are described below. Then the organisations and the associated interview participants (each in anonymised form) are presented, finally the five Case constellations of this multiple-case study, in which the individual stakeholders met within the context of EEI projects are explained in rich detail.

4.1 Data Collection and Analysis – Research Design

According to Saunders et al. (2016, p. 163), research design can be understood as the general plan of how the research questions should be answered. It includes ethical issues, the sources from which and also the way how data is collected and analysed.

4.1.1 Ethical Issues

Data collection phase began with an initial application to the University Research Ethics Committee for ethics clearance. This was granted without any restrictions or conditions.

In the area of ethical issues, a number of aspects had to be taken into account – both on the part of and with regard to the person of the researcher, the nature and manner of the research as well as in dealing with those involved. In the following, these aspects and their consideration in this research are described:

- Integrity and objectivity: The researcher conducted the research independently. The superiors (during the time of his employment at the ESCO) were informed by the researcher in good time before the start of the research. The ESCO as former employer did not exert any influence at any time – neither in the determination of the topic, the selection of the Cases nor that of the participants to be interviewed. No remuneration for the researcher in connection with this research was granted or promised; all interviews were conducted in the researcher's free time or during breaks. There was no obligation to disclose the research results to the ESCO. The subsequent (and current) employer of the researcher was also not affected by the researcher's ongoing research activities; all work was carried out in the researcher's free time and there was no dependency either. The participants were also never promised any remuneration or other advantage – neither personally nor for their respective organisation. The participants from Customer side were explicitly promised not to pass on results to the ESCO in a form attributable to the specific projects.
- Voluntary participation and informed consent: The potential participants were first contacted by telephone and informed about the planned research. If one initially was interested in participating, the researcher sent an information and consent form via e-mail. This form contained the following details: the type of research, the requirements and impact of participation, the rights of the

participant, the way the data was to be stored, analysed and reported, and to whom one could turn in case of concern. After returning the signed form, an appointment for an interview was made.

The consent form can be found in the Annex, part C.

- Privacy, respect and avoidance of harm: None of the respondents never was in any way dependent on the researcher; this also applied to ESCO respondents; there was no hierarchical allocation of respondents to the researcher. However, one respondent was the researcher's manager (the Commercial Director of the ESCO). All respondents voluntarily declared their participation, there was no pressure to participate at any time, a refusal to participate was sympathetically accepted and not questioned. The first contact was made by the researcher during normal working hours, as far as possible via a business mobile phone number to the potential participant. In the case of unavailability, a corresponding message was left. The private context of the interview and the exclusive use of the collected data for academic purposes in connection with this research were explicitly emphasised. An attempt was made in the face-to-face interviews to avoid any form of stress (e.g. through overzealous questioning for those involved). The participants knew that answering a question could be rejected at any time. Private aspects of the participants were not relevant, the context only referred to professional contents in matters of the Cases.
- Right to withdraw: All participants in the research were given the opportunity to withdraw their participation. In the information and consent form the explicit reference to this possibility was given. None of the participants made use of this possibility.
- Confidentiality and anonymity: An important point for the participants was the basic assurance of anonymity and confidentiality, concerning both the identity of the organisations involved and that of their representatives, participating as interviewees. It was assured that the researcher was not allowed to pass them on in any published work, dissertation or to third parties. After the consent of the participants, the interviews were audio recorded using the researcher's private equipment. The intended handling of the digital data was explained to the participants. Before the start of the audio recording of each of the interviews, the following code was agreed with the participants regarding the involved stakeholders: Names of organisations were not mentioned, instead the terms ‘Customer’, ‘ESCO’ and ‘TPF’ were used. No further instructions were given to the participants. They were addressed by the researcher with their real name. One participant asked to anonymise his person in all subsequent steps, this wish was granted, but in fact no person was named in the written report of this research. In subsection 4.1.3 (p. 69 and following) codes (so-called ‘Designations’) were assigned to the participants, which in turn were named with their respective function in their organisation. Personal data were not relevant for this research, such information was not collected and therefore no corresponding procedures had to be taken. It can be assumed that the measures taken to anonymise the identities of those involved preclude of their retroactive identification.
- Safety: Ethical aspects have also been taken into account with regard to the person of the researcher. Risks related to safety have been identified, in particular with regard to travel to the interviews and the places where the interviews were conducted, and attempts have been made to minimise these risks by means of anticipatory planning and appropriate design.

As shown above and according to Saunders et al. (2016, p. 141) in an interpretivist research a researcher is part of what is researched, the subjective interpretations are key to the contribution of the research and the role of a researcher is reflexive.

As a former employee of the ESCO, the researcher had in-depth knowledge of ES markets in general as well as on the ESCO under study and of the projects selected for the case studies in particular.

The researcher personally was convinced of the usefulness of EEI measures for the general reduction of CO2 emissions and was also of the opinion that ESCOs in general basically offer a target-oriented concept for the successful implementation of these measures. Already from his own professional practice as an employee of the ESCO under study, the researcher had the perception of certain existing barriers to the implementation of EEI measures. For professional reasons, the researcher had already discussed the issue of barriers in the past with his colleagues – some of them later participated in this research.

4.1.2 Selection of Stakeholders and Cases, Access to the Interview Participants

The set of five Cases for this research was carefully selected by the researcher. The decisive selection criteria were scope, content and funding structure of the respective EEI project (with the intention of covering a broad range through targeted selection), as well as the size of the client and the availability of a suitable contact person. The five Cases were referred to as Cases 'A' – 'E'.

The central element of each Case of the multiple-case study was the ESCO, which was involved as a corresponding stakeholder in each of the EEI projects examined.

At the time of data collection, the ESCO was organised regionally. Each regional unit had all the competences and capacities to cover the entire cycle of an EEI project. The commercial issues were each handled by a commercial manager for each regional unit.

At that time, this function was performed by the researcher himself in one of these regional units. This circumstance was also the main reason for the selection of the ESCO in question as the object of investigation. In this way, the researcher already had a deeper insight into all projects of the regional unit prior to this research, and personal contact with the representatives within the stakeholder organisations involved in the Cases.

Due to the economic orientation of the research objectives, the commercial manager or person with similar responsibility on the Customer side was identified as the preferred contact person. On the TPF side, the interview with the head of the relevant department was sought. At the ESCO, in addition to the Commercial Director, the Head of Corporate Controlling and Finance, the Senior Sales Manager and the Head of Project Development (in his role of former Project Manager in a certain Case) were also contacted as potential participants.

A total of 12 potential participants was addressed – as one contacted potential participant from Customer side refused to participate after a period of reflection and consultation with the researcher for personal reasons, in a further step his manager (and at the same time the managing director of this Customer) was addressed, who then assumed the role of the participant. So, an aspired total of 11 participants (all of male gender, therefore only male forms are used in the following, when applicable)

consented. The interviews then were conducted on the five defined Cases, with four participants from Customers, four from the ESCO and three from TPF organisation.

With the exception of one (the participant of Customer D), the researcher was personally acquainted with all of the participants prior to the enquiry. The contact with the prior was established via a colleague of the researcher from part of the ESCO.

4.1.3 Interview Practice

Data collection in the form of non-standardised, semi-structured face-to-face interviews was carried out between June 2016 and February 2017. The researcher attached great importance to using different question types in the discussion with the participants, both open and probing questions were used. All interviews were carried out in German, the first language of all participants.

The interviews in general took place at each of the premises of the participants. Exceptions were three interviews with ESCO participants, one took place in a meeting room at another location of the ESCO, two in the researcher's personal office.

The common motive of all participants was to take part in an academic research project on a topic that also stemmed from their professional practice as well as to support the researcher in his work. All participants were willing to provide sufficient time for the respective interview, and the questions were answered willingly and in full detail.

The researcher had developed an interview schedule for this purpose, which was used for all interviews. An essential part of the schedule was a question catalogue. Based on the barrier framework by Cagno et al. (2013, refer to subsection 2.4.6, p. 38 and following) as well as on the researcher's personal knowledge, the catalogue was developed by the researcher himself. The catalogue was divided into the following subject areas:

- Participant and organisation – details about the role of the person and the organisation he represented;
- EE and projects specifics – content of EEI measure and ES contracted, as well as potential projects;
- Specifics and barriers – barriers perceived, aligned to the framework of Cagno et al. (2013)

The interview schedule can be found in the Annex, part B.

The first interview took place on 21/06/2016 and was a form of pilot, as the participant was the ESCO Commercial Director and an expert on all EEI projects selected. With the experiences from this interview the catalogue of questions was supplemented and finalised.

Adjustments were made to the structure and scope of the catalogue according to the stakeholder role played by the organisation of the participant in the EEI project concerned. In order to ensure unambiguous identification, the interviews were assigned a designation whose syntax is composed of a consecutive numbering in the first place (‘01’ – ‘11’) and the stakeholder with its designation – if applicable (‘C’ = Customer and ‘A’ – ‘D’; ‘T’ = TPF organisation and ‘1’ – ‘3’; ‘E’ = ESCO) in the second place.

The following table provides an overview of the details of the interviews carried out:

Table 4-13 – Overview of Interview Details

Interview Date	Participant (Job/Role in Organisation)	Company Affiliation (Years)	Stakeholder	Designation	Duration (Minutes)
21/06/2016	Commercial Director	11	ESCO	01_E	40
06/07/2016	Head of Corporate Controlling and Finance	7	ESCO	02_E	36
13/07/2016	Head of Energy Financing	9	TPF 1	03_T1	80
13/07/2016	Director of Structured Financing	3	TPF 2	04_T2	39
20/07/2016	Head of Corporate Controlling and Finance	15	Customer C	05_CC	23
19/08/2016	Director of Energy Efficiency Funds	2	TPF 3	06_T3	49
25/08/2016	Commercial Head of Site	18	Customer A	07_CA	33
16/09/2016	Senior Sales Manager	5	ESCO	08_E	81
23/11/2016	Head of Strategic Business Development	11	Customer D	09_CD	37
06/12/2016	(Former) Project Manager	10	ESCO	10_E	35
08/02/2017	Managing Director	13	Customer B	11_CB	35
				TOTAL // AVERAGE:	**488 // 44**

From the preceding overview it can be seen that...

- ...on average, the interviews lasted almost 45 minutes, with the conversations with the Customer participants lasting the shortest on average (about 32 minutes) and the conversations with the participants of the TPF organisations the longest on average (about 56 minutes),
- the interviews with the participants of the TPF organisations and those of the ESCO showed a large variance, some of the interviews were very long, some relatively short. In total, interviews were conducted over a period of more than six hours.

4.1.4 Data Analysis and Write-up

The researcher followed the process of a template analysis, which offers a systematic, structured and holistic approach to the analyses of qualitative data. According to Saunders et al. (2016), the procedure includes the following five steps:

a) Becoming familiar with the data,

b) Coding initial transcript,

c) Developing a first list of codes and topics (the 'Coding template'),

d) Searching for key issues and recognise relationships,

e) Evaluating.

The audio recording of the interviews was transcribed by a commercial service provider. The application of strict rules was agreed. Since the transcription was not carried out by himself, the researcher familiarised himself intensively with the interview data by listening to the audio recordings several

times and reading the transcribed text documents. For the subsequent analyses, the researcher imported the transcribed text data into the NVivo 12 software tool, which enabled coding, hierarchisation, grouping and structured interpretation of the data.

A first transcript was coded, from which a list of initial codes was developed. The coding categorised data in the data elements (the interview text files) with similar meanings, links data units that referred to the same aspect or meaning, and linked aspects or meanings to compare and contrast them. Two code sources were used:

- 'A priori' (= theory-driven) codes derived from terms of existing theory and literature (with regard to barriers, reference was made to the barrier framework of Cagno et al. (2013), which was selected accordingly in subsection 2.4.10, p. 40 and following);
- 'In vivo' (= data-driven) codes based on the actual conditions of the interviews.

These codes were arranged and rearranged until a first template was derived. Subsequent transcripts were then coded with the codes of the first template, which was successively revised if new data revealed deficiencies in the codes used, resulting in the development of a final coding template. These were then used to represent relationships between topics hierarchically and sideways. This analytical tool was used to develop an initial conceptual framework, which was later revised and finalised to present and examine important topics and relationships in the data. The original data were thus grouped together for final analyses.

4.2 Overview of Stakeholder Organisations involved

A total of nine organisations was involved in this research (whereby the participants belonged to only eight of these organisations, i.e. no participant was involved from the organisation of Customer E). These nine organisations and the participants can be assigned to the three stakeholder groups as follows:

Table 4-14 – Overview of Stakeholders, Organisations and Participants involved

Stakeholder	Organisation (Designation)	Participant (Job/Role in Organisation)	
Energy Service Company	ESCO	01_E	Commercial Director
		02_E	Head of Corporate Controlling and Finance
		08_E	Senior Sales Manager
		10_E	(Former) Project Manager
Customer	Customer A	07_CA	Commercial Head of Site
	Customer B	11_CB	Managing Director
	Customer C	05_CC	Head of Corporate Controlling and Finance
	Customer D	09_CD	Head of Strategic Business Development
	Customer E	*N/A*	
Third Party Financier	TPF 1	03_T1	Head of Energy Financing
	TPF 2	04_T2	Director of Structured Financing
	TPF 3	06_T3	Director of Energy Efficiency Funds

Facts and details on these organisations are portrayed in the subsections bellow grouped by stakeholders, overviews in the form of 'Company profiles' are attached.

4.2.1 Energy Service Company

At the time of data collection the ESCO was a nationwide organisation which, through a German parent company, belonged to a French group of companies with international operations specialising in technical services.

The organisation had been active in the ES market for more than 20 years through several predecessor organisations and after inorganic growth in Germany. The organisation's origins lied both in utility organisations and in an organisation from the construction and facility management sector.

The ESCO went through several phases of corporate development:

- In phase 1 of corporate development in the international group of companies with one of the largest European utility organisations at the beginning of the business activity of the ESCO, sufficient liquidity was generally available to finance EEI projects with the group's own funds. The capitalisation of fixed assets invested played no role in reference to the already very asset-heavy balance sheets of these group, as some of the affiliates were energy generation plants.
- In phase 2, this focus changed following the takeover and merger of this predecessor organisation with an affiliate of a German group of companies with one of the largest European construction organisations active in the field of facility management. Liquidity to finance EEI investments was no longer available from group funds and had to be procured externally – although loan financing was not permitted. The capitalisation of fixed assets was to be avoided as far as possible.
- In phase 3, at the time of data collection for this research, following the takeover of the ESCO by an international group of companies with its focus on technical services – the last paradigm shift to date took place. Liquidity generated from the operating business was to be used solely for inorganic growth and not for investments in technical equipment; in addition, the capitalisation of corresponding fixed assets was generally excluded.

It can be assumed that, due to their affiliation to international groups, International Financial Reporting Standards (IFRS, for definitions and details of key terms regarding accounting standards refer to glossary, p. 16 and following), were also applied at the level of the consolidated financial statements in addition to the local accounting standard of the German Commercial Code (HGB).

During the phases of corporate development, different corporate policies came into effect and also influenced the project design of EEI projects – which regularly have very long contract terms – so that projects consisting of earlier phases each had special features which could not have been realised in this way at the time of data collection.

However, regardless of the phase of the corporate development, business purpose of the ESCO was to provide the full range of ES (both in the form of ESC and EPC):

- Energy analysis, audit and management,
- Project design,
- Implementation of energy conversion, distribution and control equipment,
- Operation and maintenance of equipment, facility management,
- Primary energy (and/or final energy) purchase,
- Supply of useful energy streams (such as heat, cold, indoor climate, electricity, compressed air, light, water and waste water),
- Monitoring and evaluation of savings, as well as
- Financing of EEI investments (first with own resources, later via TPF organisations).

The ESCO saw itself as one of the market leaders in Germany in the field of ES. Customers came from the industrial, real estate/residential and public/municipal sectors, however, were not private households.

The following table in the form of a company profile shows some basics as well as (historical and current or future respectively) economic project requirements and specifics from the perspective of the ESCO:

Table 4-15 – ESCO: Company Profile, economic Project Requirements and Specifics

Organisation of the **ESCO** – Company profile	
Basics:	
Sector classification	NACE-Code M71.1: Architectural and engineering activities and related technical consultancy
Operating performance	EUR 50 Mio. < FY 2016 < EUR 100 Mio.
Number of employees	Ca. 200
Type of enterprise	Private limited company, affiliate
Accounting standard	**IFRS** (current situation from group) // **HGB** (also historically)
Economic project requirements and specifics (historically – phase 1 of corporate development):	
Capitalisation	**Irrelevant**
Funding	**Own resources**
Collateral available	**Not needed**
Collateralisation from Customer	**Bank guarantee**
Other	Long contract terms (>= 10 years) are desired from Customer retention perspective
Economic project requirements and specifics (current situation – phase 3 of corporate development and for future projects):	
Capitalisation	**Off-balance required**
Funding	**External required** (Customer or TPF)
Collateral available	**Cession of ES contract rates**
Collateralisation from Customer	• **Easement** • **Waiver of the objection on debt service**
Other	Long contract terms are considered problematic from risk perspective

The change in economic project requirements and specifics between the phases of corporate development can clearly be seen from the company profile.

It is finally to be emphasised again, that, in accordance with the most recent corporate policy, EEI projects could only be realised through external funds and on the basis of an off-balance solution for the ESCO.

4.2.2 Customer Organisations

The energy-intensive business purpose was common to the participating Customer organisations. Of the five organisations in total, three were engaged in the food production sector (Customers B, C and E), one in the chemical industry (Customer A) and one in the hospital activities sector (Customer D). Due to the energy requirement profile, Customer D was assigned to the industrial sector and not to the public/municipal or real estate/residential sector and therefore came into the focus of this research.

All organisations were located in northern and eastern Germany and were mainly active in the German market.

Three succeeding phases of EEI projects were distinct:

a) Project design (contract negotiations and project planning);

b) Implementation;

c) Operations management.

During data collection, four Customers (Customer A, B, C, and D) were already contractually linked to the ESCO in EEI projects. These projects were in different phases at that time. These and further details concerning the Customer organisations are presented in detail (the respective project content is described in section 4.3, p. 81 and following):

- Customer A was an affiliate of one of the largest automotive suppliers in the world and was present at several sites throughout Germany. The parent company was a listed blue-chip stock company. Participant was the commercial head for one of these sites.

  The Customer's location had its origins in the 1930s as production site, and a large part of the infrastructure still originated in those times. At the time of data collection, various group companies (hence sister organisation of the Customer) were located on the site, their business purposes ranged from administration and training of new employees to research and development and production of a special sub-product area. The spaces for use by the different sister organisations were sublet by the Customer's organisation.

  The organisation was a long-standing Customer of the ESCO, the contractual basis was already concluded between a predecessor company of the ESCO (phase 1 of its corporate development) and a predecessor company of the Customer organisation. The Customer’s plant technology was in the operations management phase, contract negotiations on follow-up projects were currently conducted and the project design phase was on the way.

Table 4-16 – Customer A: Company Profile, economic Project Requirements and Specifics

Organisation of **Customer A** – Company profile	
Basics:	
Sector classification	NACE-Code C20: Manufacture of chemicals and chemical products
Operating performance	Site: EUR 100 Mio. < FY 2016
Number of employees	Site: ca. 3,500
Type of enterprise	• Organisation: Private limited company, affiliate • Site: One of several locations of the company
Accounting standard	**IFRS** (current situation from group) // **HGB** (also historically)
Economic project requirements and specifics (historically):	
Start of ES	2001
Capitalisation	**Off-balance required**
Funding	**External required** (provided from ESCO)
Collateral available	**N/A**
Motivation for ESCO engagement	• Outsourcing, concentration on core business, reduction of headcount • Reduction in fixed assets capitalised • Creation of liquidity through the sale of fixed assets
Economic project requirements and specifics (future projects as well as contract renewal):	
Capitalisation	**Irrelevant** (due to new accounting standard IFRS 16)
Funding	**Own resources, company projects compete for funds**
Collateral available	**Not needed**
Motivation for ESCO engagement	System availability
Other	• Three-party contract (participation of TPF) not wanted • Only short contract terms may be agreed upon (<= three years)

This Customer was the largest and most important in the ESCO portfolio and one of the most important in the company group's portfolio. As a reference Customer (i.e. an organisation which agreed that the ESCO could use a detailed presentation of the project specifics for marketing purposes, including the full company name), the project was actively used by the ESCO for acquisition activities.

- Customer B belonged to an owner-managed medium-sized group of companies, active in the dairy industry with a focus on yoghurt and fresh delicatessen products. Customer B had a single production site. The commercial officer was not available for an interview, instead the managing director of the organisation participated.

  The Customer was founded at the beginning of the 20th century as a dairy cooperative and, in the course of its existence, developed into a specialist supplier with a wide range of refined dairy products.

  The organisation was a long-standing Customer of the ESCO, the contractual basis was already concluded with a predecessor company of the ESCO (phase 1 of its corporate development). The Customer's plant technology was in the operations management phase, contract negotiations on follow-up projects were currently conducted and the project design phase was on the way.

Table 4-17 – Customer B: Company Profile, economic Project Requirements and Specifics

Organisation of **Customer B** – Company profile	
Basics:	
Sector classification	NACE-Code C10.5: Manufacture of dairy products
Operating performance	FY 2016 > EUR 100 Mio.
Number of employees	Ca. 300
Type of enterprise	Private limited company, affiliate
Accounting standard	**HGB**
Economic project requirements and specifics (historically):	
Start of ES	2005
Capitalisation	**Irrelevant**
Funding	**External required**
Collateral available	**Bank guarantee (in case of covenant breach)**
Motivation for ESCO engagement	• Liquidity protection, as own and available bank funds were tied up by other investment measures • Cost reduction • System availability • Access to know-how
Other	Transfer of ownership of fixed assets invested to Customer required at the end of the ES contract term
Economic project requirements and specifics (future projects as well as contract renewal):	
Capitalisation	**Irrelevant**
Funding	**External required**
Collateral available	• **Easement** • **Waiver of the objection on debt service**
Motivation for ESCO engagement	• Cost reduction • Reduction of CO2 (using 'Green energy') • System availability • Access to know-how

This Customer also was a reference Customer, whose project was used by the ESCO for acquisition purposes. One of the implemented technical solutions was awarded by the Ministry of the Environment of the Federal Republic of Germany. Moreover, the Customer's managing director was willing to present the EEI project to interested third parties and also to introduce potential Customers of the ESCO.

- Customer C was an owner-managed organisation with a single production site. Participant was the head of controlling and finance and hence the commercial responsible for the EEI project.

  The organisation had its predecessors in the 19th century as a small shop butchery, which over the years developed into a handcrafted butchery factory. The current location has been in operation since 1993 and has been successively expanded in several stages.

  The implementation phase of this Customer's EEI project had just been completed and the plant technology had been handed over to operations management phase. The contractual basis was concluded in phase 3 of the corporate development of the ESCO.

Table 4-18 – Customer C: Company Profile, economic Project Requirements and Specifics

Organisation of **Customer C** – Company profile	
Basics:	
Sector classification	NACE-Code C10.1: Processing and preserving of meat and production of meat products
Operating performance	EUR 50 Mio. < FY 2016 < EUR 100 Mio.
Number of employees	Ca. 150
Type of enterprise	Private limited company
Accounting standard	**HGB**
Economic project requirements and specifics (current situation):	
Start of service contract	2015
Capitalisation	**Irrelevant**
Funding	**External required; subvention aspired**
Collateral available	• **Pledge (blanket assignment)** • **Mortgage**
Motivation for ESCO engagement	• Independence from energy suppliers • Access to know-how • Cost reduction

At the time of data collection, the Customer was not yet a reference Customer. The researcher had no information as to whether the Customer could be acquired in the meantime for these marketing purposes – and whether it was in the interest of the ESCO to use this project with a comparatively limited scope (regarding the project content refer to subsection 4.3.3, p. 85 and following) of services for acquisition purposes.

- Customer D had several locations in a major city. Participant was the head of strategic business development – the commercial responsible for the EEI project at one location.

  The Customer was one of the largest university hospitals in Europe and had a history of more than 300 years. In total, the hospital had more than 3,000 beds at its locations and treated more than 800,000 patients annually. Over 7,000 students were enrolled in various university courses.

  The implementation phase of this Customer's EEI project was still in progress, the contractual basis was concluded in phase 3 of the corporate development of the ESCO.

Table 4-19 – Customer D: Company Profile, economic Project Requirements and Specifics

Organisation of **Customer D** – Company profile	
Basics:	
Sector classification	NACE-Code Q86.1: Hospital activities
Operating performance	EUR 100 Mio. < FY 2016
Number of employees	Ca. 6,500
Type of enterprise	Public corporation
Accounting standard	**HGB**
Economic project requirements and specifics (current situation):	
Start of ES	Proposed: 2017
Capitalisation	**Irrelevant**
Funding	**External required**
Collateral available	• **Easement** • **Waiver of the objection on debt service**
Motivation for ESCO engagement	• Cost reduction • Liquidity protection, since own and bank funds were not directly available to the public sector • Independence from energy suppliers

As an institution under public law, this Customer was dependent on the financing possibilities of the public sector and was therefore predestined as a Customer for EEI contracting projects. In contrast to office buildings used for administration or education, this type of organisation was energy-intensive.

At the time of data collection, the Customer was not yet a reference Customer. The researcher had no information as to whether the Customer could be acquired in the meantime for these marketing purposes.

- Customer E was a medium-sized company with a single production site and belonged to a group of companies. The parent company – one of the largest agricultural organisations in Europe – was a listed stock corporation. This parent company got into an existential crisis during the data collection phase and was wound up as a result of insolvency. The Customer also was directly affected by this situation.
  Project design phase was on the way, however contract negotiations with this potential Customer were unsuccessful and were terminated shortly before the time of data collection – due to apparent barriers.

Table 4-20 – Customer E: Company Profile, economic Project Requirements and Specifics

Organisation of **Customer E** – Company profile	
Basics:	
Sector classification	NACE-Code C10.3: Processing and preserving of fruit and vegetables
Operating performance	FY 2016 < EUR 50 Mio.
Number of employees	*Unknown*
Type of enterprise	Private limited company, affiliate
Accounting standard	*Unknown*
Economic project requirements and specifics (current situation):	
Start of ES	*N/A*
Capitalisation	*Unknown*
Funding	***External required***
Collateral available	*Unknown*
Motivation for ESCO engagement	• Creation of liquidity through the sale of fixed assets • Cost reduction

The project was terminated before all conditions were defined, therefore capitalisation as well as collateral available are qualified as 'Unknown'.

4.2.3 Third Party Financing Organisations

At the time of data collection, the ESCO was in contact with a total of three TPF organisations. In the past (starting with phase 2 of corporate development of the ESCO), financing – mainly lease – was concluded with further TPF organisations, but it was intended not to continue these business relationships after termination of the current contracts.

One of the TPF organisations (TPF 2) was contractually already linked to the ESCO in EEI projects, the two remaining TPF organisations (TPF 1 and TPF 3) were in (final) contract discussions regarding future EEI projects, also with some of the Customer organisations involved in this research.

- TPF 1 was the affiliate of a public bank and with about 400 employees one of the largest manufacturer-independent lease companies in Germany. The structured finance division offered financing solutions for special investment objects, including EEI projects. The organisation's portfolio included lease financing as well as hire purchase (for definitions and details of key terms regarding financing methods refer to glossary, p. 11 and following).

Table 4-21 – TPF 1: Company Profile, economic Project Requirements and Specifics

Organisation of **TPF 1** – Company profile	
Basics:	
Sector classification	NACE-Code K64.9: Other financial service activities, except insurance and pension funding
Type	Lease company (affiliate of a public bank)
Refinancing	Parent company (public bank)
Economic project requirements and specifics (current situation):	
Criteria for granting financing	Customer credit-worthiness
Financing method offered	• Lease • Hire purchase
Financing volume	EUR 200,000 < Investment EEI project< (theoretically) no limit
Options for collateralisation required	• Easement • Guarantee • Legal ownership on fixed assets invested

- TPF 2, with about 80 employees, was one of the larger lease companies in Germany, independent of both banks and manufacturers. One of the divisions focused on financial solutions for EEI projects. The organisation's portfolio included several financing methods.

Table 4-22 – TPF 2: Company Profile, economic Project Requirements and Specifics

Organisation of **TPF 2** – Company profile	
Basics:	
Sector classification	NACE-Code K64.9: Other financial service activities, except insurance and pension funding
Type	Lease company (independent)
Refinancing	Refinancing partners (external banks)
Economic project requirements and specifics (current situation):	
Criteria for granting financing	• Affiliation to certain industries • Customer credit-worthiness
Financing method offered	• Forfeiting • Lease • Hire purchase
Financing volume	EUR 500,000 < Investment EEI project< EUR 25 Mio.
Options for collateralisation required	• Easement (in case of lease) • Mortgage (in case of lease) • Pledge (in case of hire purchase) • Waiver of the objection on debt service • Legal ownership on fixed assets invested

- TPF 3 was a Swiss investment manager with about 50 employees. The organisation specialised in financing EEI projects and saw itself as a global leader in 'Financing the energy transition'. The organisation was the first investment manager to set up its own EEI fund, in which private investors committed themselves to long-term stable returns for financing EEI projects. The organisation concentrated on ES projects in the areas of industry, real estate/residential and public/municipal. The portfolio included also several financing methods.

Table 4-23 – TPF 3: Company Profile, economic Project Requirements and Specifics

Organisation of **TPF 3** – Company profile	
Basics:	
Sector classification	NACE-Code K64.3: Trusts, funds and similar financial entities
Type	Funds (independent investment manager)
Refinancing	Investors
Economic project requirements and specifics (current situation):	
Criteria for granting financing	• Effective CO2-reduction • Customer credit-worthiness, has to be rated at least 'Investment-grade'
Financing method offered	• Forfeiting (preferred) • Lease • Loan
Financing volume	EUR 20,000 (standardised) // EUR 750,000 < Investment EEI project < EUR 24 Mio.
Options for collateralisation required	• Guarantee (in case of forfeiting) • Easement (in case of lease) • Mortgage (in case of lease) • Legal ownership on fixed assets invested
Other	• Fixed-interest distribution to investors results in comparatively high interest rates • ESCO is usually contractual partner

4.3 Details on the Cases selected

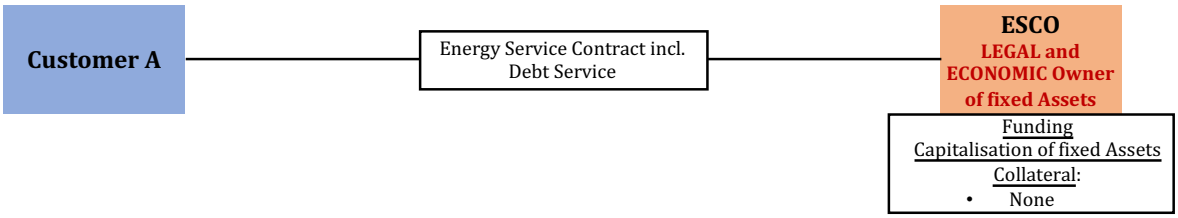
In addition to the ESCO and the respective Customer organisations, the TPF organisations were involved in some of the Cases. This and the further specifics of the Cases of this multiple-case study are described in detail in the following subsections.

The ESCO was an active stakeholder in each of the Cases. The main distinguishing feature between the Cases was the stakeholder Customer, this was different in each Case and gave the designation to the respective Case (Case 'A' – Case 'E'). In Case C, only these two stakeholders were involved. The TPF organisations were involved actively in the other Cases or were interviewed at least about these Cases.

4.3.1 Case A

The contractual basis in Case A was an ESC, which, however contained a performance component. The following figure shows the stakeholders involved and the relevant contract specifics of the persisting contract from 2001:

Figure 4-11 – Case A: Contract Structure



For the 10-year contract term, ESCO guaranteed the Customer a saving of 5% of the previous energy costs – to be realised by means of purchase prices for useful energy streams and services supplied, which

were determined on the basis of planned quantities. The primary energies required for this were purchased by the Customer, passed on to the ESCO and bought back in the form of useful energy streams.

Any savings beyond this remained with the ESCO. The debt service was paid as part of a basic price. From the start of the contract until the date of data collection, the ESCO had invested an amount in EUR well into the double-digit millions (the three participants were unable to reach an exact value).

After expiry of the original contract term, the ESC contract term was extended again by one year, unless its termination with a notice period of six months.

The following ES respectively measures have been implemented since the start of the contract and during the contract term:

- Energy analysis;
- Purchase of the existing energy conversion, distribution and control equipment, previously owned by the Customer; transfer of employees to the ESCO, thus financing of EEI measure;
- Takeover of the operation and maintenance of the equipment as well as facility management; refurbishment, modernisation and optimisation of the plants; extension of the control systems to ensure trouble-free operation and to enable the analysis of media flows;
- Supply of the Customer's production site with useful energy streams (including electricity, but also hot, cold and pressurised water, steam, compressed air);
- Monitoring and evaluation of savings;
- Conduct of energy audits.

Only the stakeholders ESCO and Customer were involved in the existing contract from 2001. The following table shows the (potential) stakeholders, organisations as well as the participants involved in this research:

Table 4-24 – Case A: Stakeholders, Organisations and Participants involved

Stakeholder	Organisation (Designation)	Participant (Job/Role in Organisation)	
Effective:			
Energy Service Company	ESCO	01_E	Commercial Director
		02_E	Head of Corporate Controlling and Finance
Customer	Customer A	07_CA	Commercial Head of Site
Potential:			
Third Party Financier	TPF 1	03_T1	Head of Energy Financing

At the time of data collection, the ESCO intended, in the context of major investment measures (development of independent electricity generation and steam supply), to re-equip the ESC contract with a longer term. This measure was to be financed through the participation of a TPF organisation, since the financing solution originally practised with ESCO funds was no longer possible due to the paradigm shift in corporate policy that had taken place in the meantime.

The potential EEI measure consisted of the following additional ES:

- Project design;
- Implementation of an independent electricity generation (a CHP unit) and steam supply;
- Financing via TPF.

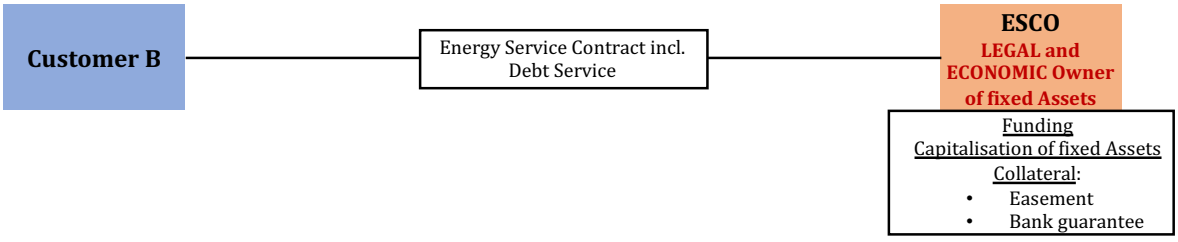
The Customer organisation, however, rejected a contract constellation with more than one contractual party. The participation of a TPF organisation was therefore generally excluded. As the Customer organisation assumed that it would also have to capitalise the fixed assets currently capitalised by the ESCO on its own as a result of the upcoming amendments to IFRS (particularly IFRS 16), off-balance solutions no longer played a role for future measures. Furthermore, financing should be presented from the group's own resources. EEI projects competed with other investment measures on the basis of their possible return on investment. Due to a paradigm shift in the maximum term of supplier contracts, which also took place on the Customer side, those with terms of more than three years were excluded. As a result, no new contractual basis could be found at this time for implementing the EEI measures planned by the ESCO at the Customers' site.

Furthermore, in the course of 2018, the researcher became aware that the original ESC contract (from 2001) had been terminated by the Customer. For this case, the ESC contract stipulated the return of the fixed assets and the employees taken over by the ESCO. The Customer declared its intention to negotiate a new contractual relationship with a significantly shorter term and only covering maintenance of the equipment as scope of ES.

4.3.2 Case B

The contractual basis in Case B was an ESC, which, however contained a performance component. The following figure shows the stakeholders involved and the relevant contract specifics of the persisting contract from 2005:

Figure 4-12 – Case B: Contract Structure of initial EEI Project



For the 10-year contract term, the ESCO guaranteed the Customer a saving of 5% of the previous energy costs – to be realised by means of purchase prices for useful energy streams and services supplied, which were determined on the basis of planned quantities. The primary energies required for this were purchased by the Customer, passed on to the ESCO and bought back in the form of useful energy streams.

Any savings beyond this remained with the ESCO. The debt service was paid as part of a basic price.

The following ES respectively measures have been implemented since the start of the contract and during the contract term:

- Energy analysis;
- Purchase of the existing energy conversion, distribution and control as well as waste equipment, previously owned by the Customer, thus financing of EEI measure;
- Takeover of the operation and maintenance of the equipment as well as facility management; refurbishment, modernisation and optimisation of the plants;
- Supply of the Customer's production site with useful energy streams (steam, ice water, room cooling, compressed air, drinking water, waste water – sewage treatment plant);
- Monitoring and evaluation of savings;
- Conduct of energy audits.

Further expansion during the contract term was already contractually agreed at the beginning. So, during the lifetime of the original ESC, the scope of ES – with the contract structure unchanged – was amended by the following measure:

- Project design;
- Implementation of an energy centre with CHP unit and absorption chiller, steam boiler and oil-free compressed air.

The investment at the beginning of the contract amounted to around EUR 2 Mio., the energy centre represented a further investment of around EUR 5 Mio.

The existing ESC contract term was extended in advance by 15 years. The contractually agreed termination arrangement prohibited the ESCO from selling the energy centre to a TPF organisation (e.g. a lease company) in order to grant the Customer various rights to the equipment. Financing and capitalisation were therefore still part of the responsibility of the ESCO.

Hence, only the stakeholders ESCO and Customer were active in the persisting contract from 2005. The following table shows the (potential) stakeholders, organisations as well as the participants involved in this research:

Table 4-25 – Case B: Stakeholders, Organisations and Participants involved

Stakeholder	Organisation (Designation)	Participant (Job/Role in Organisation)	
Effective:			
Energy Service Company	ESCO	01_E	Commercial Director
		02_E	Head of Corporate Controlling and Finance
		10_E	(Former) Project Manager
Customer	Customer B	11_CB	Managing Director
Potential:			
Third Party Financier	TPF 1	03_T1	Head of Energy Financing
	TPF 2	04_T2	Director of Structured Financing

At the time of data collection, Customer and ESCO were negotiating the expansion of the energy centre.

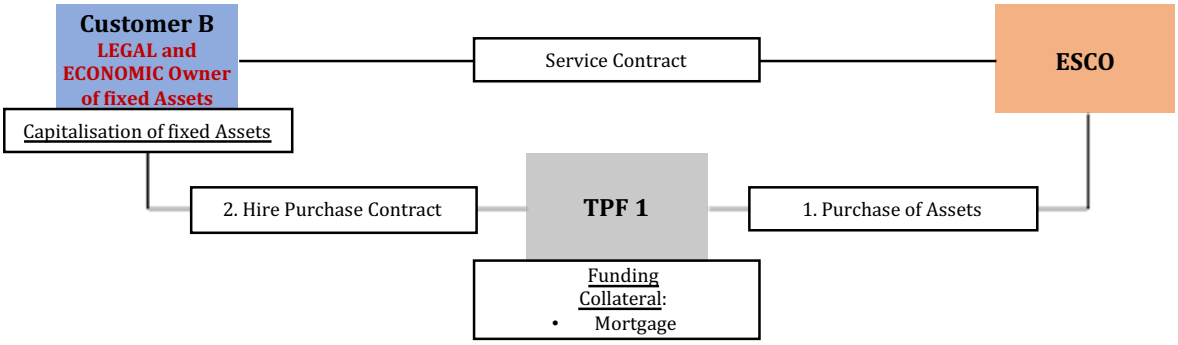
The intended EEI measure consisted of the following additional ES:

- Project design;
- Implementation of a further CHP unit;
- Financing of the investment via TPF.

This measure was to be financed through the participation of a TPF organisation, since the financing solution originally practised with the ESCO funds on its side was no longer possible due to the paradigm shift in corporate policy that had taken place in the meantime.

The following figure shows the stakeholders involved and the relevant contract specifics of the proposed contract and the financing in the form of a hire purchase:

Figure 4-13 – Case B: Contract Structure of proposed EEI Project



In the course of 2018, the researcher became aware that – after completion of the project design – the implementation of the intended further EEI measure had been stopped by the Customer for the time being. The background to this was the prospect of a deterioration in the economic viability of the measure as a result of expected legislative changes to the EEG as well as KWKG (for definitions and details of key terms regarding energy, efficiency and corresponding legislation refer to glossary, p. 7 and following), in which corresponding remuneration should be reduced and exemptions from EEG levies should no longer apply.

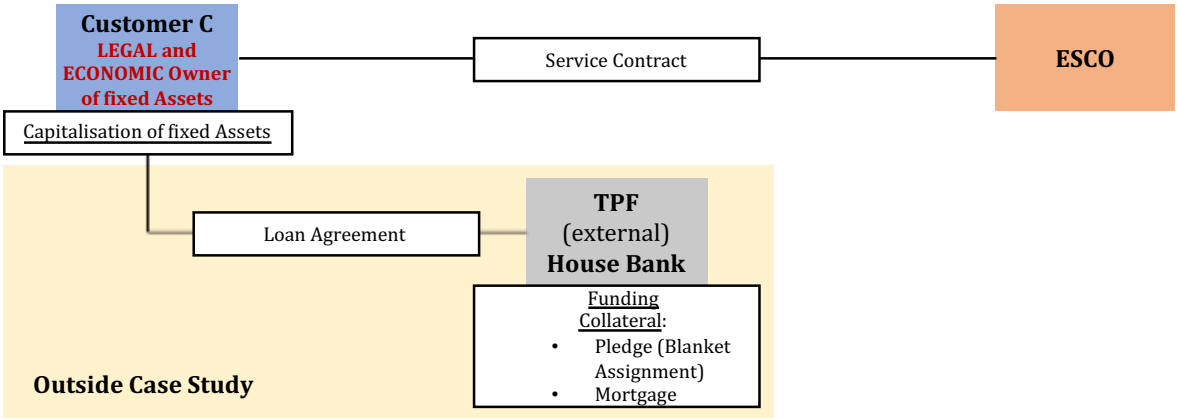
The exact modalities of this legislation have been changed several times in recent years, but even operational plants have so far been granted preservation of the status quo in principle. Recent developments have led the Customer to suspect effective deteriorations in the economic conditions calculated for this EEI project.

4.3.3 Case C

The basis in this Case was a service contract. The contribution of the ESCO to this EEI project was limited to the design and implementation of the equipment. At the end of this phase, the operations management of the technology was transferred to the ownership and responsibility of the Customer, who in turn financed the EE technology through a separate contractual relationship with a self-provided TPF. The ESCO was paid in the form of a basic price.

There were two separate two-party contracts, which are shown in the following figure:

Figure 4-14 – Case C: Contract Structure



So, financing was outside the scope of this multiple-case study.

The EEI project was only part of a larger investment by the Customer, which also expanded the overall production capacity. The following services respectively measures were part of the EEI project:

- Energy analysis;
- Project design;
- Implementation of a CHP plant and a waste heat boiler for steam production with thermal afterburning of the flue gases, which was also used for steam generation; dissolution of two existing energy centres, merger to one energy centre;
- Maintenance of equipment.

The investment volume of the EEI measure amounted to a total of EUR 1.8 Mio.

An ES contract with a correspondingly long term was not concluded, the only services remaining with the ESCO were maintenance and repair of the plants over a term of initially three years. In this project, the ESCO therefore essentially only acted as a plant constructor.

The background for this approach chosen by the Customer was the possibility to receive a subsidy measure from the German Federal State via KfW Bank in which the Customer was based. The prerequisite for receiving this subsidy was that the EEI measure was embedded in a larger project connected to production expansion. For this reason, the ESCO was also excluded from receiving this support. The volume of the subsidy amounted to 25% of the total investment.

From the perspective of the Customer's house bank, which provided the financing for the project and organised the subsidy, a comparatively high equity component was reached by this subsidy, which in turn made it possible to grant favourable conditions for financing the entire measure.

The following table shows the stakeholders, organisations as well as the participants involved in this research:

Table 4-26 – Case C: Stakeholders, Organisations and Participants involved

Stakeholder	Organisation (Designation)	Participant (Job/Role in Organisation)	
Effective:			
Energy Service Company	ESCO	01_E	Commercial Director
		02_E	Head of Corporate Controlling and Finance
		08_E	Senior Sales Manager
Customer	Customer C	05_CC	Head of Corporate Controlling and Finance

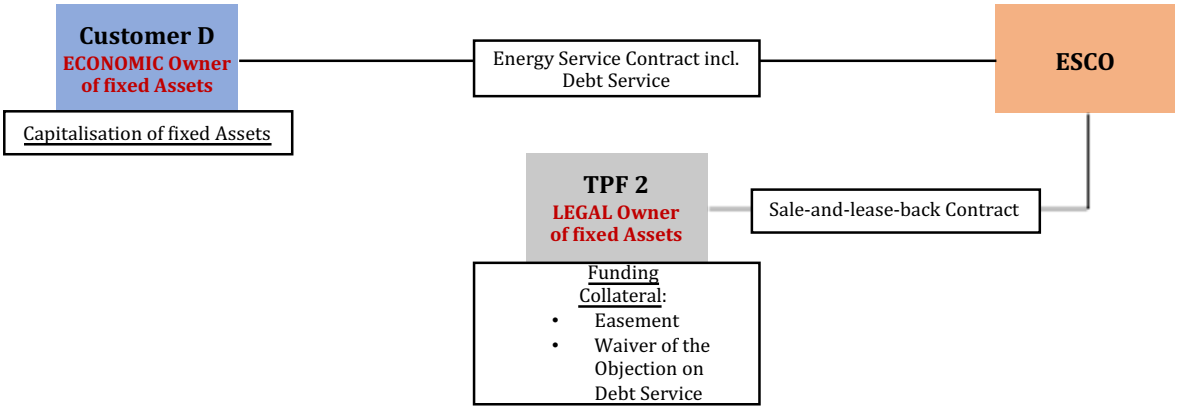
The EEI project could not be realised within the scope of an ES contract with the ESCO due to the financing of the production expansion measure required by the Customer. Even if the EEI measure had been eligible on its own, the ESCO (under the current corporate policy) would not have been able to obtain the subsidy because of the loan financing required for this.

4.3.4 Case D

The contractual basis in Case D was an ESC, calculated savings from the EEI measure were not contractually guaranteed by the ESCO and remained with the Customer, who paid the ESCO for the operation of the plant and the financing in the form of a basic price.

The following figure shows the stakeholders involved and the relevant contract specifics of the project:

Figure 4-15 – Case D: Contract Structure



The following ES respectively measures were part of the EEI project:

- Project design;
- Implementation of two combined cooling, heat and power plants (CCHP, the so-called trigeneration);
- Takeover of the operation and maintenance of the equipment as well as facility management;
- Supply of the Customer's production site with useful energy streams (steam, which is required in large quantities for the sterilisation of the hospital equipment, cold for cooling in summer, as well as electricity);
- Monitoring and evaluation of savings;
- Financing of the investment via TPF.

The investment for the EEI technology amounted to approx. EUR 13.5 million, the ES contract was concluded for a term of 15 years.

The project was awarded within the framework of a Europe-wide call for tenders. A competitor of the ESCO was selected successfully in the first round. Only with unsuccessful contract negotiations did the ESCO develop an alternative technical concept based on CCHP after the solution originally required by the Customer based on a gas turbine had turned out to be the less economically attractive solution for the EEI project.

The following table shows the stakeholders, organisations as well as the participants involved in this research:

Table 4-27 – Case D: Stakeholders, Organisations and Participants involved

Stakeholder	Organisation (Designation)	Participant (Job/Role in Organisation)	
Effective:			
Energy Service Company	ESCO	01_E	Commercial Director
		02_E	Head of Corporate Controlling and Finance
		08_E	Senior Sales Manager
Customer	Customer D	09_CD	Head of Strategic Business Development
Third Party Financier	TPF 1	03_T1	Head of Energy Financing

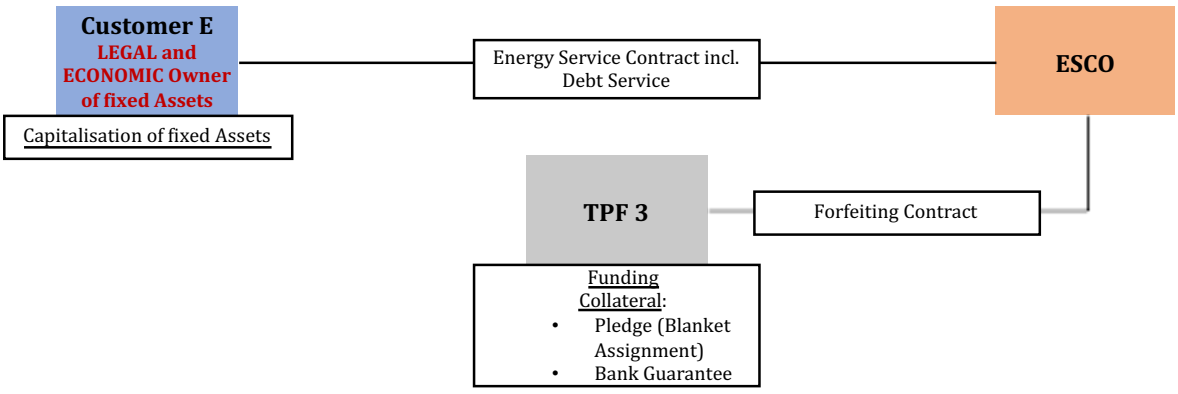
This EEI measure was the largest implementation in the history of the ESCO and its predecessor organisations.

4.3.5 Case E

Case E was based on an EEI project that was not implemented. An ESC contract was prepared by the potential stakeholders and was on its way to completion, but negotiations were terminated before contract conclusion. It was intended to finance the investment through the method of forfeiting.

The following figure shows the stakeholders involved and the relevant contract specifics of the project:

Figure 4-16 – Case E: Contract Structure



The following ES respectively measures were part of the potential EEI project:

- Energy analysis;
- Project design;
- Purchase of existing CHP plant, previously owned by the Customer, thus financing of EEI measure via TPF with the financing method of forfeiting (i.e. the ESCO finally sells the EEI equipment to the Customer and passes the purchase price claim on to the TPF; the Customer has to pay its liability over the term of the ES contract with a debt service component);
- Extension to a combined cooling, heat and power plant (CCHP, trigeneration);
- Takeover of operation and maintenance of the equipment as well as facility management;
- Supply of the Customer's production site with useful energy streams (steam for cooking the vegetables, cold for freezing the ready meals, electricity);
- Monitoring and evaluation of savings;
- Conduct of energy audits.

The investment for the EEI technology amounted to approx. EUR 1.5 million, the ES contract was proposed for a term of 10 to 15 years.

The following table shows the stakeholders, organisations as well as the participants involved in this research:

Table 4-28 – Case E: Stakeholders, Organisations and Participants involved

Stakeholder	Organisation (Designation)	Participant (Job/Role in Organisation)	
Potential:			
Energy Service Company	ESCO	01_E	Commercial Director
		02_E	Head of Corporate Controlling and Finance
		03_E	Senior Sales Manager
Customer	*Customer E*	*N/A*	
Third Party Financier	TPF 1	03_T1	Head of Energy Financing
	TPF 3	06_T3	Director of Energy Efficiency Funds

At the time of the contract negotiations, massive liquidity problems on the part of the Customer's parent company became public. Expiring bond financings could not be redeemed and at the same time suspicions of fraudulent actions in connection with the liquidation of fixed assets arose. As a result, no TPF under economic conditions was available for the EEI project, which had to be terminated.

4.3.6 Scope of Energy Services provided in the Cases

As can be seen from the detailed descriptions in the previous subsection, the scope of ES provided by the ESCO differed considerably both between the five Cases and over time within certain Cases.

The following table gives a concluding overview of the project scopes. A distinction is made between the effective (in the implementation or operations management phase) and the potential design phase (planned and/or under negotiation) measures at the time of data collection:

Table 4-29 – Overview of ES provided (effectively/potentially) by ESCO in the Cases

Scope of ES *(effectively/potentially)* **provided**	**Case**						
	A		**B**		**C**	**D**	**E**
	Effective	*Potential*	*Effective*	*Potential*	*Effective*	*Effective*	*Potential*
Energy analysis	**X**		**X**		**X**	-	**X**
Project design	-	**X**	**X**		**X**	**X**	**X**
Implementation of equipment	-	**X**	**X**		**X**	**X**	**X**
Operation of equipment	**X**		**X**		-	**X**	**X**
Maintenance, facility management	**X**		**X**		**X**	**X**	**X**
Primary/final energy purchase	-		-		-	-	-
Supply of useful energy	**X**		**X**		-	**X**	**X**
Monitoring and evaluation of savings	**X**		**X**		-	**X**	**X**
Financing (Customer//ESCO//TPF)	- // **X** // -	**X** // - // -	- // **X** // -	- // -// **X**	**X** // - // -	- // - // **X**	- // - // **X**
Capitalisation (Customer//ESCO//TPF)	- // **X** // -	**X** // - // -	- // **X** // -	**X** // - // -	**X** // - // -	**X** // - // -	Unknown
Energy audits	**X**		**X**		-	-	**X**

From the preceding overview it can be seen that...

- ...the ESCO – with the exception of Case C – covered or planned to cover an extensive and in some Cases even comprehensive scope of ES.
- ...the primary/final energy purchase alone was not the subject of the (potential) scope in any of the Cases, i.e. in all five Cases the Customers held the primary/final energy supply contracts and provided these energy streams to the ESCO for processing or charged the ESCO with the corresponding energy procurement costs (or intended to do so).
- ...the scope of the ES in Case C only comprised the design and implementation of the equipment and its maintenance, while in the other Cases a form of ESC with correspondingly long contract terms was intended or assigned.
- ...an important distinguishing feature between all of the five Cases and within these – if applicable – between effective and potential situations was the financing method and the capitalisation, following the latest corporate policy of the ESCO, according to which this ES scope no longer could be offered.

4.4 Summary of Chapter 4

In this chapter, after an introductory description of the data collection and analysis procedures, the organisations involved as stakeholders in the five Cases of this multiple-case study were outlined in detail. Specific situations, especially with regard to financing and capitalisation, were presented, also in view of the changing corporate policy of the ESCO.

It was made clear that the EEI projects in the Cases were at different stages of the EEI project cycle at the time of data collection.

Information on events relating to the Cases relevant to this research which occurred after the time of data collection and which came to the knowledge of the researcher has also been included. Influences and effects of these situations were presented in the descriptions of the Cases.

The following chapter explains in detail the barriers that have been found through the analyses resulting from these situations in the five Cases that have inhibited or even completely prevented the realisation of projects or measures.

Chapter 5: Analyses and Findings

This chapter systematises and summarises the findings from the analyses of the collected data on the five Cases of the multiple-case study described in the previous chapter and based on the barrier framework of Cagno et al. (2013).

In the following, it is described which economic barriers were identified and how specific stakeholder situations and constellations influenced these barriers. It is shown under which conditions the realisation of these EEI projects in the German industrial sector was hindered or prevented, in particular in order to provide a deeper understanding of the underlying influencing factors, to give recommendations for overcoming these barriers and thereby to promote the development of the German ESCO business.

5.1 Overview of Findings derived

In the first analysis of the primary data, it was examined which of the six economic barriers from the framework of Cagno et al. (2013) were addressed by the stakeholders involved in the five Cases. The evaluation distinguished those Cases in which all of the three stakeholders were involved from those in which only two stakeholders were involved – either because TPF was not part of the EEI project (as in Case C) or because the Customer was not available (as in Case E).

In addition to the six barriers of the reference framework, a further provisional barrier – '7. UNCOVERED ISSUES' – was added in order to include barrier issues which, in the opinion of the researcher, are connected to the area of economic barriers but cannot be subsumed to one of the six economic barriers of the framework of Cagno et al. (2013).

In the following table, the number of stakeholders whose participants addressed a barrier issue (maximum three or two respectively) is given for each of the barriers by Cases.

Using a colour scheme based on traffic light colours, the significance of the barriers for the respective Case is visualised as a function of the number of addressing stakeholders in the style of a 'heatmap':

Table 5-30 – Overview of economic Barriers identified by Cases, Nominations of Stakeholders

Economic Barrier **Aggregated from Stakeholders**	**Case** 3 of 3 Stakeholders involved (Max. Nomination = 3)		 2 of 3 Stakeholders involved (Max. Nomination = 2)		
	B	**D**	**A**	**C**	**E**
1. External Risks	**2**	**1**	**-**	**1**	**-**
2. Low Capital Availability	**3**	**1**	**2**	**1**	**2**
3. Intervention not sufficiently profitable	**1**	**1**	**-**	**-**	**-**
4. Hidden Costs	**-**	**1**	**-**	**-**	**-**
5. Investment (Transaction) Costs	**-**	**1**	**1**	**-**	**-**
6. Intervention-related Risks	**-**	**1**	**-**	**-**	**-**
7. UNCOVERED ISSUES	**1**	**1**	**1**	**-**	**-**

From the preceding overview it can be seen that...

- ...with regard to the barriers addressed, the situation is comparatively uneven between the five Cases; especially in Cases C and E only few barriers were identified; this is probably due to the incomplete view of these EEI projects – in both Cases the perspective of one stakeholder was not covered: Essentially in Case E was the absence of the Customer perspective – as well as the early termination of the project before further barriers could arise or be identified. In Case C, it was the absence of the perspective of the financing party – normally the TPF organisation – due to the financing provided by the Customer organisation itself via its house bank, resulting in a significantly reduced scope of ES provided by the ESCO,
- ...in the other Cases, the barriers '1. External Risk' and '2. Low Capital Availability' were very pronounced, while the remaining barriers have been mentioned only sporadically,
- ...in several Cases nominations also were made to the provisional barrier '7. UNCOVERED ISSUES'.

In a further analysis, the significance of economic barriers was evaluated on the basis of the number of nominations by stakeholders. A distinction as to whether a particular barrier was identified by only one or several organisations of the respective stakeholder group is not made in this evaluation – the following table shows the aggregation according to the three stakeholder perspectives overall. Depending on the number of affected Cases (four for each stakeholder), the number of nominations (i.e. a maximum of 4) for the respective barrier is given again in the form of a 'heatmap':

Table 5-31 – Overview of economic Barriers identified by Stakeholders, Nominations to Cases

Economic Barrier **Aggregated from Cases**	**Stakeholder** Nominated in X Cases (Max. Nomination = 4)		
	Customer	**ESCO**	**TPF**
1. External Risks	**3**	**1**	**-**
2. Low Capital Availability	**3**	**3**	**3**
3. Intervention not sufficiently profitable	**2**	**-**	**-**
4. Hidden Costs	**1**	**-**	**-**
5. Investment (Transaction) Costs	**1**	**1**	**1**
6. Intervention-related Risks	**1**	**-**	**-**
7. UNCOVERED ISSUES	**1**	**1**	**1**

From the preceding overview it can be seen that...

- ...the barrier '2. Low Capital Availability' is to be regarded of fundamental significance from the perspective of all stakeholders,
- ...a further barrier with at least high relevance for one of the stakeholders is '1. External Risks', which was identified in three Cases from the perspective of the participants from the Customers,
- ...the three barriers '3. Intervention not sufficiently profitable', '4. Hidden Costs' and '6. Intervention-related Risks' obviously only were of significance for one of the Customer organisations,
- ...from all stakeholder perspectives, also barrier issues were addressed that were subsumed under the provisional barrier '7. UNCOVERED ISSUES'.

In contrast to the interviews with participants from Customer organisations concerning their specific Cases, in the interviews with the participants of the ESCO and the TPF organisations further issues were discussed. These and additional issues addressed from Customer D, who also reported on experiences from a further project of its organisation – are shown in the following table in the form of a 'heatmap':

Table 5-32 – Overview of economic Barriers identified by Stakeholders, further Issues with intrinsic Relevance to Research Questions

Economic Barrier **Further Issues with intrinsic Relevance to Research Questions**	**Stakeholder** **Customer**	4 Participants (Max. Nomination = 4) **ESCO**	3 Participants (Max. Nomination = 3) **TPF**
1. External Risks	-	**2**	-
2. Low Capital Availability	**1**	**1**	**2**
3. Intervention not sufficiently profitable	-	**2**	**1**
4. Hidden Costs	-	-	-
5. Investment (Transaction) Costs	-	**1**	**2**
6. Intervention-related Risks	-	**1**	**2**
7. UNCOVERED ISSUES	-	**3**	**2**

From the preceding overview it can be seen that...

- ...from the perspective of the ESCO, there were no significant additional nominations of barriers,
- ...barriers addressed at least by several of the participants were '1. External Risks' and '3. Intervention not sufficiently profitable',
- ...from the perspective of the TPF organisations, the analyses of the barriers identified in this context showed the following focus: A majority of the participants addressed barriers from '2. Low Capital Availability', '5. Investment (Transaction) Costs' and '6. Intervention-related Risks',
- ...from the perspectives of the ESCO as well as the TPF organisations, the barrier '4. Hidden Costs' was not relevant from this context,
- ...several economic barriers were addressed by these two stakeholders, which were subsumed under the provisional barrier '7. UNCOVERED ISSUES'.

In further analyses, the economic barriers addressed in the interviews were considered by each of the stakeholders separately.

- Customer perspective by Cases: In the following table, marked in red are the barriers that have been addressed by participants of the respective Customer organisation:

Table 5-33 – Overview of economic Barriers identified by Cases, Nominations of Customer Participants

Economic Barrier	**Case**				
<u>Customer</u> Perspective	**A**	**B**	**C**	**D**	**E**
1. External Risks	-	X	X	X	*Unknown*
2. Low Capital Availability	X	X	-	X	
3. Intervention not sufficiently profitable	-	X	-	X	
4. Hidden Costs	-	-	-	X	
5. Investment (Transaction) Costs	-	-	-	-	
6. Intervention-related Risks	-	-	-	X	
7. UNCOVERED ISSUES	X	-	-	-	

From the preceding overview it can be seen that...

- ...since no participant was involved, Case E was not evaluated in this context,
- ...for Case C only one barrier was addressed – in contrast to Case D, with five out of six barriers of the framework of Cagno et al. (2013),
- ...in general, the most significant barrier issues from the perspective of the participants from Customers were '1. External Risks' and '2. Low Capital Availability' with three out of four possible nominations,
- ...the barrier '5. Investment (Transaction) Costs' was not addressed at all,
- ...in Case A, barriers were also addressed that were subsumed under the provisional barrier '7. UNCOVERED ISSUES'.

- <u>ESCO perspective by Cases</u>: Analogous to the previous Customer perspective, the following table shows the barriers addressed by participants from the ESCO:

Table 5-34 – Overview of economic Barriers identified by Cases, Nominations of ESCO Participants

Economic Barrier – by Case	**Case**				
<u>ESCO</u> Perspective	**A**	**B**	**C**	**D**	**E**
1. External Risks	*Only effective EEI Project*	X	-	-	-
2. Low Capital Availability	*Only effective EEI Project*	X	X	-	X
3. Intervention not sufficiently profitable	*Only effective EEI Project*	-	-	-	-
4. Hidden Costs	*Only effective EEI Project*	-	-	-	-
5. Investment (Transaction) Costs	*Only effective EEI Project*	-	-	X	-
6. Intervention-related Risks	*Only effective EEI Project*	-	-	-	-
7. UNCOVERED ISSUES	*Only effective EEI Project*	-	-	X	-

With regard to Case A, barriers specific to the potential EEI project were missed out to address in the interviews carried out with the participants from the ESCO. Rather, those issues were discussed with intrinsic relevance to the research questions.

From the preceding overview it can be seen that...

- ...from the perspective of the participants from the ESCO, the barrier '2. Low Capital Availability' was the most significant with reference to the five Cases,
- ...most barriers were addressed for Case B with two nominations,
- ...compared to the interviews with the participants from the Customers, those of the ESCO addressed significantly fewer barriers to the Cases.
- ...in Case D, barriers were also addressed that were subsumed under the provisional barrier '7. UNCOVERED ISSUES'.

- TPF perspective by Cases: As the third of the three stakeholders represented, the following table shows the barriers addressed by participants from TPF organisations:

Table 5-35 – Overview of economic Barriers identified by Cases, Nominations of TPF Participants

Economic Barrier	**Case**				
TPF Perspective	**A**	**B**	**C**	**D**	**E**
1. External Risks	-	-		-	-
2. Low Capital Availability	X	X		-	X
3. Intervention not sufficiently profitable	-	-		-	-
4. Hidden Costs	-	-	*N/A*	-	-
5. Investment (Transaction) Costs	X	-		-	-
6. Intervention-related Risks	-	-		-	-
7. UNCOVERED ISSUES	-	X		-	-

From the preceding overview it can be seen that...

- ...from the perspective of the participants from the TPF organisations, the barrier '2. Low Capital Availability' was the most significant in relation to the five Cases – as was also the case previously from the perspective of the participants of the ESCO,
- ...in contrast to the prior stakeholder, no barrier was addressed for Case D,
- ....most barriers were addressed for Case A,
- ...in both Cases A and B, barriers were also addressed that were subsumed under the provisional barrier '7. UNCOVERED ISSUES'.

In the following section, all these barrier issues are further examined and the different economic barriers identified are analysed in detail – supported by statements taken from the interviews.

5.2 Details on the economic Barriers found from Analyses

In the precedent analyses, the significance of economic barriers was presented from the perspective of the participants grouped by Cases as well as by stakeholders. In the following subsections, each of the barriers is examined in more detail.

As already mentioned, all interviews were conducted in German. In order to provide a comprehensive picture of the findings from these interviews, passages of the transcriptions that the researcher considered to be significant or revealing are quoted below. The original quotation in German language was deliberately omitted. In accurately translating the original quotations, the researcher ensured that they were reproduced as verbatim and meaningful as possible.

As an introduction to each economic barrier, its content is listed according to Cagno et al. (2013).

Within the aggregation by barriers, the findings are grouped by Cases and in them by stakeholders and at last by participants.

5.2.1 External Risks

This barrier implies, that an EEI measure can be inhibited or prevented …

> *…by highly volatile energy prices, which create a high degree of uncertainty in the estimation of future or long-term operating costs; this may lead to BAT investments being avoided compared to conventional technologies due to higher investment needs – also uncertainty about the price of energy produced from fossil fuels, which does not reflect all the environmental and social costs associated with production, conversion, transport and use; this means that EEI measures appear less profitable than would be socially optimal, and price signals are therefore an barrier to investment in the purchase of EE technology.*

Because of its nature, the origin of this barrier lies outside the Customer organisation and also outside the influence of the other two stakeholders involved. According to Cagno et al. (2013), this barrier is located at a very early stage of the decision-making process in EEI projects (refer to Figure 2-7, p. 44).

Due to the already mentioned significance of this barrier for the EEI projects of the Cases, an attempt was made to further subdivide this barrier. The following distinction was developed in the course of coding of the interviews as 'In vivo' codes (concerning the different code sources refer to subsection 4.1.4, p. 70 and following):

a) Energy prices – determined by volatility of purchase prices of primary and final energy as well as electricity
b) Legislation – determined by changes of legal bases for remuneration, allocations and bonifications, e.g. from feed-in tariffs or KWKG

From the perspective of the Customers, the aspect 'a) Energy prices' was addressed in Cases B and D, the aspect 'b) Legislation' was even mentioned in Cases B, C and D. From the perspective of the ESCO, the aspects 'a) Energy prices' as well as 'b) Legislation' were addressed concerning Case B.

In the associated projects, savings on the primary and final energy side as well as bonifications (i.e. surcharges received by the organisation in connection with the EEG for electricity generated in CHP plants) meant significant effects for the economic efficiency of the EEI measures.

In the case of Customer A, the focus of the original EEI project was on the outsourcing of the relevant facilities as well as the revenues from their sale to the ESCO. Thus, this barrier only in this Case had no significance.

For the participants of the TPF organisations, this barrier was not significant overall. Legislative influences with an effect on their sphere of influence were apparently not expected or anticipated by this side.

- Case B: The ratio of electricity to gas prices was an important element for the amortisation of the EEI equipment, as external electricity procurement was to be substituted by gas procurement for own electricity generation.

  11_CB: *"[The cost of] energy is always very difficult to estimate; where are the energy costs in one to two years? In my core business, I know things very well and can determine exactly – okay, I invest a million and have refinanced it after two years. With regard to the energy sector, this is always very difficult. Is the price of gas falling? Will the price of electricity fall? Will the [amortisation] time be extended?"*

  Part of the economic efficiency of the planned expansion of the energy centre was the situation of the EEG levies, from which the company was exempt and which, above all, freed the electricity produced by an organisation itself, e.g. from CHP plants. At the time of the data collection it was questionable to what extent this model would be continued in the future.

  11_CB: *"It was already a confusion about the EEG in recent years. [...] there were companies that were exempt from EEG levies, others not. Our industry was also partly exempt in this way. And for many [other organisations] it was unclear how long one would be exempted. Will one be liberated or won't? And this led to delays [in matters of the realisation of EEI measures]."*

  "From today's perspective, this is again a somewhat clearer picture for our company, namely that our industry will no longer be exempt from EEG levies at all in the future – which is not nice from the facts if you are no longer exempt, but it gives you the opportunity to make a decision now."

  One ESCO participant had a similar perception of this barrier concerning 'b) Legislation'.

  10_E: *"At the moment when legislation drafts that are relevant to future projects are actually under discussion, the Customer organisation will always tend to act cautiously and wait to see what fact is. And it won't make a decision for that long. It does not take any risks, which it cannot foresee; especially since with payback periods of more than six or seven years we always 'look into the glass ball' to see how energy prices, EEG levies or other things will develop. If it then knows that legislation is under discussion, it will do nothing. From our perspective and certainly also [...] from the perspective of the Customer who would like to increase efficiency, [...] it is harmful if reliability is not there. Then the decision is not made in this form."*

- Case C: With regard to 'b) legislation' on the one hand, the Customer assessed the possible burden of the EEG levies on electricity produced by the organisation itself and, on the other hand, the handling of the KWKG bonification as problematic. At least the basic entitlement to the bonification was beyond question at the time of data collection. This barrier was therefore presumably not addressed by the ESCO in this Case. The component of 'a) Energy prices' to electricity generation

and to the ratio of electricity to gas prices was not a priority. The main feature of this EEI project was the use of waste heat from the CHP plant for production processes and not the feed-in or use of the electricity produced.

> **05_CC**: *"[...] this were the framework conditions that did not fit. [...] The Ministry of Economic Affairs [in this Federal State] did not know how high the EEG levies to be paid on the electricity generated on own equipment was. [Also] nobody knew anything about the bonification [from KWKG]. We haven't got that back yet, for 2015. [...]. This is a disaster. [...]. Nobody knew how to do that [...] with the certificate, i.e. with the certified quantities of us. And that's why we're still waiting for the bonification."*

- Case D: Analogous to Case B – besides the steam generation for the operational processes of the Customer – also in this Case the amortisation via the ratio of gas to electricity prices was an important facet of the EEI project.

> **09_CD**: *"How has the electricity price developed? Because [in my organisation] I was always told [...] that the price of electricity was falling. And the so-called working price has actually fallen. But what was always not taken into account [...] is that taxes, levies and so on overcompensate and consequently [...] the gross price of electricity, which we have to pay, is growing."*

Comparable to the situation in Case C, there was no experience values on the part of the Customer with regard to the process of bonification from KWKG. Whether an entitlement to bonification could still be asserted at all was unclear at the time of data collection.

> **09_CD**: *"The bonification from KWKG, that is about EUR 3.5 million for the project and this should not be given away, and meanwhile the legal situation has changed a bit. We have to see if we can get it. In order to benefit from bonification now, we need the consent of a large supplier, and it is questionable whether it will agree."*
>
> *"In my opinion, it is actually not right to take these CHP plants or these decentralised issues away from the subsidy funds, [...]. If it's a political issue, you can't change it. Nevertheless, it is a point that the profitability [of the EEI measure] has of course been further and further burdened by this."*

- Further issues concerning this barrier with intrinsic relevance to the research questions: Several ESCO participants raised supplementary issues regarding this barrier. Both the development of 'a) Energy prices' for primary and final energy as well as 'b) Legislation' issues concerning the continuity of current bonification from KWKG, exemptions from EEG levies and the protection of existing installations as well appeared to be problematic. This barrier applied to both existing contracts and acquisition projects in general:

> **01_E**: *"The legislator did not distinguish itself by demonstrating consistency, but by various changes in the legislation, a great uncertainty arose in the companies. In the meantime, we had hoped that certain bonifications, for example, could shorten the payback period if investments were made in particularly EE equipment. But there is*

no protection of the status quo in these areas. And if the legislator today reverses a decision made yesterday with new laws [...]cutting off advantages there, then that is certainly a barrier."

"[Regarding bonification from KWKG] there have been many changes lately. And it's also true that at some point there won't be anyone going through it anymore, and the criteria are sometimes relatively spongy. There is an uncertainty. Yes, you have to deal with the legislator. You do not know how they then interpret their own laws."

08_E*: "Energy prices are currently very low. Oil and gas are cheaper than ever. [...] The pressure of suffering that I [– the Customer –] have to do something because of my energy prices has become weaker."*

"We are heavily involved in combined heat and power plants, CHP plants. If you simply look at what has happened in the last three or four years to the deterioration of legislation for this technology for industrial companies, then everyone could think: 'Oh, CHP plants, that's the worst thing', every year some subsidy case is withdrawn. So it [...] is getting worse and worse economically. [...] And a company manager [of a costumer organisation] could say: 'It's not intentional for me to buy such a plant, otherwise the legislator would behave quite differently.' And here we come and say: 'You get a great technology. You have a highly economic investment.' And then he'll say: 'Yes, look what's happening on the legislative side in recent years. Now I suddenly have to pay levies for electricity I use myself and I don't get any more subsidies.' So you might think that the plants have a negative image."

"[...] Equipment that was economically viable three, four, five years ago is becoming worse and worse, so to speak, due to the legislative conditions. Not that they are not economic, not that. It is, however, if three years ago I already had an inhibition threshold because the economic efficiency was not really enough for me, then the inhibition threshold has of course now become even greater. [...]. So it becomes harder to sell something from an economic perspective, because the savings effect has decreased, like three, four, or five years ago."

Since the causes of this barrier were located outside the sphere of the three stakeholders, no influence of a constellation or specific situation of individual stakeholders could be determined in this context.

As described by Cagno et al. (2013), it could be stated that this barrier had an impact on other economic barriers and could suspend an originally given economic efficiency of an EEI measure.

It should be noted that this barrier was of great significance in the context of the Cases of this multiple-case study. The issues addressed by the research participants could be qualified as of fundamental interest in the decision-making process for the implementation of an EEI project.

The significance of this barrier was also directly linked to the cost reduction motive, which was pursued by all Customers as an effect of the EEI measure (refer to the company profiles of the Customer organisations shown in subsection 4.2.2, p. 74 and following).

The reason for choosing the multiple-case study over the single-case study strategy is the possibility to compare between Cases. In this context, attempts are made to achieve transferable outcome.

The transferability of the results of the analyses of this economic barrier to the Cases is as follows:

Table 5-36 – Transferability of Findings across Cases regarding the economic Barrier 'External Risks'

Transferability of Findings	Outcome by Case				
	A	B	C	D	E
If savings on the primary and final energy side as well as KWKG bonifications were essential components of the economic efficiency of the EEI measures and these in turn were essential drivers for their implementation, uncertainties regarding the development of these factors inhibited or prevented the implementation of EEI measures. This meant a barrier from '**External Risks**'. **Similar outcome could be obtained across Cases** (for Case B reported from participants of the ESCO after data collection phase was the stop of implementation due to expected changes of the EEG).	N/A	**X**	**X**	**X**	N/A

5.2.2 Low Capital Availability

This barrier implies, that an EEI measure can be inhibited or prevented...

> *...by insufficient capital from internal funds and difficulties in borrowing or equity raising or by internal capital budgeting procedures and investment assessments.*

The origin of this barrier can be located only internally to the Customer, the cause for the appearance of this barrier is a situation or constellation on the part of the Customer organisation alone. Therefore the concrete form of the barrier is very different in the Cases and has concrete effects on the other stakeholders or on the perception of this barrier from their perspective. According to Cagno et al. (2013), this barrier is located at an advanced stage of the decision-making process in EEI projects (refer to Figure 2-7, p. 44).

Due to the significance of this barrier for EEI projects already mentioned in the previous section, an attempt was made to further subdivide this barrier. The following structure was developed in the course of coding of the interviews as 'In vivo' codes (concerning the different code sources refer to subsection 4.1.4, p. 70 and following):

a) Credit-worthiness – determined by credit-worthiness of the Customer for TPF or ESCO financing
b) Duration – determined by duration of financing (both internal funds and TPF or ESCO)
c) Collateralisation – determined by collateralisation for TPF or ESCO financing (for definitions and details of key terms regarding collateralisation refer to glossary, p. 11 and following).
d) Refinancing – determined by the requirements of refinancing (both internal funds and TPF or ESCO financing)
e) Volume – determined by the level of financing required (both internal funds and TPF or ESCO)

From the perspective of the Customers, the aspects 'b) Duration' (in Cases A, B and D), 'd) Refinancing' (in Case B) and 'e) Volume' (nominated in the interview concerning Case D, but with no concrete reference to this Case) were addressed. It is in the nature of things that the aspects 'a) Credit-worthiness' and 'c) Collateralisation' had no relevance from the perspective of the participants from the Customers

– these had significance for the two other stakeholders whose financing (indirectly for the ESCO and directly for the TPF organisations) was affected.

Accordingly, the participants of the ESCO addressed the aspects 'a) Credit-worthiness' (in Cases B and E), 'b) Duration', 'c) Collateralisation' (in Case E), and also 'd) Refinancing' (in Cases B and C).

As expected, from the perspective of the participants of the TPF organisations, only the aspects 'b) Credit-worthiness' (in Case E) and 'c) Collateralisation' (in Cases A, B and E) were addressed.

Below, aspects of these segments of the barrier are described within the Cases.

- Case A: Since the Customer excluded the participation of a TPF organisation and would therefore have to use its own resources exclusively for future projects (due to corresponding restrictions on the part of the ESCO), the barriers in this area laid in the Customer's perspective in the aspect of 'b) Duration' of the project and the amortisation time of the EEI measure:

  07_CA:*"...and there I have [...] a big [...] problem, we have a period of consideration for bigger investments of about 10 years, while an ESCO looks at 15 or even 20 years [...] and that also means that from the perspective of the ESCO a highly efficient project or a highly efficient measure is simply not economical from our perspective."*

  "An ESCO always thinks completely differently than a producer does, and we have hurdle rates for projects in our group, which means that to a certain extent we would agree to a project; [...] if these hurdle rates are exceeded, the project is actually no longer economically interesting for us."

  As a barrier to a possible TPF involvement in the potential EEI project, the participants from the TPF organisations addressed the aspect of 'c) Collateralisation':

  03_T1: *"He [the Customer] was not prepared to make a declaration of obligation [in the form of a waiver of objections as an instrument of collateral] to a financing partner of the ESCO [thus financing could not be provided]."*

- Case B: With regard to the aspect 'c) Collateralisation' and the resulting financing method to be chosen for the potential EEI measure, the TPF organisation in question explained the following limitation – also as the reason for finally selecting the financing method of hire purchase:

  03_T1: *"So we as a lease company have no problem to grant a third party outside the lease contract [in this case the Customer organisation] a purchase option. [...] But the lessee [in this case the ESCO] cannot say from the outset: 'I can sell the object to you [the Customer organisation]', because the ESCO does not own it at all."*

  04_T2: *"Lease is not possible from the existing construct with the ES contract, because at the end of the lease term we have various options and the ownership does not automatically return [to the lessee]. So it was difficult for the ESCO because there might not be an energy centre available to fulfil the ES contract. So after negotiations, we switched from lease to hire purchase."*

  During a certain phase (phase 2 to 3 of the corporate development of the ESCO), neither the Customer nor the ESCO was able to provide funding for EEI projects. The ESCO itself was not able to

raise either its own funds or external funds, and the Customer was not allowed to raise external funds under the aspect of 'a) Credit-worthiness':

> **10_E**: *"The Customer did not want to finance [through TPF] on the basis of its solvency, its shareholder did not allow this; we could not, our shareholder did not allow this. Nevertheless, there were projects that were totally sensible in terms of efficiency, but simply could not be financed; Now we [...] managed to negotiate and agree on the financing on its credit-worthiness [with TPF in the form of hire purchase]. This gave us the go-ahead [...] to get new projects back on track."*

EEI projects competed with other potential projects of the Customer in financing with own resources, at a time when external financing by TPF organisations was excluded and the ESCO was not able to provide it, the aspect 'b) Duration' played an important role:

> **11_CB**: *"...everything under two years [amortisation time] is actually always done and everything over five years is looked at very, very closely."*

> *"It is often that projects will only be refinanced in a few years' time. In three, four, maybe even five. And there I can always find projects in my own processes that can be refinanced quite quickly, namely somewhere in two or two and a half years, so that energy projects often fall behind as a result."*

The paradigm shift in corporate policy on the part of the ESCO regarding the financing of potential EEI projects also induced the perception of a barrier concerning the aspect of 'd) Refinancing' on the part of the Customer:

> **11_CB**: *"...the decision could have been made more quickly if the financing had still been completely with the ESCO. Sure, at that time everything was in one hand, only one company [the ESCO] had to decide. Now with a partnership that one company [the TPF organisation] is financing and the other one is the ESCO, [...] two [parties] are at the table who have to decide."*

- Case C: The participant from the Customer did not identify any issues at all to this barrier. A participant from the ESCO again addressed the aspect of 'd) Refinancing', in this Case as a reason for the small ES Scope finally contracted:

> **08_E**: *"Subsidy mechanisms complicate our business to a certain extent. If we do not benefit from this subsidy, we are in a worse position per se than if the Customer builds the plant on its own. [...] It's the same equipment, but if the Customer does it on its own, it gets a 25% subsidy. If we build the plant for it, there is none. In our possibilities of financing we do not get the subsidy."*

And further, concerning EEI measures in the context of subsidy mechanisms in general, the participant from the ESCO explained:

> **08_E**: *"The legislator [via KfW Bank] wants to see what it [the Customer organisation] brings for the 25% of subsidies: Are they spent properly? And then [...] exactly that comes to light that [the Customer] then invites tenders and compares plant constructors. The legislator is certain that as little money as possible has been*

spent. This is perhaps the cheapest system, but not the best system in terms of EE, [because the invitation to tender] is aimed at an investment volume and the pressure comes from these subsidy mechanisms to disclose this to the subsidy bank. [Hence, the cheapest solution in matters of investment volume is to be selected and not the most efficient one]."

- Case D: In contrast to the previous Case C, in this Case only the Customer addressed aspects concerning this barrier. Neither participants from the ESCO nor the TPF organisations mentioned further aspects – as this was a public-sector organisation, external financing could in principle be easily obtained. In particular, the aspect of 'b) Duration' of the project and the underlying external financing appeared problematic for the Customer before signing the ES contract:

  09_CD*: "We live here in a very conservative landscape when it comes to such a project, [...] the resistance we had to overcome was considerable."*

- Case E: The EEI project ultimately failed because of this barrier addressed by participants of the ESCO as well as of the TPF organisations. Essential aspects were 'a) Credit-worthiness', which was not given by the Customer and 'c) Collateralisation' resulting from the prior which was not feasible and also not economically justifiable.

  01_E*: "...the Customer did not have such an outstanding credit rating. In this respect, we found it difficult to find a TPF for this project. We found one, subject to certain restrictions – relatively strict conditions."*

  08_E*: "We had a TPF, of course, with a high level of collateral. Due to the significantly poorer credit-worthiness and then in the end even due to the insolvency proceedings, one hundred percent collateralisation was necessary."*

  "Our side cannot take any risk the worse the credit-worthiness is. And on the other hand, the Customer's hand is simply tied. How can it then procure collateral if it is not well?"

  "That the project did not come to fruition was the uncertainty due to the fast pace of this industry and that in the situation no one is willing to conclude long-term contracts. But no one is prepared to [conclude] a ten-year contract."

  03_T1*: "The Customer [...] faces risks known in the market that could not be assessed by the TPF organisation and the ESCO. [...] These risks [...] could become existential and therefore we as TPF organisation [...] finally said, that we would not do it; we recommend that you [the ESCO] make this risk clear to you again."*

  "In fact, we would have relied only on [the solvency of the] ESCO. The ESCO should have given us a collateral that even if it [the Customer organisation] fails, we are really risk-free."

  06_T3*: "The project [...] failed due to credit default risk reasons; [...] this company did not meet the credit risk requirements of our funds guidelines. We always try to obtain a credit rating that complies with our guidelines through collateral, [...] for example*

by capitalising the underlying fixed assets, by having a resale value assessed or by covering a portion with a bank guarantee. But in this specific case the risk of credit default was so high that this was not possible or would simply have become uneconomical."

- Further issues concerning this barrier with intrinsic relevance to the research questions: A further issue was raised by the participant of Customer D, who reported on a previous public infrastructure project concerning the aspect 'e) Volume'. An EEI measure could not be taken into account because the funds originally released were insufficient:

  09_CD: *"...a large building was erected here, [...] the construction volume that was estimated [...] was not sufficient and [...] all the energy saving measures that were planned were removed, so that the whole building is now an energy destruction machine; [...] they built cheaply, they stayed within the budget, but the follow-up costs are catastrophic."*

  The participants of the ESCO addressed further aspects of this barrier, concerning 'a) Credit-worthiness' and 'c) Collateralisation':

  08_E: *"The TPF organisation signs the financing contract with the ESCO and wants collateral. This means that we have a tripartite relationship because we as ESCO do not want to give the collateral to the TPF organisation, so the Customer has to provide the collateral. So this is usually a massive negotiating point, which can lead to difficulties in drafting the contract."*

  "For certain issues easements have to be registered [as collateral], which can be a big barrier, because of course many Customers do not want to fill the land register [...], just because the plant belongs to the company A, B or C [the TPF organisation].

  "Basically, we can't get TPF if we invest something and don't have a Customer from whom we can get the collateral. Example: District heating network – there are 10 different [Customer] organisations hanging behind. On whom this investment should be based on? We always need a third party because we don't provide the collateral ourselves. So far, we have only succeeded in doing this if we have a single Customer to that can provide the collateral."

  Moreover, specific aspects of this barrier were also addressed from the perspective of the TPF organisations. These in general had far-reaching regulatory or statutory requirements with regard to 'c) Collateralisation':

  03_T1: *"...a declaration of obligation [= abstract promise of debt, waiver of objection] by a Customer to the financier of the ESCO is not something that [a Customer] likes to do. This is an instrument that is necessary to focus on the Customer and not on the ESCO; [...] if this collateral instrument does not work, then [...] the financing from our company will not be possible."*

06_T3*: "In order to meet the investment-grade criterion, the collateral provided by an ES contract is sufficient. What we also need is a guarantee from the ESCO to cover the performance risk. So we cannot assume any performance risk."*

"With EE projects [...] savings are achieved, but you cannot pay back anything [a TPF financing] with savings, i.e. you are dependent on [the Customer] having enough cash to return it to the TPF because you cannot separate the cash flows of the savings. There is no liquidity that I can separate and focus on, but I always have a corporate credit risk."

"[...] there is no standardisation with regard to the structuring of projects and in particular project contracts. This means that the contracts between ESCO and the Customer do not meet the requirements that a TPF organisation needs to have the certainty that it can really separate and assess the risks appropriately. This contractual stabilisation, this understanding of which contractual risks a TPF organisation can or cannot take and which financing clauses the contracts must have, often does not exist [...]."

The fund-based financing provided by TPF 3 is tied to its duration, so the aspect of 'b) Duration' also becomes important in general:

06_T3*: "[The term of the funds is limited,] we must have repaid the capital by June 2027. [...]. We could finance 15 years, but at the end of the term we would need a right for a third party to take over that financing from us."*

Although the causes of this barrier – as described at the beginning – are solely on the part of the Customer, the situation as well as the constellation of the other stakeholders had a clear influence on this barrier: The necessity of financing by means of external funds from the point of view of the Customer (e.g. as internal specifications regarding the amortisation period of the project are not achieved) generated the need for collateralisation of this financing and corresponding contractual arrangements (which may negatively influence the barrier '5. Investment (Transaction) Costs'). Furthermore, if the ESCO did not provide the necessary funds, financing costs also resulted which, in the case of lease or forfeiting, had poorer conditions than loan or hire purchase financing from the Customer's point of view. The required financing volume also had an influence on the level of financing costs. In addition, these forms of financing created complex structures with regard to ownership and procedures at the end of the project term. These effects could in turn have a negative impact on the barrier '3. Intervention not sufficiently profitable'.

Subsidy measures of KfW Bank required the loan financing of an intended EEI measure and, if necessary, its embedding in a larger, production-related measure. These conditions could be fulfilled by the Customer, but not by the ESCO, as the latter was not able to arrange a loan financing in accordance with its corporate policy. The project structures required to obtain the subsidy measures could thus significantly reduce the scope of ES services and thus impair ESCO's potential business. In this way, legislative activities resulting in subsidy schemes could weaken the position of the ESCO – contrary to

what was intended by the EED. Thus, when EEI measures were only one of several facets of an overall larger project, existing EE potentials were not be fully exploited or even ignored.

The significance of this barrier was directly related to the liquidity protection motive of Customers A, B and D (refer to the company profiles of the Customer organisations shown in subsection 4.2.2, p. 74 and following).

For this barrier, it should also be noted that it was of great significance in the context of the Cases of this multiple-case study. If there were restrictions on the financing by the Customer and even more so by the ESCO, this led to significant complications and impediments for potential EEI projects.

The transferability of the results of the analyses of this economic barrier to the Cases was as follows:

Table 5-37 – Transferability of Findings across Cases regarding the economic Barrier 'Low Capital Availability'

Transferability of Findings	**Outcome by Case**				
	A	**B**	**C**	**D**	**E**
If a Customer sought financing from its own resources, the EEI project had to compete with other projects (related to the organisation's core business). EEI projects usually were inferior in their economic viability, therefore the EEI projects of this multiple-case study were generally not financed from own resources. This meant a barrier from '**Low Capital Availability**'. **Similar outcome could be obtained across Cases.**	**X**	**X**	N/A	**X**	N/A
If the financing was provided by the Customer, the ESCO had to accept a significantly shortened project duration and reduced scope of ES. This meant (at least for ESCO's business activities) a barrier from '**Low Capital Availability**'. **Similar outcome could be obtained across Cases** (for Case A reported from participants of the ESCO after data collection phase, for Case B concerning previous potential EEI projects).	**X**	**X**	**X**	N/A	N/A
If the Customer did not have sufficient credit-worthiness or could not provide appropriate collateralisation, the EEI project could not be realised on the basis of external financing. This meant a barrier from '**Low Capital Availability**'. **Contrary outcome could be obtained across Cases** (sufficient credit-worthiness can be supposed for the other Cases, as no such barrier was addressed from the TPF organisations involved).	N/A	**X**	**X**	**X**	**X**

5.2.3 Intervention not sufficiently profitable

This barrier implies, that an EEI measure can be inhibited or prevented by...

...solutions that are in principle, but not necessarily cost-effective in all cases and organisations.

The origin of this barrier can be located both internally on the part of the Customer and externally (e.g. with the other stakeholders involved).

According to Cagno et al. (2013), this barrier is located at the final stage of the decision-making process in EEI projects (refer to Figure 2-7, p. 44).

This barrier played a rather subordinate role in the Cases, only from the perspective of Customers in Cases B and D it was addressed.

- Case B: Several EEI measures had already been implemented at the site of Customer B by the ESCO. However, the ESCO was contractually obliged to continuously implement EEI measures relevant to remuneration. From the perspective of the Customer, the available EE potential gradually was exhausted:

  11_CB: *"The 80-20 rule can be applied here. We have certainly skimmed off 80 percent of the possibilities and the last 20 are still to be lifted. Whether our service provider is satisfied with these 20 percent in the long term, we hope, but we cannot judge."*

- Case D: The situation that at the time of data collection the EEI measure was still at the beginning of the project term and that the expected effects could still be realised meant a possible barrier from the perspective of the Customer:

  09_CD: *"On the other hand, it is also the case that a presentation [by the ESCO] did indeed show that it would be possible to achieve economic success in the next 15 years. And there also was the clear statement that one [the Customer] has a certain expectation, and under this expectation the ESCO should not have taken part at all."*

  In addition, the financing costs in this Case represented a significant portion of the costs that had to be amortised due to the effects to be achieved from the EEI measure:

  09_CD: *"[...] if we could have financed by ourselves, the figures would of course look even better. [...]. In such a three-party constellation, everyone wants to earn money, and that's legitimate. [...]. If we had not had three parties now, but only two, then it [the effects] would be distributed differently."*

- Further issues concerning this barrier with intrinsic relevance to the research questions: Further issues were raised by the participants of the ESCO, concerning additional aspects which could constitute this barrier, arising from
  - Customers – by their purchasing guidelines and the need for comparability of offers for ES:

    08_E: *"So we have a case where the Customer's purchasing department must have three comparable offers. However, this is not so easy to present in our area. And [...] because you have to make things comparable, you pop around until it is, and then the project may become uninteresting for us."*

  - TPF organisations – by costs of external financing:

    02_E: *"At the end of the day, the costs [of the EEI measure] are of course decisive for the Customer. It is then always [...] to ask the question, how much does the overall project become more expensive due to TPF? Here the interest rate of the banks, [...] competes with the opportunity interest rate of an ESCO. [...]. If a third party is involved, there is no longer talk about opportunity interest rates, which are included in the project [on the part of the ESCO], but about real costs, which must then be generated [by the EEI project]. And with these, the bottom line is that the project is more expensive."*

The special situation of the funds-based financing in the case of TPF 3 resulted in an issue concerning this barrier (which also can be seen as an opportunity) from volume-dependent financing conditions:

> **06_T3***: "[...] we clearly differ from a lease company or a bank because we have a high incentive to invest a lot of money because we have received deposits from our investors, and they want to see their money placed. [...]. This means that we have room for manoeuvre in terms of conditions, depending on the transaction volume. I can offer better for a 15 million project than for a two million project."*

With this barrier, no influences from the situation or the constellation of the stakeholders involved could be identified in the Cases. With regard to the two barriers described previously, this barrier is under their indirect influence, as effects from '1. External Risks' and '2. Low Capital Availability' may lead to a cost situation in connection with the intended EEI measure, under the influence of which it can no longer economically be realised. As already said, the participants did not attach any particular significance to this barrier.

The analyses regarding this economic barrier did not produce transferable findings with significance for this multiple-case study.

5.2.4 Hidden Costs

This barrier implies, that an EEI measure can be inhibited or prevented by...

> *...costs, which are not included in the original estimate of the investment planning and eliminate thereby the originally calculated cost efficiency.*

The origin of this barrier can be located both internally on the part of the Customer and externally (e.g. with the other stakeholders involved). Unforeseen (and thus hidden) costs can arise on the part of all stakeholders involved or beyond their sphere – and also at any time or in any phase of the EEI project.

According to Cagno et al. (2013), this barrier is located at the final stage of the decision-making process in EEI projects (refer to Figure 2-7, p. 44).

This barrier also played a minor role in the Cases and only was addressed from the Customer's perspective in Case D.

- Case D: In this EEI project, the situation was that certain elements of the equipment invested had to be added to the planned scope without reaching an improvement of the efficiency of the overall EEI measure:

  > **09_CD***: "It's connected to the contracts we had with the utilities. We could not get out of the district heating contract with one supplier. [...]. The big problem is that this supplier owns the district heating network [on our site]. That means we had to think again, if it doesn't play along now, what do we do? The end of the story is that we have to build our own network here, but this goes against profitability.*

Even with this barrier, no influences from the situation or constellation of the stakeholders involved could be identified in the Cases. As already mentioned, the participants did not attach any particular significance to this barrier.

From the perspectives of the participants from the ESCO and the TPF organisations, this barrier was of no relevance.

The analyses regarding this economic barrier did not produce transferable findings with significance for this multiple-case study.

5.2.5 Investment (Transaction) Costs

This barrier implies, that an EEI measure can be inhibited or prevented by...

> *...initially high design and manufacturing costs for providing an EE technology.*

The origin of this barrier can only be located outside of the Customer organisation. The reasons for the occurrence of this barrier lie in the transaction itself on the part of the other stakeholders.

According to Cagno et al. (2013), this barrier is located at the final stage of the decision-making process in EEI projects (refer to Figure 2-7, p. 44).

This barrier was not addressed at all from the perspective of the Customers and only twice with reference to Cases, once from that of a TPF organisation (Case A) and the ESCO (Case D). These two stakeholders also addressed further issues concerning this barrier with intrinsic relevance to the research questions.

- Case A: A project structure consisting of three stakeholders – due to the requirements of the ESCO – would have required extensive contract arrangements, especially on part of the TPF organisation:

  > **03_T1***: "[...] the contract models, which would also have meant an off-balance solution for the Customer, were very intensive in reviewing, and in the end it [the Customer organisation] did not want that."*

- Case D: The tendering procedure of the public authorities constituted a (potential) barrier for the ESCO:

  > **08_E***: "[...] One barrier is the incredibly high pre-production costs with which an ESCO has to make an advance contribution to the development of such a project in a call for tenders, for project design and all these topics. These are the initial costs that are not covered if the tender is awarded to another party. [...]. We cushion this by trying to get the analyses paid for. [...]. One [the tendering Customer] could say: if I have three [bidders] in the competition, the third gets 50,000 EUR, the second 100,000 EUR and the winner's project has to cover that. But these mechanisms do not exist in the public sector. And to that extent it is a difficult decision to enter a tender."*

- Further issues concerning this barrier with intrinsic relevance to the research questions: Further issues were raised by a participant of the ESCO, who addressed a barrier to ESCO's business from the fact that Customers used its expertise to ultimately implement the EEI project on their own without contracting the ESCO:

02_E*: "Strong competition was, of course, always in the Customer's own implementation. [...] In the past, Customers repeatedly had the project design done [by the ESCO], but at the end of the day they made the decision for their own solution [without the participation of the ESCO]."*

Moreover, from the perspective of the participants from the TPF organisations, the complexity on the contractual side in general was seen as main driver for transaction-related costs – also in relation to the volume of the potential EEI measure:

03_T1*: "The more complex the structure of a project, the more expensive the deal becomes. The more long-term this project is [...], the more expensive the financing will be."*

"Risks arising from such a project or involved in such a project determine the price."

"Many companies are not prepared to deal with such complex contractual relationships. Many companies – especially in the commercial sector – are very much concerned with themselves. [...]. On the other hand [...] it is an intellectual challenge to arrange all this in a tax, legal and financial way. This requires certain capacities, and these are not available in many companies, even if we are talking about large corporations. [...]. It makes no sense to discuss such complex contract structures for [an investment of] 500,000 EUR. If we talk about two, three, four, five and more million EUR, then the effort to invest so much at the beginning is also worthwhile."

06_T3*: "One possibility that we offer and that is particularly suitable for very large projects is [...] that we ourselves formally assume the role of contractor, i.e. conclude the contract with the Customer and supply contracts with the ESCO, which is a construct to structure an off-balance solution on both sides. This is contractually very complex to arrange; therefore it has high transaction costs and is only worthwhile for very large projects."*

"An ESCO that requires an off-balance solution for itself has clear disadvantages in the market. Not only from the financing conditions, but also from in the structuring of the project."

Referring to this barrier, influences from the situation or the constellation of the actors involved were generally identified: With an off-balance solution, requested by both the Customer and the ESCO, significant transaction costs arose from complex contract structures associated with this.

As described concerning the two barriers '1. External Risks' and '2. Low Capital Availability' above, this barrier was also under their indirect influence, since corresponding effects could lead to a cost situation under which the intended EEI measure was no longer economically profitable.

Furthermore, this barrier was not of any great significance.

The transferability of the results of the analyses of this economic barrier to the Cases was as follows:

Table 5-38 – Transferability of Findings across Cases regarding the economic Barrier 'Investment (Transaction) Costs'

Transferability of Findings	Outcome by Case				
	A	B	C	D	E
If on the part of the Customer a tender procedure is chosen for procurement, the EEI project could be inhibited by the ESCO's refusal to participate in the procedure due to high acquisition costs as up-front transaction costs and their lack of coverage in the event of a contract not being awarded. This meant a barrier from '**Investment (Transaction) Costs**'. **Contrary outcome could be obtained across Cases** (no tender procedure was chosen by the other Customers, no such barrier was addressed from the ESCO for the other Cases).	X	X	X	X	X
If the Customer demands an off-balance solution, the EEI project could be prevented due to the complex nature of the contract and the reluctance of the ESCO to capitalise the fixed assets. This meant a barrier from '**Investment (Transaction) Costs**'. **Contrary outcome could be obtained across Cases** (no off-balance solutions was demanded by the other Customers, no such barrier was addressed from the ESCO for the other Cases).	X	X	X	X	N/A

5.2.6 Intervention-related Risks

This barrier implies, that an EEI measure can be inhibited or prevented by...

> *...uncertainties in investments, which always entail risks of operational failure; uncertainties also exist with regard to the duration and availability of EE technologies and the long-term availability of calculated energy cost savings, especially if the discount rates for future costs and benefits are either lower than the available return on investments with comparable risk or higher than the financing rate of the measure.*

The origin of this barrier can be located both internally on the part of the Customer and externally (e.g. with the other stakeholders involved).

According to Cagno et al. (2013), this barrier is located at the final stage of the decision-making process in EEI projects (refer to Figure 2-7, p. 44).

This barrier also played a minor role in the Cases and was again addressed from the perspective of the Customers only in Case D.

- Case D: The background for addressing this barrier from the perspective of the Customer was the need for unrestricted supply security of the hospital in connection with the implementation of the EEI measure:

> **09_CD***: "What cannot happen under any circumstances – because we are in the health sector – is that there are some network fluctuations, network failures [of the steam supply]. [...]. You certainly have to assess the risk a little differently here than if you were in a factory building."*
>
> *"So the question is really, [...] can we create our own supply network? Will we be able to get the connections right to the steam network supply? Are we in a position to take the steam network off the grid because we have a 24-hour supply? So these are the considerations. I mean, the simple option would really have been to replace three boilers and that was it."*

The situation that at the time of data collection the EEI measure was still at the beginning of the project term and that the expected effects could still be realised meant a possible barrier from the perspective of the Customer:

> **09_CD***: "Large projects don't necessarily generate big profit leaps right from the start, but I have to go partly into pre-financing in order to achieve [...] the efficiencies in the following years."*

- Further issues concerning this barrier with intrinsic relevance to the research questions: Further issues were mentioned by a participant of the ESCO, who considered this barrier of intervention-related risks to be fundamental in the event that the Customer did not believe that the EEI measure would guarantee the unrestricted availability of its facilities:

  > **02_E***: "The point, of course, is [...], if there are technical difficulties that can stop the production process, the Customer will make the decision [to not implement the EEI measure] overnight. EE will never stop a production line or anything like that."*

  Moreover, from the perspective of a TPF organisation, a barrier in this context laid above all in the usability of the equipment once installed and financed*:*

  > **03_T1***: "We [...] are dealing with objects that are not fungible [i.e. transferable or usable in another project], there is a large CHP, absorber, compressed air system or boiler, we can usually not use these objects elsewhere [...]. If you also imagine an energy centre, you have the fixed assets [...], which represent certain values, which are bought by the ESCO. But we also talk about costs for planning, development, installation of piping, partial construction work. [...] In other words, if you're talking about a CHP project today, let's assume that we're talking about five million EUR of investment costs, then we're talking about a million euros that aren't worth anything in the case of cases [i.e. in the event of a failure of the Customer organisation] that simply go up in smoke. So I don't have any value in return [...]."*

In the case of the TPF 3 based on the EEI funds, specific requirements had to be met from the funds prospectus:

> **06_T3***: "We always have to demonstrate [to investors] that energy and CO2 will be saved for the project [...]."*

With this barrier, once again no influences from the situation or constellation of the stakeholders involved were identified in the Cases. Although aspects of this barrier were addressed by participants from all three stakeholders, it was still not considered to be very significant.

The analyses regarding this economic barrier did not produce transferable findings with significance for this multiple-case study.

5.2.7 Uncovered Issues – Complementary economic Barrier

Issues mentioned in the interviews inhibited or prevented the implementation of EEI projects in terms of content but could not be subsumed under any of the economic barriers of the framework of Cagno et

al. (2013), thus from the researcher's opinion represented an economic barrier. These issues are structured and explained below.

The upcoming introduction of the new standard IFRS 16 with the mandatory recognition of rights of use on the balance sheet (especially in connection with lease financing) at the time of data collection resulted in expected though unintended adjustments – i.e. extensions – to the balance sheets of Stakeholders Customer A in Case A and the ESCO in Case D, who were required to apply this standard due to their affiliation to group structures. In the opinion of the TPF participants, the possibility of a joint off-balance solution for both stakeholders Customer and ESCO within the framework of a three-party contract could no longer be assumed in future. The extent to which this situation would affect future EEI projects was not foreseeable at that time.

The origin of this barrier can be located both internally on the part of the Customer and externally (e.g. with the ESCO involved). As this issue is a matter of principle and independent of the specific EEI measure, this barrier is to be located at a very early stage of the decision-making process in EEI projects (concerning these stages refer to Figure 2-7, p. 44).

For this issues, as well, the significant importance for the Cases of this multiple-case study, as well as for the ESCO involved in general, applies. Due to this significance of these issues subsumed in this provisional barrier for the EEI projects, an attempt was made to establish a complementary barrier to the area of economic barriers according to the framework of Cagno et al. (2013) – '7. Accounting Standards'.

From the perspective of the Customers, this barrier was addressed in Case A. A participant from the TPF organisations addressed issues concerning Case B, one from the ESCO concerning Case D.

- Case A: Customer A was the only Customer organisation that prepared its financial statements in accordance with the accounting standards of IFRS in addition to those of the German HGB (for definitions and details of key terms regarding accounting standards refer to glossary, p. 16 and following). The introduction of IFRS had an impact on all new ES contracts to be concluded throughout the group and thus also on ESCO's potential business.

> **07_CA***: "It is not an isolated case in the group [this form of ES, where the ESCO capitalises the fixed assets], we have almost exactly the same constellations at two other locations of the company and also at other companies of the group. Here, too, this model has been running since the end of the 1990s. The current model is not transferable to other locations against the simple background that the legal situation has completely changed. At the time, we structured the ES contracts in accordance with the HGB, but unfortunately this is no longer possible due to the application of IFRS in our Group. [...]. In other words, if you wanted to take such a step again [to arrange an ES contract], you would be putting it on a completely different footing. This means that you would no longer have to do classic ES with outsourcing, but in case of doubt you would have to make a pure service contract or perhaps think about a model in the combination of service and financing."*

"I can imagine that in many places it has actually already happened that way, that one said, we dissolve all these constructs, we don't care about the capitalisation in the meantime, furthermore the tax authorities force us afterwards somehow to capitalise more strictly than we still had to in the past [...]."

- Case B: The participant of a TPF organisation was involved in the planning and contract negotiations for the potential extension of the energy centre. In this context, he was already aware of the ESCO's corporate policy regarding the undesired capitalisation of the fixed assets:

  03_T1*: "The ESCO had no interest in capitalising such a volume – I think we talked about four million euros."*

- Case D: One ESCO participant expected to have an impact on the ESCO's balance sheet from the introduction of IFRS 16. At the time of data collection fixed assets were in legal ownership of the TPF and economic ownership of the Customer:

  01_E*: "[IFRS 16] will have an impact and I assume that we will have a problem there – we will probably have to capitalise it [the fixed assets – or rights of use, receivables and liabilities under the lease contract] then."*

- Further issues concerning this barrier with intrinsic relevance to the research questions: Further issues were raised by participants of the ESCO, as well as of the TPF organisations. Both stakeholders attached great importance to the issue of capitalisation under IFRS 16:

  01_E*: "Then, of course, there are the accounting issues, both with the Customers and with us. There are restrictions that have to be observed concerning capitalisation [...].*

  As a rule, this is that [...] an attempt has been made to finance everything off-balance as far as possible."

  "The actual situation, as I said, is that we don't have capitalised the things [the fixed assets] at the moment. And with this amendment, as I understood so far, the contracts will be revalued by 2019 at the latest. And then we will certainly have issues that will spill over into our balance sheets because they are simply there. We will not be able to prevent that."

  "Since these regulations are formulated very restrictively in IFRS, there will no longer be any distinction between forms of lease. Instead, lease is lease and must be capitalised. That is basically the requirement. In this respect, we will not be able to prevent something from being capitalised. My expectation is, since it affects everyone equally, that there will also be a rethink here, because ultimately, if everyone insists on their old principles and says that I no longer want to capitalise it, then nobody will make this investment any more. So if our corporate policy remains that we do not capitalise, we will have major problems in offering our models to Customers in the future. Probably the Customer does not want to capitalise it either. Somewhere a rethinking must take place. But for the time being, the situation from this new standard is such that we do not yet have a solution for the future design of the existing three-party model."

"Currently, in the three-party model, the TPF organisation can capitalise [the fixed assets]. In my understanding, IFRS 16 will result in either the Customer or we [the ESCO] having to capitalise the fixed assets in addition. My perception is that [...] our classic Customer often follows IFRS standards and we will therefore have a problem. Especially large corporations have to apply it [this standard], so in this respect we will definitely have problems. And we also have existing Customers who are affected."

"Whether there will also be a rethink on the part of the Customer, who will then say 'yes, if I have to capitalise this anyway now, then I no longer need the whole ES solution'. That could also be a consequence of that. It is no longer possible to convert a finance lease into an operate lease using certain constructs, but it is now being said that everything that has to do with lease is lease and must be capitalised. That is also a clarity that has been created. To that extent, it's not that bad. Of course, it is not good for those companies that are negatively affected because their model is at risk. I can imagine that [at TPF organisations] there is a lot of activity at the moment working on new models, how this circumstance will be dealt with now. It is certainly also very interesting for whole branches of industry."

02_E: *"If you have a single Customer and you update or rebuild the energy centre, you definitely have to reorient. Because it will be the case that with the right-of-use approach in IFRS 16, one will get the fixed asset to capitalise, not a third party who could be the bank, for example. That will no longer work."*

08_E: *"So we have a TPF organisation that finances in different ways. Because of our own corporate policy, we can only finance through lease companies because we don't want to capitalise the fixed assets ourselves. What [...] means a barrier for us, because we have to build the plant to be leasable. This means it must be mobile."*

"We do not want to capitalise it because it is our corporate policy. In principle, an ESCO can of course capitalise [the fixed assets]. If I do business with energy, then I can also own the equipment. It is not disadvantageous. But we said we don't want to capitalise it. The TPF organisation in the lease sector naturally wants to capitalise it, that's quite clear. Because lease business more or less lives from fixed assets. [...]. Then the Customers remain, and of course there are quite different ones. The big shareholder-driven companies don't want to capitalise it also. Lease models like this come in handy, and that's very convenient for them. A medium-sized owner-managed company, on the other hand, has no problem at all with this [capitalisation]. If, for example, it pays three millions [EUR] for equipment, why shouldn't it capitalise it?"

03_T1: *"IFRS 16 states that [leased assets subject to] a long-term lease [...] must be capitalised by the lessee [i.e. the Customer or the ESCO]. [...] This is an absolute problem area in our field of energy technology equipment, because an essential motive for both ESCO and its Customers is an off-balance solution in [achieving] savings effects from the use of these energy technology equipment."*

"One possibility to get an off-balance solution according to the current status [according to IFRS 16] would be to act with an open residual value, which we have excluded for energy centres. [...] The Customer leases the energy centre and pays the lease instalment. At the end of the contract term, I [the TPF organisation] have a residual value open with the refinancer that has not yet been amortised and I have no obligation on the Customer to continue to lease the asset and pay the lease instalments. Therefore, I have to amortise [the residual value] either through follow-up lease or from the sale of the fixed asset. We see difficulties in this, because the objects are not fungible or not fungible enough and are always tailored to the Customer and you cannot dismantle the plant and 300 kilometres further exactly identical rebuild. Therefore, we do not enter into any open residual values."

"So I think with IFRS 16 it won't be easier with the off-balance topic. On the contrary. We see a lot more problems coming our way across all asset classes. The main topic is that off-balance is in principle only possible when it comes to low-budget assets, as they are called (up to 5,000 dollars or EUR). I only have real rents with terms of up to 12 months without a final settlement. I don't think that IFRS 16 will make it any easier for the energy centre asset class. On the contrary, it becomes much more difficult."

06_T3*: "You always have to look under which accounting standard which party is under – so it is local accounting standard of German HGB, or it is IFRS because the accounting standards differ. Under HGB it is much easier to structure an off-balance operate lease than under IFRS. In my opinion, one of the big barriers is why there are no very large projects in the market, because it simply costs a lot of time, or it is very difficult to find a risk distribution in which all three parties are comfortable, and that would be an off-balance solution for the ESCO and the Customer under IFRS."*

"If both parties report under IFRS, this assumes that [the lease] is classified as a finance lease so that it is off-balance for the ESCO, and this also means that the Customer would then classify the contract as a finance lease and then have to capitalise [the fixed assets]."

"A weak Customer organisation will always prefer an off-balance solution, because it does not get so cheap money through its on-balance solution – or because an on-balance solution would influence the covenants (i.e. credit protection clauses) of its existing creditors. This in turn would increase its borrowing costs."

"Yes, we have often experienced that larger projects in particular are not realised because there is no off-balance solution for the parties involved [...]. So the classic is, how do I get a contract off-balance: I let it run for only one year, or there is an annual right of termination without compensation, then it is an off-balance contract. But then you have to have a good relationship with your Customer in order to enter into this."

"It is difficult to predict how the decision-makers at the Customer see this. [It would be possible] to structure ES contracts that are off-balance for the Customer, but then they are not off-balance for the ESCO and that of course creates an opportunity for small and medium-sized ESCOs, for whom an off-balance solution is not important, to gain market share. If they get access to capital to carry out projects and manage to define an ES contract that is off-balance for the Customer, then this is definitely a model that can then assert itself in the new world from 2019 without operate lease [with IFRS]."

"I would say that an ESCO that requires a compelling off-balance solution for itself has clear disadvantages in the market. It's not just the financing conditions that make it expensive, but also the way the project is structured."

There was no connection between these issues and another of the economic barriers.

The transferability of the results of the analyses of this complementary economic barrier to the Cases is as follows:

Table 5-39 – Transferability of Findings across Cases regarding the complementary economic barrier 'Accounting Standards'

Transferability of Findings	**Outcome by Case**				
	A	**B**	**C**	**D**	**E**
If a Customer accounted in accordance with IFRS, this had negative effects on opportunities or willingness for capitalisation. This meant an economic barrier issue, set as economic barrier '**Accounting Standards**'. **Contrary outcome could be obtained across Cases** (HGB is accounting standard used by the other Customers).	**X**	**X**	**X**	**X**	N/A

5.3 Summary of Chapter 5

In this chapter the findings from the various analyses of this qualitative multiple-case study were reported. The richness of the underlying data was underpinned by illustrative quotations. According to the research philosophy of interpretivism and the inductive approach of this qualitative-explorative research, the aim was to better understand the phenomenon of economic barriers to ES and EEI projects in German industrial sector.

The main purpose of discussion and conclusion in the next chapter is to answer the research questions to achieve the research objectives based on the findings derived from the analyses.

Chapter 6: Research Summary and Conclusion

In this chapter, the research questions will be answered and considered with regard to their role in closing gaps identified from the literature review. Recommendations based on the research objectives and the contribution of this research to the body of knowledge will be concluded. Finally, limitations and emerging opportunities for future research will be pointed out.

6.1 Discussion of Findings to answer the Research Questions

The literature review revealed that no prior research has been carried out on economic barriers to ES and EEI projects in German industrial sector – in particular from a holistic approach that includes the perspectives of all stakeholders involved, as can be done through a multiple-case study. This research was directed to close these gaps.

The use of the multiple-case study research strategy made it possible to obtain transferable results whose credibility was underpinned by carefully collected data.

This research in particular aimed to understand in depth the significance of these economic barriers, the role and importance of ESCOs in relevant EEI projects, and the influencing factors from specific stakeholder situations and constellations, in order to develop recommendations for policy and practice to overcome these barriers and (where appropriate) further develop existing conceptual frameworks in the area of economic barriers.

With regard to the research objectives, three research questions were derived. In order to answer these questions, the conditions that inhibit or prevent the implementation of EEI measures in German industry are discussed below as a result of the analyses of this research.

6.1.1 Research Question a)

'Which economic barriers for ES and EEI projects for Customers from industrial sector in Germany can be identified as significant?'

Each of the barriers of the economic area of the framework of Cagno et al. (2013) were addressed by at least one participant within the Cases of the multiple-case study. Even though the research approach did not aim to expose a ranking order within these nominations, significant as well as insignificant barriers could be contrasted. The following barriers were identified as being significant:

- '1. External risks';
- '2. Low Capital Availability';

as well as a complementary barrier not covered by this framework and hence introduced as

- '7. Accounting Standards'.

At least in part, these results corresponded with findings in the relevant literature (refer to Table 2-6, p. 26 and following), concerning other regions or market sectors.

The barrier...

- ...'1. External Risks' has been identified as significant in some papers (Kamenders et al. (2018), Marino et al. (2011), Stede (2017)), or was listed (Busch and Lagunes Diaz (2013), Nolden and Sorrell (2016), Polzin et al. (2016a)), partly under alternative designations or with only partial aspects concerning the specification of this barrier from Cagno et al. (2013);
- ...'2. Low Capital Availability' had variable importance in the literature: the highest was in Pätäri and Sinkkonen (2014), followed by Hannon et al. (2015), Kamenders et al. (2018) and Stede (2017). However, this barrier played only a minor role in others such as Bertoldi et al. (2014), Kangas et al. (2018), Kindström et al. (2016) and Virtanen et al. (2014), or was absent;
- ...'7. Accounting Standards' was not even identified in any of the papers from academic as well as grey literature. Only the barrier issue 'Complex Accounting/Book Keeping' (Busch (2013), Kamenders et al., 2018)) was already mentioned in literature – with minor importance. Nevertheless, corresponding issues may be subsumed to this complementary barrier in future research.

The reason for the emergence of the barrier '1. External Risks' was uncertainty concerning the volatility of the primary as well as final energy prices (perceived as high by the participants concerned) on the one hand, and the future legislative developments with regard to the EEG and the KWKG on the other. In particular, the concern from the Customer perspective, that the conditions existing at the time an EEI measure was implemented would not be protected for the entire duration of the project prevented the implementation of a possible EEI measure.

The significance of the barrier '2. Low Capital Availability' was based on various causes. In addition to the credit-worthiness of the Customer and the requirements of collateralisation, financing duration and volume (in the case of financing from the Customer's own funds) as well as refinancing were problem areas that inhibited and in two Cases even prevented the implementation of potential EEI projects. TPF organised by the Customer reduced the possible ES scope contracted by the ESCO.

As the last of the significant barriers, the barrier '7. Accounting Standards' only affected organisations for which – in addition to HGB – IFRS was a relevant accounting standard. This is expected to affect organisations in the industrial sector in particular, as they are most likely to have the appropriate group structures. Participants from all stakeholders attached great importance to this barrier, although the IFRS 16 standard was newly introduced at the time of data collection. Among other things, the introduction of this standard led to a Customer terminating the ES contractual relationship with the ESCO and – as an alternative to the required balance sheet disclosure of usage rights – taking over the fixed assets as well as (in accordance with the relevant contractual arrangements) the associated employees of the ESCO.

6.1.2 Research Question b)

'How do specific stakeholder situations and stakeholder constellations influence the emergence and significance of economic barriers?'

The situation of individual stakeholders as well as their contractual constellation obviously had influence on the realisation and performance of EEI projects:

- As explained in the previous subsection, the policy of the ESCO of excluding the financing and capitalisation of fixed assets from the scope of ES offered had an impact on the project structure – the stakeholder TPF organisation was required to finance the assets to be invested. If the Customer could not or did not want to finance the project from its own resources, a three-party constellation became mandatory, hence lease, forfeiting or hire purchase were the only available financing methods supported by the ESCO. If the Customer was not willing to accept such a three-party constellation, the potential EEI project could not be realised;
- Due to this need for TPF financing, the issues of credit-worthiness of the Customer organisation and possible collateralisation for the equipment to be financed became a major importance. These requirements had to be met by the Customer in order to obtain financing from the TPF organisations, which had to ensure compliance due to regulatory or statutory standards much more strongly than the ESCO in former projects by financing from own resources;
- This increase in complexity, also in the structure of contracts, led to an increase in transaction costs, which ultimately burdened the profitability of an EEI project and possibly even eliminated it;
- It was found that EEI measures that were eligible for subsidies from KfW Bank (e.g. because they were integrated into larger investment projects and linked to loan financing) could not be financed by the ESCO or through the TPF available to it. This also led to the reduction of the ES scope described in the previous subsection. In addition, it turned out that due to the tendering of the overall measure which became necessary in connection with the subsidies, suboptimal EEI measures (i.e. those which do not fully exploit the existing EEI potential) could systematically be selected and implemented depending on the tendering criteria focussing on the lowest costs and/or investment volume;
- This issue in connection with tendering by the Customer for EEI projects was also evident in the public sector, which in general have to follow this path for such projects;
- The aim of the standard-setting body for IFRS, to eliminate the possibility of designing off-balance-sheet solutions through the introduction of the accounting standard IFRS 16 and the corresponding allocation of economic ownership (e.g. via lease agreements), resulted in different expectations and intentions on the part of the stakeholders involved. While the ESCO initially expected the need to capitalise additional fixed assets or rights of use and feared that the acquisition of future projects would be impaired if the corporate policy remained unchanged, the Customer, who also was affected by the introduction of this standard, went one step further and fundamentally questioned the ES model in connection with the ESCO.

6.1.3 Research Question c)

'What prevents ESCOs from avoiding or removing these economic barriers that inhibit the realisation and development of their business and which measures (e.g. policy, business practice) could help to overcome these barriers?'

Some of the barriers identified as important to the ESCO business were outside its sphere of influence and cannot be proactively overcome:

- Energy prices – especially with regard to the volatility on global commodity markets;
- Accounting standards – especially with regard to IFRS 16 newly introduced from the international standard setting body.

At least in part, barriers fell within the political framework of the legislation of the Federal Republic of Germany and were thus also outside the productive influence of the ESCO, but at least within the competence of the unit responsible for the NEEAP:

- Energy legislation – especially with regard to EEG levies and feed-in tariffs as well as KWKG bonifications;
- Tendering – especially with regard to procedures and criteria, relevant for public authorities and subsidy recipients.

However, barrier issues identified as important for the ESCO under study resulted from its own sphere of influence:

- Corporate policy – ES was not the core business of the group of companies of the ESCO, furthermore its business differed significantly from the specifics of its sister organisations. These included in particular:
  - Financing;
  - Capitalisation.

  From a changing corporate policy, the initial role of the ESCO as a key player in EEI projects had been reduced to that of a planner, constructor and facility manager, with correspondingly shorter contract terms, expected broader competition from specialised organisations from the respective disciplines as well as lower Customer loyalty. These issues also weakened ESCO's acquisition capabilities for future ES projects.

6.2 Recommendations for Policy and Practice

From the answers to the research questions, the following recommendations were derived for policy and practice of the ESCO in order to overcome these barriers in line with the research objectives and thus close the 'Energy Efficiency Gap' and promote the development of German ESCO business activities:

- Policy: in order to achieve the goal of expanding ES to achieve reduction of energy consumption concerning the German NEEAP, the following recommendations were derived on the basis of the results gained by this research:
  - Safeguarding of the status quo of energy legislation with regard to EEG levies, feed-in tariffs and KWKG bonifications in order to create a sufficiently reliable basis for decision-making on the necessary investments – at least for existing measures;
  - Establishment of national balancing measures at volatile primary and final energy prices on international markets (especially on the basis of fossil energy resources) in order not to endanger the efficiency of EEI measurements by unfavourable price developments;

- Establishment of subsidy programmes which do not require (counterproductive) tendering mechanisms and that possibly prevent the most efficient EEI measure, unless it is the one with the lowest costs and/or the lowest investment volume.

- Practice: in order to foster a successful business development for the ESCO, the following recommendations were derived on the basis of the results gained by this research:
  - It is important for the ESCO to avoid a direct competition with specialists in the fields of planning, plant construction or facility management due to self-inflicted restrictions on a non-comprehensive or insufficient scope of ES; comparatively longer contract terms with corresponding customer loyalty appear to be enforceable only in connection with a comprehensive scope of ES contracted;
  - Opportunities to gain access to subsidies through the choice of eligible financing methods are crucial in order to prevail over corresponding proprietary solutions on the Customer side;
  - In connection with IFRS 16, the avoidance of capitalisation of fixed assets (or right of use) is likely to become less important for Group companies (to which IFRS are presumed to apply) on the Customer side. So far, off-balance solutions have been important. The issue of financing, however, remains. Three-party solutions with corresponding transaction costs put the ESCO at a competitive disadvantage compared to ESCOs, which can finance the investment measures with their own resources. This financing method should be sought;
  - Uncertainty due to (perceived) external risks on the Customers side limits the possibilities of future EEI projects. By assuming these – especially energy price – risks, potential for further EEI projects can be tapped.

6.3 Contributions to Knowledge

This research contributes to knowledge by providing an in-depth study on economic barriers to ES.

With the holistic approach of a multiple-case study, in which all perspectives of stakeholders involved were captured, this study filled identified gaps on this issue. Furthermore, a methodical contribution is made with regard to research on barriers to EE. With this approach it was also possible to deepen the understanding of the complexity resulting from the stakeholder constellation in ES contracts.

This research is relevant because the urgent issue of EE for achieving the reduction of energy consumption, is given special importance by the UN, the EU and also the Federal Republic of Germany – and ES are considered to be an essential element in this context. Recommendations for policy and practice to overcome these barriers were provided in the previous section.

This research also makes an important contribution to the conceptual framework of economic barriers to EE and ES by establishing a barrier that has not yet been considered but will probably be significant in the future – as proposed by Cagno et al. (2013) as an object of future research. A missing barrier 'Accounting Standards' was assigned.

In the following, this new barrier is added to the economic barrier system of Cagno et al. (2013):

Table 6-40 – Complemented Barrier Framework – Adding the 'Accounting Standards' Barrier
Based on Cagno et al. (2013)

Area	Barrier	Origin	This barrier implies, that an EEI measure can be inhibited or prevented ...
ECONOMIC	1. External Risks	External	...by the causes provided from Cagno et al. (2013)
	2. Low Capital Availability	Internal	
	3. Intervention not sufficiently profitable	Internal/external	
	4. Hidden Costs	Internal/external	
	5. Investment (Transaction) Costs	External	
	6. Intervention-related Risks	Internal/external	
	7. ACCOUNTING STANDARDS	**Internal/ external**	**...by Accounting Standards, provided that the underlying EEI measure and any related funding would require unintended recognition on the balance sheet.**

6.4 Limitations and Opportunities for future Research

The limitations of this research provide paths for future research:

- Based on existing contacts of the ESCO under study, the Customer perspective was covered primarily for EEI projects that were to enter into effect or had already entered. This means that fundamental economic barriers – which not only inhibit but effectively prevent the realisation of an EEI project – were systematically excluded. The researcher only became aware of the termination of the contract in Case A and the stopping of the potential project in Case B after completion of the data collection phase. Only the perspectives of the ESCO and the TPF organisations were captured with regard to one project that did not come to effect (Case E) – the researcher was unable to contact the corresponding potential Customer organisation.
- The central element of the Cases under study was the ESCO organisation in which the researcher was employed at the time of data collection. This ESCO was an affiliate of an international group of companies. This constellation influenced various barriers by means of the corporate policy, e.g. on financing and capitalisation. It can be assumed that the analyses of the situation of an independent ESCO organisation can provide other focal points.
- The considerations of this research are limited to the situation in Germany with the conditions and possibilities of the local NEAAP. It can be assumed that other EU member states defined different policy instruments to pursue the objectives of the respective NEEAPs and that these have led to different situations for the stakeholders of respective EEI projects.
- Further analysis of the added barrier of 'Accounting Standards' is needed. This also includes the impact of the introduction of the recently released accounting standard IFRS 16, which will become mandatory only after the date of data collection, as the effects of its application could not yet be the subject of this research.
- Finally, this research is limited by the use of the multiple-case study approach. Further research is encouraged using quantitative methods to test the reliability and validity of the findings.

References

Abdelaziz, E.A., Saidur, R., Mekhilef, S., 2011. A review on energy saving strategies in industrial sector. Renewable and Sustainable Energy Reviews 15, 150–168. https://doi.org/10.1016/j.rser.2010.09.003

Backlund, S., Thollander, P., 2011. The energy service gap: What does it mean?, in: ECEEE 2011 Summer Study Energy Efficiency First: The Foundation of a Low-Carbon Society. pp. 649–656.

Bertoldi, P., Boza-Kiss, B., 2017. Analysis of barriers and drivers for the development of the ESCO markets in Europe. Energy Policy 107, 345–355. https://doi.org/10.1016/j.enpol.2017.04.023

Bertoldi, P., Boza-Kiss, B., Panev, S., Labanca, N., 2014. ESCO Market Report 2013, JRC Science and Policy Report. Ispra. https://doi.org/10.2790/24203

Bertoldi, P., Boza-Kiss, B., Rezessy, S., 2007. Latest development of energy service companies across Europe - A European ESCO Update, JRC Scientific and Technical Report. https://doi.org/10.2788/19481

Bertoldi, P., Rezessy, S., 2005. Energy service companies in Europe, European Commission, Institute for Environment and Sustainability, Renewable Energies Unit. Luxemburg.

Bertoldi, P., Rezessy, S., Vine, E.L., 2006. Energy service companies in European countries: Current status and a strategy to foster their development. Energy Policy 34, 1818–1832. https://doi.org/10.1016/j.enpol.2005.01.010

Bleyl-Androschin, J.W., Schinnerl, D., 2010. Financing Options for Energy-Contracting Projects – Comparison and Evaluation; A Manual for ESCos, ESCo Customers and ESCo Project Developers including Good Practice Examples and Calculation Tool, International Energy Agency, DSM Task XVI. Graz.

Bunse, M., Irrek, W., 2010. Task 2.1: National Report on the Energy Efficiency Service Business in Germany. Wuppertal.

Busch, K., 2013. D2.4 Country Report on Identified Barriers and Success Factors for EPC Project Implementation - Germany. Berlin.

Busch, K., Lagunes Diaz, G.E., 2013. EESI 2020 Report on status quo of EPC markets in Germany. Berlin.

Cagno, E., Trianni, A., 2012. Analysis of the Most Effective Energy Efficiency Opportunities in Manufacturing Primary Metals, Plastics, and Textiles Small- and Medium-Sized Enterprises. Journal of Energy Resources Technology 134, 021005. https://doi.org/10.1115/1.4006043

Cagno, E., Worrell, E., Trianni, A., Pugliese, G., 2013. A novel approach for barriers to industrial energy efficiency. Renewable and Sustainable Energy Reviews 19, 290–308. https://doi.org/10.1016/j.rser.2012.11.007

Catarino, J., Henriques, J., Egreja, F., 2015. Portuguese SME toward energy efficiency improvement. Energy Efficiency 8, 995–1013. https://doi.org/10.1007/s12053-015-9325-7

Chai, K.H., Yeo, C., 2012. Overcoming energy efficiency barriers through systems approach-A conceptual framework. Energy Policy 46, 460–472. https://doi.org/10.1016/j.enpol.2012.04.012

Creswell, J.W., 2012. Qualitative Inquiry & Research Design: Choosing Among Five Approaches, Third Ed. ed. SAGE Publications Inc., London.

Da-li, G., 2009. Energy service companies to improve energy efficiency in China: barriers and removal measures. Procedia Earth and Planetary Science 1, 1695–1704. https://doi.org/10.1016/j.proeps.2009.09.260

De Groot, H.L.F., Verhoef, E.T., Nijkamp, P., 2001. Energy saving by firms: Decision-making, barriers and policies. Energy Economics 23, 717–740. https://doi.org/10.1016/S0140-9883(01)00083-4

Duplessis, B., Adnot, J., Dupont, M., Racapé, F., 2012. An empirical typology of energy services based on a well-developed market: France. Energy Policy 45, 268–276. https://doi.org/https://doi.org/10.1016/j.enpol.2012.02.031

Easterby-Smith, M., Thorpe, R., Jackson, P.R., 2015. Management and Business Research, Fifth Ed. ed. SAGE Publications Ltd, London.

European Parliament, 2018. Directive (EU) 2018/ 2002 of the European Parliament and of the Council of 11 December 2018, amending Directive 2012/ 27/ EU on Energy Efficiency. Official Journal of the European Union Directive 2018, 210–230.

European Parliament, 2012. Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency. Official Journal of the European Union Directive 1–56. https://doi.org/10.3000/19770677.L_2012.315.eng

European Parliament, 2006. Directive 2006/32 EC of the European Parliament and the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC. Official Journal of the European Union Directive 12–25. https://doi.org/10.1016/j.jclepro.2010.02.014

Fan, L.W., Pan, S.J., Liu, G.Q., Zhou, P., 2017. Does energy efficiency affect financial performance? Evidence from Chinese energy-intensive firms. Journal of Cleaner Production 151, 53–59. https://doi.org/10.1016/j.jclepro.2017.03.044

Fang, W.S., Miller, S.M., Yeh, C.C., 2012. The effect of ESCOs on energy use. Energy Policy 51, 558–568. https://doi.org/10.1016/j.enpol.2012.08.068

Fell, M.J., 2017. Energy services: A conceptual review. Energy Research & Social Science 27, 129–140. https://doi.org/https://doi.org/10.1016/j.erss.2017.02.010

First National Energy Efficiency Action Plan (NEEAP) of the Federal Republic of Germany, 2007.

Fleiter, T., Worrell, E., Eichhammer, W., 2011. Barriers to energy efficiency in industrial bottom-up energy demand models—A review. Renewable and Sustainable Energy Reviews 15, 3099–3111. https://doi.org/10.1016/j.rser.2011.03.025

Garbuzova-Schlifter, M., Madlener, R., 2013. Prospects and barriers for Russia's emerging ESCO market. International Journal of Energy Sector Management 7, 113–150.

https://doi.org/10.1108/17506221311316506

Garbuzova, M., Madlener, R., 2012. Towards an efficient and low carbon economy post-2012: opportunities and barriers for foreign companies in the Russian energy market. Mitigation and Adaptation Strategies for Global Change 17, 387–413. https://doi.org/10.1007/s11027-011-9332-8

Gill, J., Johnson, P., 2002. Methods for Managers, Third Ed. ed. SAGE Publications Ltd, London EC2A 4PU.

Hannon, M.J., Foxon, T.J., Gale, W.F., 2015. "Demand pull" government policies to support Product-Service System activity: The case of Energy Service Companies (ESCos) in the UK. Journal of Cleaner Production 108, 1–16. https://doi.org/10.1016/j.jclepro.2015.05.082

Hirst, E., Brown, M.A., 1990. Closing the efficiency gap: barriers to the efficient use of energy. Resources, Conservation and Recycling 3, 267–281. https://doi.org/10.1016/0921-3449(90)90023-W

Hopper, N.C., Birr, D., Stoughton, K.M., 2005. Public and Institutional Markets for ESCO Services: Comparing Programs, Practices and Performance. Berkeley, CA.

Jaffe, A.B., Stavins, R.N., 1994. The energy-efficiency gap. What does it mean? Energy Policy 22, 804–810. https://doi.org/10.1016/0301-4215(94)90138-4

Kamenders, A., Kass, K., Biseniece, E., Lupkina, L., Bazbauers, J., 2018. Quality management in energy performance contracting projects. Energy Procedia 147, 636–640. https://doi.org/10.1016/j.egypro.2018.07.082

Kangas, H.L., Lazarevic, D., Kivimaa, P., 2018. Technical skills, disinterest and non-functional regulation: Barriers to building energy efficiency in Finland viewed by energy service companies. Energy Policy 114, 63–76. https://doi.org/10.1016/j.enpol.2017.11.060

Kindström, D., Ottosson, M., Thollander, P., 2016. Driving forces for and barriers to providing energy services—a study of local and regional energy companies in Sweden. Energy Efficiency 1–19. https://doi.org/10.1007/s12053-016-9437-8

Köhn, D., 2012. Greening the financial sector: How to mainstream environmental finance in developing countries, Greening the Financial Sector: How to Mainstream Environmental Finance in Developing Countries. https://doi.org/10.1007/978-3-642-05087-9

Labanca, N., 2010. Task 2.1: Status and development of the energy efficiency service business in 18 EU countries, Change Best. Milan.

Lee, P., Ip Lam, T., Jye Dzeng, R., 2014. Current market development of energy performance contracting. Journal of Property Investment & Finance 32, 371–395. https://doi.org/10.1108/JPIF-01-2014-0003

Li, Y., Qiu, Y., Wang, Y.D., 2014. Explaining the contract terms of energy performance contracting in China: The importance of effective financing. Energy Economics 45, 401–411. https://doi.org/10.1016/j.eneco.2014.08.009

Limaye, D.R., Limaye, E.S., 2011. Scaling up energy efficiency: The case for a Super ESCO. Energy Efficiency 4, 133–144. https://doi.org/10.1007/s12053-011-9119-5

Liu, P., Zhou, Y., Zhou, D.K., Xue, L., 2017. Energy Performance Contract models for the diffusion of green-manufacturing technologies in China: A stakeholder analysis from SMEs' perspective. Energy Policy 106, 59–67. https://doi.org/10.1016/j.enpol.2017.03.040

Manoukian, A., HassabElnaby, H.R., Odabashian, V., 2015. A proposed framework for renewable energy technology commercialization and partnership synergy. American Journal of Business 30, 147–174. https://doi.org/10.1108/AJB-08-2014-0052

Marino, A., Bertoldi, P., Rezessy, S., Boza-Kiss, B., 2011. A snapshot of the European energy service market in 2010 and policy recommendations to foster a further market development. Energy Policy 39, 6190–6198. https://doi.org/10.1016/j.enpol.2011.07.019

Marino, A., Bertoldi, P., Rezessy, S., Boza-Kiss, B., 2010. Energy Service Companies Market in Europe, JRC Scientific and Technical Report. https://doi.org/10.2788/8693

Nandivada, S., 2014. Energy-efficiency retrofits in the commercial sector: An analysis of PACE financing, on-bill repayment, and energy savings performance contracts. Journal of Environmental Law and Litigation 29, 363–388.

Nolden, C., Sorrell, S., 2016. The UK market for energy service contracts in 2014-2015. Energy Efficiency 1–16. https://doi.org/10.1007/s12053-016-9430-2

Nolden, C., Sorrell, S., Polzin, F., 2016. Catalysing the energy service market: The role of intermediaries. Energy Policy 98, 420–430. https://doi.org/https://doi.org/10.1016/j.enpol.2016.08.041

O'Malley, E., Scott, S., Sorrell, S., 2003. Barriers To Energy Efficiency : Evidence From Selected Sectors, Policy Research Series. Dublin.

Oikonomou, V., Becchis, F., Steg, L., Russolillo, D., 2009. Energy saving and energy efficiency concepts for policy making. Energy Policy 37, 4787–4796. https://doi.org/10.1016/j.enpol.2009.06.035

Okay, N., Akman, U., 2010. Analysis of ESCO activities using country indicators. Renewable and Sustainable Energy Reviews 14, 2760–2771. https://doi.org/10.1016/j.rser.2010.07.013

Painuly, J.P., 2009. Financing energy efficiency: lessons from experiences in India and China. International Journal of Energy Sector Management 3, 293–307. https://doi.org/10.1108/17506220910986815

P**ätäri, S., Annala, S., Jantunen, A., Viljainen, S., Sinkkonen, A., 2016.** Enabling and hindering factors of diffusion of energy service companies in Finland - results of a Delphi study. Energy Efficiency 1–14. https://doi.org/10.1007/s12053-016-9433-z

P**ätäri, S., Sinkkonen, K., 2014.** Energy Service Companies and Energy Performance Contracting: is there a need to renew the business model? Insights from a Delphi study. Journal of Cleaner Production 66, 264–271. https://doi.org/10.1016/j.jclepro.2013.10.017

Polzin, F., von Flotow, P., Nolden, C., 2016a. Modes of governance for municipal energy efficiency services – The case of LED street lighting in Germany. Journal of Cleaner Production 139, 133–145. https://doi.org/10.1016/j.jclepro.2016.07.100

Polzin, F., von Flotow, P., Nolden, C., 2016b. What encourages local authorities to engage with energy performance contracting for retrofitting? Evidence from German municipalities. Energy Policy 94, 317–330. https://doi.org/10.1016/j.enpol.2016.03.049

Qin, Q., Liang, F., Li, L., Wei, Y.M., 2017. Selection of energy performance contracting business models: A behavioral decision-making approach. Renewable and Sustainable Energy Reviews 72, 422–433. https://doi.org/10.1016/j.rser.2017.01.058

Reddy, B.S., 2013. Barriers and drivers to energy efficiency – A new taxonomical approach. Energy Conversion and Management 74, 403–416. https://doi.org/10.1016/j.enconman.2013.06.040

Ribeiro, I., 2011. The Evolution of Energy Service Companies (ESCOs) in Ontario : Extending the Traditional ESCO Model to Renewable Energy Contracting Inês Ribeiro.

Roshchanka, V., Evans, M., 2016. Scaling up the energy service company business: Market status and company feedback in the Russian Federation. Journal of Cleaner Production 112, 3905–3914. https://doi.org/10.1016/j.jclepro.2015.05.078

Sarkar, A., Singh, J., 2010. Financing energy efficiency in developing countries-lessons learned and remaining challenges. Energy Policy 38, 5560–5571. https://doi.org/10.1016/j.enpol.2010.05.001

Saunders, M., Lewis, P., Thornhill, A., 2016. Research Methods for Business Students, Seventh Ed. ed. Pearson Education Limited, Essex CM20 2JE.

Second National Energy Efficiency Action Plan (NEEAP) of the Federal Republic of Germany, 2011.

Shonder, J., 2010. The Economics of Energy Savings Performance Contracts. ASHRAE Transactions 116, 394–400.

Smith, P.L., 2010. Energy Savings Performance Contracting with New Construction = Energy Security at White Oak. Energy Engineering 107, 51–69. https://doi.org/10.1080/01998591009709876

Soroye, K.L., Nilsson, L.J., 2010. Building a business to close the efficiency gap: the Swedish ESCO Experience. Energy Efficiency 3, 237–256. https://doi.org/10.1007/s12053-009-9069-3

Sorrell, S., 2007. The economics of energy service contracts. Energy Policy 35, 507–521. https://doi.org/10.1016/j.enpol.2005.12.009

Sorrell, S., Schleich, J., Scott, S., O'Malley, E., Trace, F., Boede, U., Ostertag, K., Radgen, D.P., 2000. Reducing Barriers to Energy Efficiency in public and private Organisations. Sussex.

Stede, J., 2017. Bridging the industrial energy efficiency gap – Assessing the evidence from the Italian white certificate scheme. Energy Policy 104, 112–123. https://doi.org/10.1016/j.enpol.2017.01.031

S**tuart, E., Carvallo, J.P., Larsen, P.H., Goldman, C.A., Gilligan, D., 2018.** Understanding recent

market trends of the US ESCO industry. Energy Efficiency. https://doi.org/10.1007/s12053-018-9633-9

Suganthi, L., Samuel, A.A., 2012. Energy models for demand forecasting - A review. Renewable and Sustainable Energy Reviews 16, 1223–1240. https://doi.org/10.1016/j.rser.2011.08.014

The International Financial Reporting Standards Foundation, 2019. IFRS 16 Leases [WWW Document]. URL www.ifrs.org (accessed 4.13.19).

Third National Energy Efficiency Action Plan (NEEAP) for the Federal Republic of Germany, 2014.

Thollander, P., Palm, J., Rohdin, P., 2010. Categorizing Barriers to Energy Efficiency : An Interdisciplinary Perspective. Energy Efficiency 49–63. https://doi.org/10.5772/266

Trianni, A., Cagno, E., Worrell, E., Pugliese, G., 2013. Empirical investigation of energy efficiency barriers in Italian manufacturing SMEs. Energy 49, 444–458. https://doi.org/10.1016/j.energy.2012.10.012

UNFCCC, 1998. Kyoto Protocol To the United Nations Framework Kyoto Protocol To the United Nations Framework. Review of European Community and International Environmental Law 7, 214–217. https://doi.org/10.1111/1467-9388.00150

Ürge-Vorsatz, D., Metz, B., 2009. Energy efficiency: How far does it get us in controlling climate change? Energy Efficiency 2, 87–94. https://doi.org/10.1007/s12053-009-9049-7

Vine, E.L., 2005. An international survey of the energy service company (ESCO) industry. Energy Policy 33, 691–704. https://doi.org/10.1016/j.enpol.2003.09.014

Virtanen, M., Heimonen, I., Sepponen, M., 2014. Stakeholder Analysis and Questionnaire Showing the Way for the Development of Business and Service Models. Energy Procedia 58, 51–57. https://doi.org/https://doi.org/10.1016/j.egypro.2014.10.408

Vogel, J.A., Lundqvist, P., Arias, J., 2015. Categorizing Barriers to Energy Efficiency in Buildings. Energy Procedia 75, 2839–2845. https://doi.org/10.1016/j.egypro.2015.07.568

Weber, L., 1997. Some reflections on barriers to the efficient use of energy. Energy Policy 25, 833–835. https://doi.org/10.1016/S0301-4215(97)00084-0

Winther, T., Gurigard, K., 2017. Energy performance contracting (EPC): a suitable mechanism for achieving energy savings in housing cooperatives? Results from a Norwegian pilot project. Energy Efficiency 10, 577–596. https://doi.org/10.1007/s12053-016-9477-0

Worrell, E., Bernstein, L., Roy, J., Price, L., Harnisch, J., 2009. Industrial energy efficiency and climate change mitigation. Energy Efficiency 2, 109–123. https://doi.org/10.1007/s12053-008-9032-8

X**u, P., Chan, E.H.W., Qian, Q.K., 2011.** Success factors of energy performance contracting (EPC) for sustainable building energy efficiency retrofit (BEER) of hotel buildings in China. Energy Policy 39, 7389–7398. https://doi.org/10.1016/j.enpol.2011.09.001

Yang, M., 2016. Energy service company and financial market development: experiences of the Global

Environment Facility. Mitigation and Adaptation Strategies for Global Change 21, 663–676. https://doi.org/10.1007/s11027-014-9603-2

Yin, R.K., 2014. Case Study Research - Design and Methods, Fifth Ed. ed. SAGE Publications, Inc., Thousand Oaks, California 91320.

Bibliography

Several company presentations and websites of the organisations involved (anonymised for reasons of confidentiality).

Annex

A Barrier Frameworks

The following tables concerning barrier frameworks contain – as far as applicable – contrasted to the Barrier Framework 6 – Cagno et al. (2013).

A.1 Barrier Framework 1 – **Hirst and Brown** (1990)

A.2 Barrier Framework 2 – **Weber** (1997)

A.3 Barrier Framework 3 – **Sorrell et al.** (2000)

A.4 Barrier Framework 4 – **De Groot et al.** (2001)

A.5 Barrier Framework 5 – **Thollander et al.** (2010)

A.6 Barrier Framework 6 – **Cagno et al.** (2013)

A.7 Barrier Framework 7 – **Reddy** (2013)

A.8 Barrier Framework 8 – **Vogel et al.** (2015)

A.9 Barrier Framework 9 – **Stede** (2017)

A.1 Barrier Framework 1 – Hirst and Brown (1990)

Table A-41 – Barrier Framework 1: Barriers, structured according to 'Types'
Based on Hirst and Brown (1990)

Type	Barrier	This barrier corresponds – concerning the framework of Cagno et al. (2013) – to the barrier…
Structural	**DISTORTION IN FUEL PRICES**	**EXTERNAL RISK**
	UNCERTAINTY ABOUT FUTURE FUEL PRICES	**EXTERNAL RISK**
	LIMITED ACCESS TO CAPITAL	**LOW CAPITAL AVAILABILITY**
	Governmental, fiscal and regulatory policies	Lack of interest in energy efficiency interventions
	Codes and Standards	Technologies not adequate/not available
	Supply Infrastructure Limitations	Technologies not available
Behavioural	Attitudes toward EE	Lack of interest in energy efficiency interventions
	PERCEIVED RISK OF EE INVESTMENT	**INTERVENTION-RELATED RISK**
	Information Gaps	Lack of information on costs and benefits
	Misplaced Incentives	Divergent interests

A.2 Barrier Framework 2 – Weber (1997)

Table A-42 – Barrier Framework 2: Barriers, structured according to 'Types'
Based on Weber (1997)

Type	Barrier	This type implies, that an EEI measure can be inhibited or prevented – by barriers emerging…	This barrier corresponds – concerning the framework of Cagno et al. (2013) – to the barrier…
Institutional	### Not subject matter ###	…from political institutions, i.e. state government and local authorities	### Not subject matter ###
Market		…from markets, or …from market failure	
Organisational		…within organisations, especially within firms	
Behavioural		…inside individuals	

A.3 Barrier Framework 3 – Sorrell et al. (2000)

Table A-43 – Barrier Framework 3: Barriers, structured according to underlying Theories and 'Perspectives' Based on Sorrell et al. (2000)

Sub-Division of Perspective	Barrier	This barrier corresponds – concerning the framework of Cagno et al. (2013) – to the barrier…
a) ECONOMIC		
Neo-Classical Economics Theory		
Non-Market Failure	**HETEROGENEITY**	**INTERVENTION NOT SUFFICIENTLY PROFITABLE**
	HIDDEN COSTS	**HIDDEN COSTS**
	ACCESS TO CAPITAL	**LOW CAPITAL AVAILABILITY**
	RISK	**INTERVENTION-RELATED RISKS / EXTERNAL RISKS**
Market Failure	Imperfect information	Lack of information on costs and benefits (1/3) / Information not clear by technology suppliers (1/2) / Information issues on energy contracts (1/2)
	Split incentives	Divergent interests
	Adverse selection	Lack of information on costs and benefits (2/3) / Identifying the inefficiencies Identifying the opportunities (1/2)
	Principal-agent relationship	Lack of information on costs and benefits (3/3)
b) Behavioural		
Transaction Cost Economics Theory, Psychology, Decision Theory		
	Bounded rationality	Lack of time / Identifying the opportunities (2/2)
The Human Dimension	Form of information	Information not clear by technology suppliers (2/2) / Information issues on energy contracts (2/2) / Imperfect evaluation criteria
	Credibility and trust	Trustworthiness of the information source
	Inertia	Inertia
	Values	Lack of interest in energy efficiency interventions / Other priorities / Lack of sharing the objectives
c) Organisational		
Organisation Theory		
	Power	Lack of awareness or ignorance (1/2)
	Culture	Low status of energy efficiency / Divergent interests / Complex decision chain / Lack of internal control / Lack of awareness or ignorance (2/2)

A.4 Barrier Framework 4 – De Groot et al. (2001)

Table A-44 – Barrier Framework 4: Barriers, structured according to 'Categories', contrasted to Barrier Framework 6 Based on De Groot et al. (2001)

Category	Barrier	This barrier corresponds – concerning the framework of Cagno et al. (2013) – to the barrier…
General	**OTHER INVESTMENTS ARE MORE IMPORTANT**	**HIDDEN COSTS**
	Technology can only be implemented after existing technology has been replaced	*###* *Not a Barrier* *###*
	ENERGY COSTS ARE NOT SUFFICIENTLY IMPORTANT	**INTERVENTION NOT SUFFICIENTLY PROFITABLE**
	Energy Efficiency has low priority	Low status of energy efficiency
	Current Installations are sufficiently efficient	*###* *Not a Barrier* *###*
	Currently introducing a new Technology	*###* *Not a Barrier* *###*
	Difficult to implement due to internal Organisation	Divergent interests / Complex decision chains / Lack of internal control Lack of time
Financial	**INTERNAL CONSTRAINTS ON THE BUDGET**	**INVESTMENT COSTS**
	PROBLEMS WITH EXTERNAL FINANCING	**LOW CAPITAL AVAILABILITY**
Uncertainty	**UNCERTAINTY REGARDING THE QUALITY**	**INTERVENTION-RELATED RISK**
	BETTER TO WAIT FOR SUBSIDIES	**HIDDEN COSTS**
	Technology will become cheaper	Lack of information on costs and benefits / Identifying the opportunities
	No good Overview of existing Technologies	Information not clear by technology suppliers
	Better to await Experience of Colleagues	Inertia / Lack of awareness or ignorance
	MAYBE NEW TECHNOLOGY WILL NOT SATISFY FUTURE STANDARDS	**INTERVENTION-RELATED RISK /** Imperfect evaluation criteria

A.5 Barrier Framework 5 – Thollander et al. (2010)

Table A-45 – Barrier Framework 5: Barriers, structured according to 'Areas', contrasted to Barrier Framework 6 Based on Thollander et al. (2010)

Area (Classification)	Barrier	This barrier corresponds – concerning the framework of Cagno et al. (2013) – to the barrier…
The technical System	**ACCESS TO CAPITAL**	**LOW CAPITAL AVAILABILITY**
	HETEROGENEITY	**INTERVENTION NOT SUFFICIENTLY PROFITABLE**
	HIDDEN COSTS	**HIDDEN COSTS**
	RISK	**INTERVENTION-RELATED RISK / EXTERNAL RISK**
The technological Regime	Imperfect Information	Lack of information on costs and benefits (1/3) / Information not clear by technology suppliers (1/2) / Information issues on energy contracts (1/2) Imperfect evaluation criteria
	Adverse Selection	Lack of information on costs and benefits (2/3) / Identifying the opportunities
	Split incentives	Divergent interests
	Form of Information	Information not clear by technology suppliers (2/2) / Information issues on energy contracts (2/2)
The socio-technical regime	Principal-Agent Relationship	Lack of information on costs and benefits (3/3)
	Credibility and Trust	Trustworthiness of the information source
	Values	Lack of interest in energy efficiency interventions / Other priorities / Lack of sharing the objectives
	Inertia	Inertia
	Bounded Rationality	Lack of time / Identifying the opportunities (2/2)
	Power	Lack of awareness or ignorance (1/2)
	Culture	Low status of energy efficiency / Divergent interests / Complex decision chain / Lack of internal control / Lack of awareness or ignorance (2/2)

A.6 Barrier Framework 6 – Cagno et al. (2013)

Table A-46 – Barrier Framework 6: Barriers, structured according to 'Areas', contrasted to Barrier Framework 6 Based on Cagno et al. (2013)

Area	Origin	Barrier	This barrier implies, that an EEI measure can be inhibited or prevented ...
Technologic	External	Technologies not adequate	....by technical characteristics of EE technology (including guidelines and norms setting standards for planning and design) which may be so specific that in certain cases they cannot be adopted regardless of their cost.
	External	Technologies not available	...by (regionally) limited availability of EE technology and experience and expertise of service providers - there may not be a sufficient number of experts available for technology, operation and maintenance of EE technologies.
Informational	External	Lack of information on costs and benefits	...by a lack of (credible) information about the performance of EE technologies on perceived risks can complicate decisions about the introduction of such systems; incomplete information can also lead to inefficient products that drive efficient products out of the market.
	External	Information not clear by technology suppliers	....by providing information for the investment decision by the technology supplier which the Customer does not accept because it is not specific, descriptive, simple or personal.
	External	Information issues on energy contracts	....by providing information for the investment decision by the ES provider/utility which the Customer does not accept because it is not specific, descriptive, simple or personal.
	External	Trustworthiness of the information source	...by information sources for the investment decision that do not appear credible and trustworthy to successfully communicate information about EEI measures; the absence of these factors leads to inefficient decisions by ignoring or suppressing EEI measures because Customers lack confidence in the service provider.
ECONOMIC	**External**	**1. EXTERNAL RISKS**	...by highly volatile energy prices, which create a high degree of uncertainty in the estimation of future or long-term operating costs; this may lead to BAT investments being avoided compared to conventional technologies due to higher investment needs - and uncertainty about the price of energy produced from fossil fuels, which does not reflect all the environmental and social costs associated with production, conversion, transport and use; this means that EEI measures are less profitable than would be socially optimal, and price signals are therefore an barrier to investment in the purchase of EE technology.
	Internal	**2. LOW CAPITAL AVAILABILITY**	...by insufficient capital from own resources and difficulties in borrowing or raising equity, or internal investment planning procedures and investment evaluation related to higher investment needs for BAT systems compared to conventional technology; in manufacturing, EEI measures are hindered by the preference of investments that increase production over EEI investments that reduce operating costs; often a two-tier system of investment criteria is also used, where product-independent investments, such as energy cost reductions or savings, must achieve a significantly higher return than product-related investments; the resulting very high discount rates then lead to a situation known as the 'Payback gap'; often a two-tier system of investment criteria is also used, where product-independent investments, such as energy savings, must achieve a significantly higher rate of return than product-related investments; the resulting higher discount interest rates then lead to a situation known as the 'Payback gap'.
	Internal / External	**3. INTERVENTION NOT SUFFICIENTLY PROFITABLE**	…by solutions that are in principle, but not necessarily cost-effective in all cases and organisations.
	Internal / External	**4. HIDDEN COSTS**	...by costs, which are not included in the original estimate of the investment planning (e.g. transaction costs for the collection, analysis and application of the measures, in addition, costs of the information procurement and analysis as well as the personnel training) and eliminate thereby the originally calculated cost efficiency.

Area	Origin	Barrier	This barrier implies, that an EEI measure can be inhibited or prevented ...
	External	**5. INVESTMENT COSTS**	...by initially high design and manufacturing costs for providing an energy efficient technology.
	Internal / External	**6. INTERVENTION-RELATED RISKS**	...by uncertainties in investments in EEI measures, which always entail risks of operational failure; uncertainties also exist with regard to the duration and availability of EE technologies and the long-term availability of calculated energy cost savings, especially if the discount rates for future costs and benefits are either lower than the available return on investments with comparable risk or higher than the financing rate of the measure.
Behavioural	Internal	Lack of interest in energy efficiency interventions	...by the absence of a truly ambitious person responsible for the investment decision, preferably represented by a key member of top management, and by a strong social emphasis on comfort, lightness and convenience, which may be at odds with EE.
	Internal	Other priorities	...by decision-makers who focus on core business activities and therefore tend to evaluate only those interventions that have a significant impact on the activities of the main production system, whereby EEI measures can be ignored.
	Internal	Lack of sharing the objectives	...by misaligning the behaviour of personnel with regard to the objectives of energy management, resulting in a low implementation of energy management practices.
	Internal	Inertia	...by an individual boycotting change within an organisation, which prevents energy efficiency measures that are cost-effective from being implemented.
	Internal	Imperfect evaluation criteria	...by a lack of information about EEI potential, leading to investment decisions by the Customer based on other criteria (e.g. investment volume of the measure) or missed cost-efficient opportunities
Organisational	Internal	Low status of energy efficiency	...by a culture within the organisation that does not attach value to environmental content and thus does not promote investment in energy efficiency.
	Internal	Divergent interests	...by a lack of interest, the organisation may be unable to properly address the benefits to the decision-makers responsible for the investment, as well as possible conflicts in the use of limited resources.
	Internal	Complex decision chain	...by an odd and not smooth flow of information due to decision processes that involve multiple functions.
	Internal	Lack of internal control	...by control systems put in place by the organisation's management that are inadequate and discourage staff from implementing EEI measures.
	Internal	Lack of time	...by decisions taken on the basis of time, attention and information constraints and therefore not as foreseen in economic models (i.e. on the basis of perfect information).
Competences	Internal	Identifying the inefficiencies	...by the lack of specific competences for methods and tools to identify energy waste despite existing awareness of energy issues and in the awareness of the benefits of EE technologies.
	Internal	Identifying the opportunities	...by the lack of specific competences for methods and tools to identify EEI potentials despite existing awareness of energy issues and in the awareness of the benefits of EE technologies.
	Internal	Implementing the interventions	...by lack of support from employees or external consultants in implementing energy efficiency practices and interventions.
	External	Difficulty in gathering external competences	... by pricing or availability of experts on existing energy-efficient technologies.
Awareness	Internal	Lack of awareness or ignorance	...by low energy management status (e.g. due to formal authorities and control of scarce resources) and thus low priority of energy issues.

A.7 Barrier Framework 7 – Reddy (2013)

Table A-47 – Barrier Framework 7: Hierarchical Structure of the 'Spheres' Based on Reddy (2013)

Area (Sphere of Influence)	Barriers from this Sphere…	Actor is… … influenced by / … in position to remove Barrier
a) External: Society, Market and Policy Design (Taxes, Regulations, Policies)		
Macro	…occur at the highest level: Government, market and society (e.g. electricity prices, laws on savings from EEI projects, subsidies, etc.). Since these barriers are not project- or organisation-specific they cannot be influenced by the project stakeholders.	• Technological: Can remove by Lobbying and Rule Making • **Financial: Can remove as prime authorities on allocation and enforcement** • Legal: Can remove as Law-making and Law-enforcing Bodies • Market related: Can remove by intervening and taking corrective Measures • Institutional/Organisational: Can remove with structural Adjustments • Informational: Influenced by Information Gaps • Behavioural: Can remove non-Acceptance of EE Technology
b) Internal: Organisational Design (Structures, Incentives)/Project Design (Structures, Incentives)		
Meso	...refer to the organisations associated with the project (in the context of this research the stakeholders, hence Customer, ESCO or TPF organisation). These barriers can arise in a variety of or at all relevant projects (primarily from the perspective of the ESCO or the TPF organisation) and can generally be overcome by changes in their organisational design.	• Technological: Can remove by Development and Supply of EE Solutions • **Financial: Influenced to follow Guidelines; Can remove by making requisite Provisions (Financial Institutions and Banks)** • Legal: Influenced to follow Provisions • Market related: Influenced by Market Failures • Institutional/Organisational: Can remove with structural Adjustments • Informational: Influenced by Information Gaps • Behavioural: Can remove non-Acceptance of EE Technology
Micro	… are those that occur at the lowest level within a project. These barriers in general are unique to a particular project. By changing the project design (for example by changing the incentives for energy savings, replacing the technology or increasing the project size) the feasibility of the EEI measure can be increased.	• Technological: Influenced as user of EE Solutions • **Financial: Influenced to follow Provisions** • Legal: Influenced to follow Provisions • Market related: Influenced by Market Failures • Institutional/Organisational: Can remove with structural Adjustments • Informational: Influenced by Information Gaps • Behavioural: Can remove non-Acceptance of EE Technology

A.8 Barrier Framework 8 – Vogel et al. (2015)

Table A-48 – Barrier Framework 8: Barriers, structured according to 'System Structure', contrasted to Barrier Framework 6 Based on Vogel et al. (2015)

System Structure	Barrier	This barrier corresponds – concerning the framework of Cagno et al. (2013) – to the barrier…
Contextual Level	Weak national Energy Regulations when refurbishing Buildings	### *Building specific* ###
	Incoherent national and municipal Energy Regulations	### *Building specific* ###
	Ambiguous Energy related Rules and Regulations	### *Building specific* ###
	Unclear Incentives for the Market to reach Energy Targets	### *Building specific* ###
	Regulations or Certifications, or both? No common Way forward when planning multifamily	### *Building specific* ###
	Weak national Research & Development inhibit Regulation Development	### *Building specific* ###
	Certifications and Geography	### *Building specific* ###
	Cut up Planning Process	### *Building specific* ###
	Broken Agency – different Incentives for different actors	Divergent interests (1/3)
	Lack of Contact Areas between Energy User and Energy Producer	Difficulty in gathering external competences
	Agreement Structure do not promote Innovation or the Use of emergent Technologies	### *Building specific* ###
	Altering Energy Agreements	
	Low Transparency of Energy Pricing Models	Lack of information on costs and benefits / Information issues on energy contracts
	Innovation and Technology Advancements not in line with the Planning Process	Inertia (1/3)
	Vague or non-existing Incentives for distributed Energy Production	Divergent interests (2/3)
	Buildings as Part of the Energy System	### *Building specific* ###
Sector Level	Weak or lacking Feedback Structures	Lack of internal control (1/3)
	Resistance to Change	Inertia (2/3)
	Weak Communication Structures between Companies, Organisations, and Academia	Difficulty in gathering external competences
	Lacking System View, leading to lost Opportunities	Identifying the opportunities
	Lacking Comprehension of System Benefits	Lack of awareness or ignorance (1/3)
	Technology Lock-ins	### *Building specific* ###
	Extensive Feedback Cycle Time	Lack of internal control (2/3) / Complex decision chain (1/2)
	Research & Development only at Company Levels constrain Progress	Complex decision chain (2/2)
	Weak or non-existing Incentives for using latest Technology	Divergent interests (3/3)

System Structure	Barrier	This barrier corresponds – concerning the framework of Cagno et al. (2013) – to the barrier…
	INNOVATION BUDGETS COUPLED TO PROJECT BUDGETS	**LOW CAPITAL AVAILABILITY**
	TECHNICAL ACCOUNTING RULES NOT IN LINE WITH LIFE SPANS OF THE PRODUCTS	### **ONLY BARRIER FRAMEWORK IN WHICH THIS BARRIER IS ADDRESSED** ###
Project Level	Lacking Project Goals and Objectives	### *Building specific* ###
	Lacking Knowledge of Details in Projects	Identifying the inefficiencies
	Time dependent Knowledge	Inertia (3/3)
	Actor dependent Knowledge	Lack of interest in energy efficiency interventions
	Lacking Knowledge of and Interest in Energy related Topics	Information issues on energy contracts / Lack of interest in energy efficiency interventions
	Low Interest of future Energy related Topics	Lack of sharing the objectives
	Lacking Transparency weakens System Benefits	Trustworthiness of the information source
	PERCEIVED INCREASE OF OPERATION COSTS AND RISKS WITH INTRODUCTION OF NEW TECHNOLOGY	**HIDDEN COSTS / INTERVENTION-RELATED RISKS**
	Insufficient and inconsistent calculation methods	Lack of internal control (3/3)
	Lacking knowledge about investment horizons, risks and life spans	Lack of awareness or ignorance (2/3)
	Lacking transparency in numbers	Lack of awareness or ignorance (2/3)

A.9 Barrier Framework 9 – Stede (2017)

Table A-49 – Barrier Framework 9: Barriers, structured according to 'Categories', contrasted to Barrier Framework 6 Based on Stede (2017)

Category	Main barrier / Sub barrier	This barrier corresponds – concerning the framework of Cagno et al. (2013) – to the barrier…
Financial	**PAYBACK TIME** / **PROFITABILITY OF INVESTMENT**	**INTERVENTION NOT SUFFICIENTLY PROFITABLE**
	RISKINESS OF INVESTMENT	**INTERVENTION-RELATED RISK / EXTERNAL RISK**
	ACCESS TO FINANCE	**LOW CAPITAL AVAILABILITY**
Informational/ Behavioural/ Institutional	Imperfect Information	Lack of information on costs and benefits / Information not clear by technology suppliers / Information issues on energy contracts
	Lack of Awareness of Investment Opportunities	Identifying the inefficiencies / Identifying the opportunities
	Lack of Trust in ESCOs	Trustworthiness of the information source
	Lack of skilled Personnel / Lack of internal Competences	Implementing the interventions
	Low Priority of EEI Measures	Lack of interest in energy efficiency interventions Other priorities
	OTHER INVESTMENT PRIORITIES	**HIDDEN COSTS**
External	Regulatory uncertainty / Bureaucratic hurdles	Lack of interest in energy efficiency interventions

B Interview Schedule

The following images show the interview schedule used by the researcher in specific versions for each of the stakeholders.

MATTHIAS VOLKER **BERGMANN**

Interview Schedule

Interview questions – ESCO

Economic barriers to energy services and energy efficiency improvement projects in German Industrial Sector – a multiple-case study

Date: _____

Name: _____

Interviewee and organisation

1) Role / function of organisation ☐

_____ ☐

2) Role / function of interviewee in organisation ☐

_____ ☐

3) Company affiliation ☐

_____ ☐

Energy efficiency and projects

4) What are energy efficiency projects? ☐

_____ ☐

a) Subjects of / examples for projects? ☐

_____ ☐

b) Invest (average) of projects? ☐

_____ ☐

c) Motivation / trigger for project? ☐

_____ ☐

d) Client specifics (branch, credit rating, ...)? ☐

_____ ☐

MATTHIAS VOLKER **BERGMANN**

Interview Schedule

5) What are stakeholders in EE projects?

_ _

Barriers

6) "Energy efficiency gap " (Jaffe & Stavins, 1994)

_ _

7) Reasons for failure / non-implementation of projects

_ _

8) Financing

a) Which stakeholder funds projects in general – preferred party?

_ _

b) Different types of funding: run time; volume; risks?

_ _

c) Influence of refinancing party on project decisions?

_ _

d) Validation concepts – differing with types of funding?

_ _

e) Further requirements in projects, contracts or stakeholders?

_ _

f) What influences terms of funding?

_ _

g) Barriers on potential project fundings?

_ _

MATTHIAS VOLKER **BERGMANN**

Interview Schedule

9) Capitalisation

a) Which accounting standards are relevant (HGB, IFRS)?

_ _

b) Which stakeholder capitalises investment (assets, liabilities)?

_ _

c) Possibilities and restrictions of off-balance capitalisation (HGB, IFRS)

_ _

d) Differences of funding types concerning capitalisation

_ _

e) Further requirements in projects, contracts or stakeholders

_ _

f) Expected effects on projects, ESCOs, financing parties from IFRS 16?

_ _

g) Importance of capitalisation on realisation of projects?

_ _

10) Further economic barriers on EE projects?

a) External Risks

_ _

b) Intervention not sufficiently profitable

_ _

c) Hidden Costs

_ _

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Interview Schedule

d) Investment (Transaction) Costs ☐

_ ⬚

e) Intervention-related Risks ☐

_ ⬚

f) Further / Other ☐

_ ⬚

QUESTIONS ON SELECTED CASES

	A	**B**	**C**	**D**	**E**
1) Branch of client (NACE-Code)	☐	☐	☐	☐	☐
2) Subject of project	☐	☐	☐	☐	☐
3) Status, start and run time of project	☐	☐	☐	☐	☐
4) Invest	☐	☐	☐	☐	☐
5) Stakeholder	☐	☐	☐	☐	☐
6) Funding of invest	☐	☐	☐	☐	☐
7) Capitalisation	☐	☐	☐	☐	☐
8) Expected effect from IFRS 16	☐	☐	☐	☐	☐
9) Pecularities / difficulties – if applicable	☐	☐	☐	☐	☐

MATTHIAS VOLKER **BERGMANN**

Interview Schedule

Interview questions – CUSTOMER

Economic barriers to energy services and energy efficiency improvement projects in German Industrial Sector – a multiple-case study

Date: _

Name: _

Interviewee and organisation

1) Branch of organisation (NACE), size, shareholders ☐

_ ⬚

2) Role / function of interviewee in organisation ☐

_ ⬚

3) Company affiliation ☐

_ ⬚

Energy efficiency and projects

4) Concrete project

a) Focus (production or infrastructure); status? ☐

_ ⬚

b) Motivation / trigger for project? ☐

_ ⬚

c) What are stakeholders in project? ☐

_ ⬚

d) Contracting? Why? What is it? ☐

_ ⬚

e) Experience: Model for further project? ☐

_ ⬚

MATTHIAS VOLKER **BERGMANN**

Interview Schedule

Commercial specifics

5) "Energy efficiency gap" (Jaffe & Stavins, 1994)

_ _

6) Were EE projects subordinate to other investments?

_ _

7) Invest

a) Investment decision: whose responsibility?

_ _

b) Crucial criteria for evaluation (e.g. pay off period)?

_ _

c) Prioritisation between infrastructure / production / product & marktet projects?

_ _

8) Financing

a) Invest of projects?

_ _

b) Funding type selected; run time; volume?

_ _

c) If applicable: Why no investment credit of house bank?

_ _

d) Validation concept – what type?

_ _

e) What influenced terms of funding?

_ _

f) Further requirements in projects, contracts and stakeholders? ☐

_ ☐

g) Conclusion / validation of funding type ☐

_ ☐

9) Capitalisation

a) Which accounting standards are relevant? ☐

_ ☐

b) Which stakeholder capitalises investment? Firm policy? ☐

_ ☐

c) If applicable: Requirements in contract design? ☐

_ ☐

d) Conclusion / validation of capitalisation ☐

_ ☐

11) Further economic barriers on EE projects?

a) External Risks ☐

_ ☐

b) Intervention not sufficiently profitable ☐

_ ☐

c) Hidden Costs ☐

_ ☐

d) Investment (Transaction) Costs ☐

_ ☐

MATTHIAS VOLKER **BERGMANN**

Interview Schedule

e) Intervention-related Risks ☐

_ ⬚

f) Further / Other ☐

_ ⬚

MATTHIAS VOLKER **BERGMANN**

Interview Schedule

Interview questions – THIRD PARTY FINANCING

Economic barriers to energy services and energy efficiency improvement projects in German Industrial Sector – a multiple-case study

Date: _____

Name: _____

Interviewee and organisation

1) Role / function of organisation ☐

_____ ☐

2) Does organisation hold a banking license? ☐

_____ ☐

3) Company affiliation ☐

_____ ☐

Energy efficiency and projects

4) What are energy efficiency projects? ☐

_____ ☐

a) Subjects of / examples for projects? ☐

_____ ☐

b) Invest (average) of projects? ☐

_____ ☐

5) Client specifics (branch, credit rating,...) ☐

_____ ☐

6) What are stakeholders in EE projects ☐

_____ ☐

MATTHIAS VOLKER **BERGMANN**

Interview Schedule

Barriers

7) "Energy efficiency gap" (Jaffe & Stavins, 1994)

_ _

8) Financing

a) Different types of financing; run time; volume; risiks?

_ _

b) Influence of refinancing party on projects decisions?

_ _

c) Preferred stakeholder for financing contract?

_ _

d) Validation concepts – differing with types of financing?

_ _

e) Regulatory requirements ("BaFin", "Leasingerlass" ...)?

_ _

f) What influences terms of financing?

_ _

g) Barriers on potential project financing?

_ _

9) Capitalisation

a) Differences on financing types in combination with accounting standards

_ _

b) Possibilities and restrictions of off-balance capitalisation (HGB, IFRS)

_ _

c) Requirements in contract design ☐

_ ⋯

d) Expected effects on projects, ESCOs, financing parties from amendment of IFRS 16 ☐

_ ⋯

12) Further economic barriers on EE projects?

a) External Risks ☐

_ ⋯

b) Intervention not sufficiently profitable ☐

_ ⋯

c) Hidden Costs ☐

_ ⋯

d) Investment (Transaction) Costs ☐

_ ⋯

e) Intervention-related Risks ☐

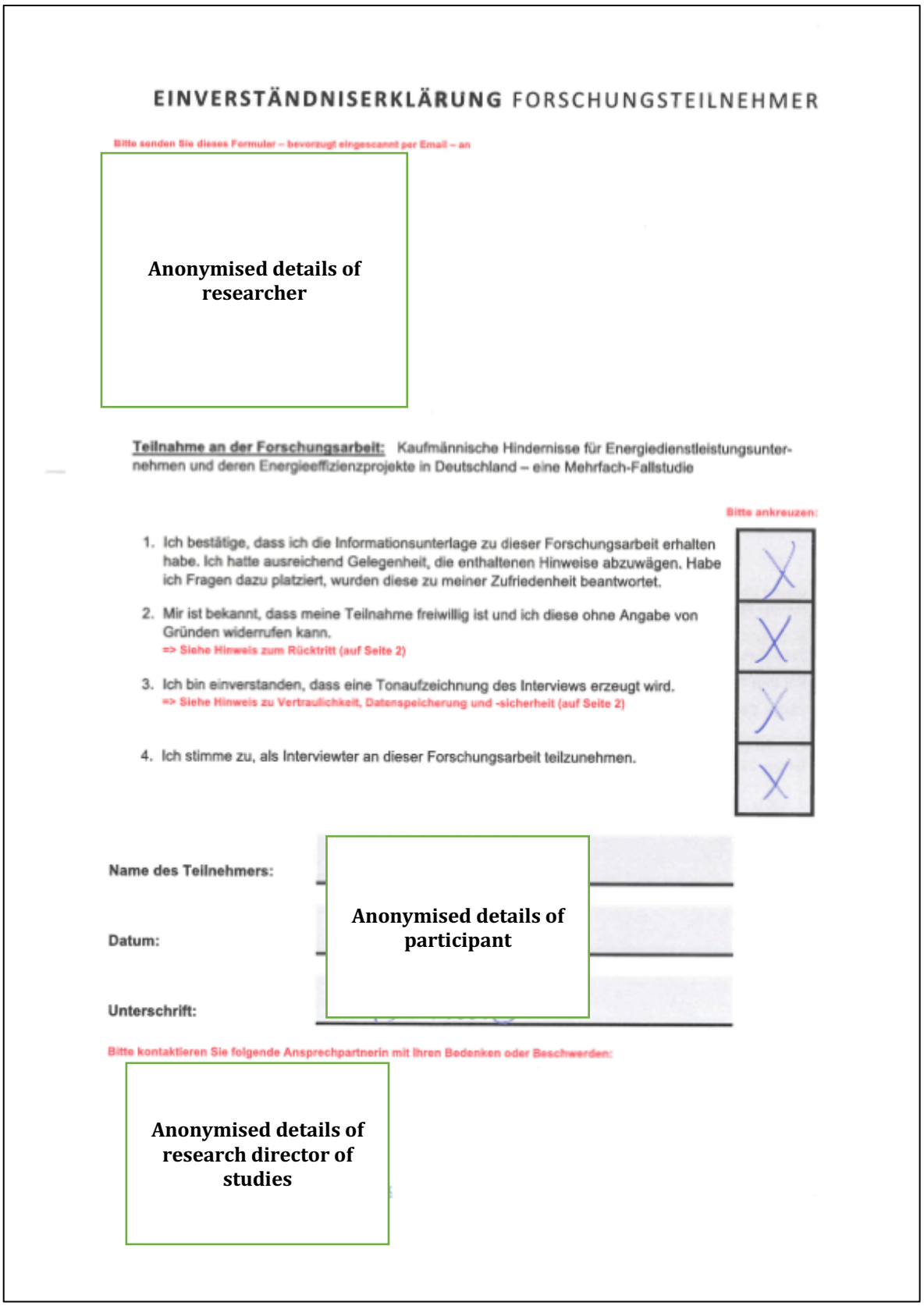
_ ⋯

f) Further / Other ☐

_ ⋯

C Consent Form

The image below shows a scan of a consent form in German language, completed by a participant. Personal details of the researcher, participant and research advisor have been anonymised.



EINVERSTÄNDNISERKLÄRUNG FORSCHUNGSTEILNEHMER

Bitte senden Sie dieses Formular – bevorzugt eingescannt per Email – an

Anonymised details of researcher

Teilnahme an der Forschungsarbeit: Kaufmännische Hindernisse für Energiedienstleistungsunternehmen und deren Energieeffizienzprojekte in Deutschland – eine Mehrfach-Fallstudie

Bitte ankreuzen:

1. Ich bestätige, dass ich die Informationsunterlage zu dieser Forschungsarbeit erhalten habe. Ich hatte ausreichend Gelegenheit, die enthaltenen Hinweise abzuwägen. Habe ich Fragen dazu platziert, wurden diese zu meiner Zufriedenheit beantwortet. X
2. Mir ist bekannt, dass meine Teilnahme freiwillig ist und ich diese ohne Angabe von Gründen widerrufen kann. X
   => Siehe Hinweis zum Rücktritt (auf Seite 2)
3. Ich bin einverstanden, dass eine Tonaufzeichnung des Interviews erzeugt wird. X
   => Siehe Hinweis zu Vertraulichkeit, Datenspeicherung und -sicherheit (auf Seite 2)
4. Ich stimme zu, als Interviewter an dieser Forschungsarbeit teilzunehmen. X

Name des Teilnehmers:

Datum:

Unterschrift:

Anonymised details of participant

Bitte kontaktieren Sie folgende Ansprechpartnerin mit Ihren Bedenken oder Beschwerden:

Anonymised details of research director of studies