1. Current tendencies regarding sustainable energy strategies and knowledge intensive business services

1.1. Conceptual framework of today's innovative business practices

1. 1. 1. Defining elements of the concept of innovative business practices

Innovative business practices are defined more and more by Corporate Social Responsibility (CSR), efficiency and innovations. If in addition they need to be sustainable also, they take many stakeholder interests in account too. Those include economical, but also ecologic and social interest. In that context, Brocken at al. (2014) introduced archetypes for sustainable business models in order to describe their mechanisms and solutions (Figure 2). That they placed the maximisation of material and energy efficiency into the technological group is been seen critical by the author. Efficiency in these areas is not just technology related but also depending strongly on the individual's behaviour. A similar argument can be debated for the grouping of other archetypes also.

groupings							
technological			organisational		social		
related archetypes							
maximise material and energy efficiency	create value from waste	substitute with renewables and natural processes	repurpose for society/ environment	develop scale up solutions	deliver functionality rather than ownership	adopt a stewardship role	encourage sufficiency

Figure 2: Sustainable business model archetypes
Source: Brocken et al. (2014)

The innovation of business practices is going along also with change. With the energy transition being a process coming along with massive change potential for concerned parties, enterprises need to change their processes, strategies and structures, need to develop new business models (Abrell, 2012). These changes are required in order to achieve improvements in such systems; on the other hand, change mostly requires a paradigm shift (Kolbusa, 2013), (Kreutzer, 2014).

G. Weber, *Sustainability and Energy Management*, Sustainable Management, Wertschöpfung und Effizienz, https://doi.org/10.1007/978-3-658-20222-4_2

Changes, such as the energy transition are understood by many organisations as opportunity, by others as crisis. As such risk management is a helpful tool in order to shift risk into opportunities (Kronenberg et al., 2010) or as Kres (2015) says: "organisations, able to build a bridge out of know-how and creativity towards innovation and new perspectives will always be able to be sustainably productive". In the context of changes in the energy economics, sustainability is an important factor and motivator. In absence of one generally recommended innovation measurement tool (Eggink, 2012), change management is in this context a suited tool to accompany the change process ensuring that the system modifications are sustainable and make sense for a long time. Schinnenburg and Schambeck (2015) and (Lozano, 2015) differentiate the kinds of change by their external visibility and the degree of the change. Change caused by shifting towards a corporate CSR strategy represents here a high level of change at a minimal external visibility potential (Figure 3).

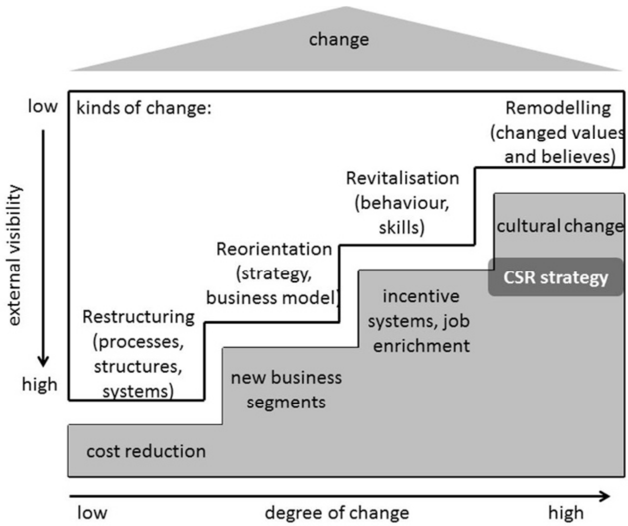

Figure 3: Kinds and motivators for change
Source: by author based on Schinnenburg and Schambeck (2015)

a) Change and innovation

The change management and innovation management processes are directly linked to each other (Figure 4). Whereas innovation management is focused on the elements know-how, the innovation itself (hence the product), the customer value as well the success in the market (change management) focuses on the organisation (its internal complexity) and its business strategy (influenced by external complexity) (see also Werther and Jacobs, 2014).

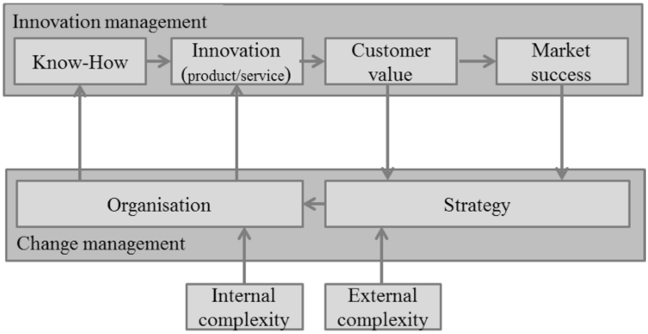

Figure 4: Correlation of innovation management and change management
Source: by author based on Freund (2013)

Changes in organizations are complex (Ehrenmann, 2015). In literature several definitions and explanations can be found. There are several different kinds of change and its interpretation distinguished as visualized in Figure 5, changes related to the energy transition are highlighted (italics).

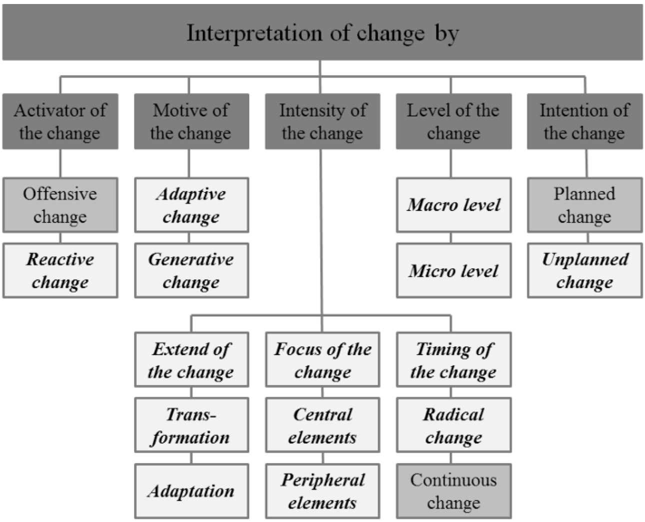

Figure 5: Interpretation of change in energy economics
Changes in energy economics during the German energy transition in italics
Source: by author, based on Pescher (2010)

Looking at its activators, change driven by law, such as change in the energy economics, cause reactive change and the organisation acts as a consequence of external factors (Pescher, 2010). Driven by its motive, adaptive changes are the consequence of an organisation reacting to external environmental factors (Figure 6), which also are related to energy economics. Innovations are good examples for generative changes which are initiated by the organisation and impact the environment.

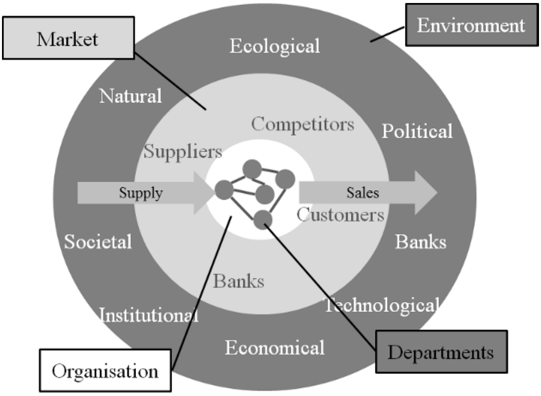

Figure 6: Categories of the organisations surrounding
Source: by author based on Lauer (2014)

In case of adaptive changes only several areas of the organisation are affected, whereas transformations touch the organisation completely. In the case of energy economics adaptive changes as well as transformations can occur.

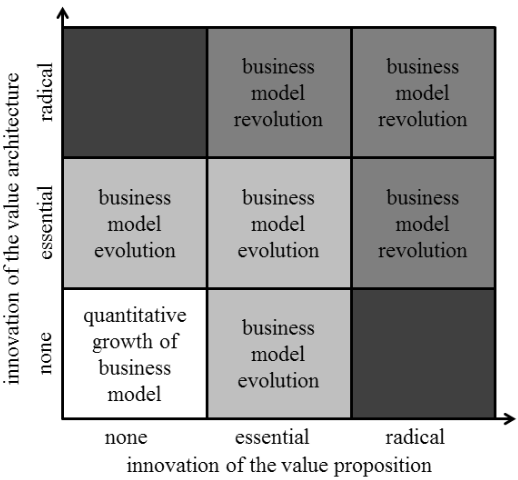

Figure 7: Development approach of the innovation of business models
Source: Steinhauer (2015)

In terms of timing (starting point), the energy transition in Germany resulted in a radical rather than a continuous change. However, the impacts of the changes definitively are on the long-term. As such, these changes in the first place were unplannable and concerned micro (team related) as well as macro (organisation and its environment) levels of the organisations.

In the context of business models, Steinhauer (2015) distinguishes several approaches depending on the innovation levels of the value proposition and the value architecture. In the case of no innovation only quantitative growth can be experienced. The more the innovation levels increase, the evolutionary and the radical business model can be found.

b) Change in times of crisis

Change management serves in order to design an optimal process to successfully get from the starting point to the targeted endpoint (Lauer, 2014; Werther and Jacobs, 2014). Traditionally change management is used proactively in order to steer planned organisational changes, such as mergers and acquisitions; on the other hand change management is used as a reaction to crisis-like events and aspects, such as the energy transition. During crisis-like events, organisations usually pass through three phases (Figure 8).

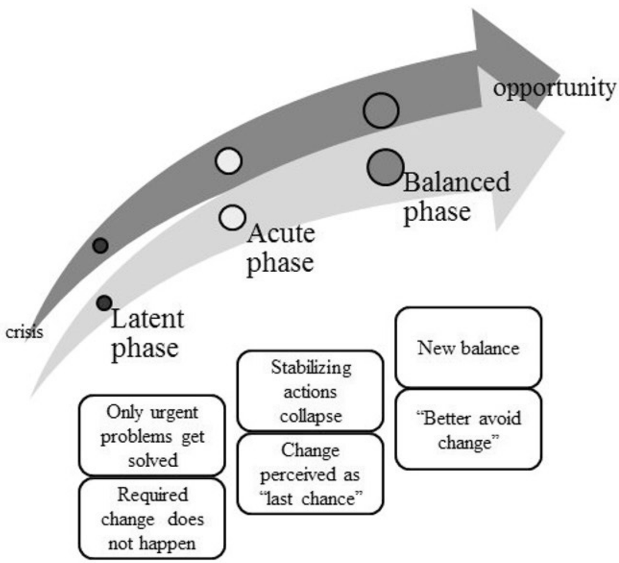

Figure 8: The role of change during the phases of crises
Source: by author based on Lauer (2014)

The first phase is focusing on solving urgent problems. In the second phase stabilising action collapse and change is being perceived as "the last chance". The third phase is characterized by a new balanced position in which change better is avoided. Over time the crises hereby develops to be an opportunity.

People tend to do things as they are used to do them for long; changing habits is associated with inconvenience, pain, additional effort and/or antipathy. For a successful migration towards new, effective procedures, change management is an effective process for organisations allowing lateral thinking (Spindler, 2011; Weber et al., 2014a; Werther and Jacobs, 2014).

Literature does not provide one uniform definition of change management (Namokel and Rösner, 2010; Pescher, 2010). Gerth (2013) as well as Doppler and Lauterburg (1997) describe some principles of change management with target-oriented management being the most important element of the change management process. The change management process follows certain steps being (Figure 9):

- Idea creation or reason for the change
- Definition of the new objectives
- RASI (responsibility-approval-support-information) definition
- Process planning
- Process control

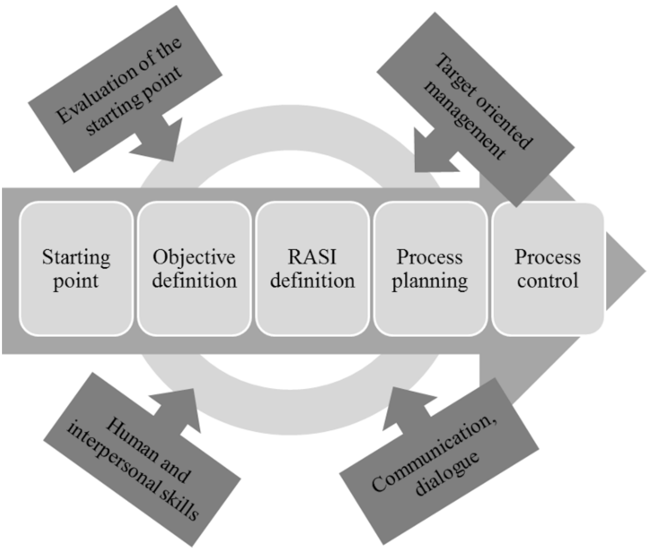

Figure 9: Elements and steps of the change management process
Source: by author based on literature referenced in text and author's own experience

Several management processes are involved in the change management process and need to be applied to it (Figure 10). As change is not a smooth process, conflict management and networking skills are as important as team spirit (Studt, 2013; Rosenstiel et al., 2012; Zehrer and Mössenlechner, 2010).

In the context of changes in energy economics systems in particular external factors such as energy cost, politics, competitors and others are important to be considered (Matuszek, 2013; Petersen, 2011).

With that, the change management process basically follows the PDCA (plan-do check-act)-process (Figure 33 in this chapter), which is the key element in energy management systems according to ISO 50001industry norm (Weber et al., 2014a).

Another set of process elements is the evaluation of the starting point (based on proper data) (Wilfing, 2013), holistic thinking, and consideration of structural, technical as well as economic and ecological aspects. Human and interpersonal aspects complete the element set of the change management process (Lauer, 2014; Weber et al., 2014a). Needless to say that all concerned persons and parties need to be involved in the process and to communicate via dialogue, allowing and ensuring a process-oriented controlling during the execution phase of the initiative (Brauner at al., 2012; Deutinger, 2013; Stolzenberg and Heberle, 2013).

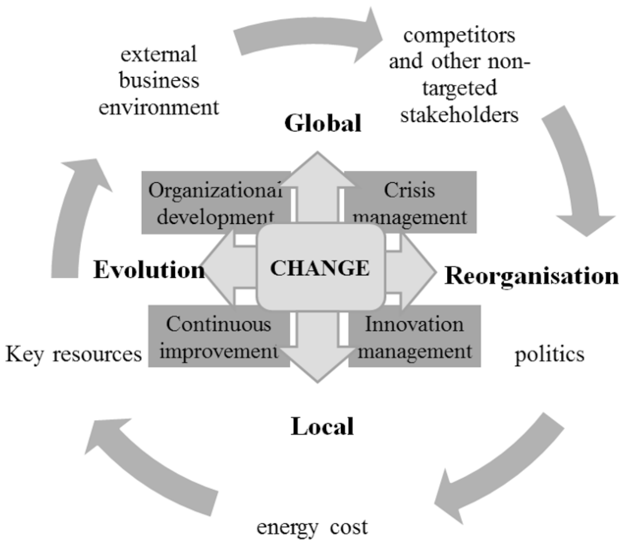

Figure 10: Change management processes and selected surroundings
Source: by author based on his research, ref. to Weber at al. (2014a)

At the end, people are the drivers of the change process. Therefore it is important to select people with social and professional competencies. This is especially important in changes driven by external factors which cannot be influenced from within the organisation. An example is the changes in the energy economics driven by governments (Weber et al., 2014a).

The change management process is a widely used tool to commercialize “green products” by accessing new segments. Thereby new so far unattended customers can be attracted, the economics of value creation for the enterprise can be improved and its network in the context of energy economics expanded (Freund, 2013; Mescheder and Sallach, 2012; Sommer, 2012; Weber et al., 2014a). In the context of the energy transition, organisations are confronted with change process driven by external energy economics. The trend-shift from conventional towards renewable energy sources forces conventional energy suppliers towards a strategic change. This strategic change process builds up on the previously mentioned three step crisis change process and is characterised by the five phase initialisation, conceptualisation, mobilisation, execution, and consolidation and have individual objectives (Figure 11).

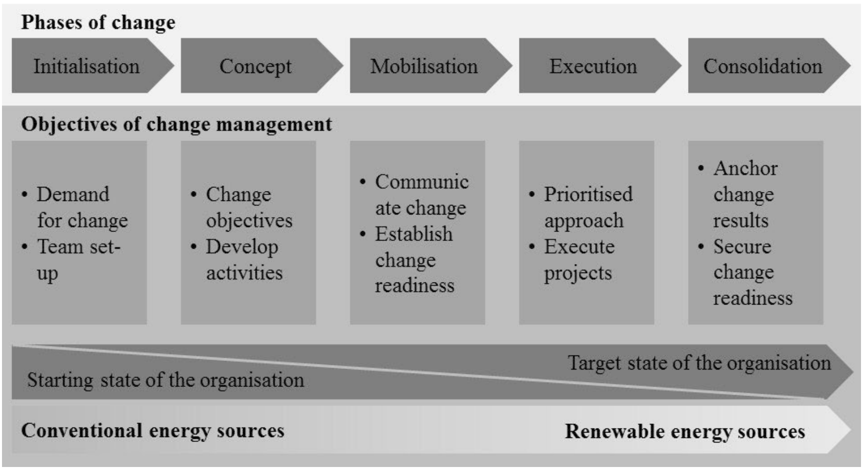

Figure 11: Strategic change management process during changing energy economics
Source: by author based on Krüger (2014)

c) The change management team

Change is not coming for free. As mentioned earlier, change is perceived as “pain”, paradigm shift, leaving the comfort zone, etc. (Zimmermann, 2015). Not only in conservative organisations change requires substantial effort in order to overcome internal resistance and convince the employees on its necessity. Resistance needs to be "changed" into willingness and support. Also change requires an enormous effort for its strategic management. In order to do so it requires leadership, the employees and a project management process (Krüger, 2014). For managing all the related tasks during the change process, Noe (2014) proposes a defined structure of a change team (Figure 12). The steering committee hereby consists of members delegated by the top management. Its objective is to guide the project management team, make necessary decisions throughout the process and be the link to the top management. The project manager is leading the core task force with members from concerned departments and is the connection to the steering committee. In addition, the project team has access to additional support by quality management, controlling, human resources (HR) and the work council. External consultants are accompanying the process, supporting the steering committee and the project management team. In addition process teams can support the core team with specific knowledge of processes, products and/or services. In order to operational, the team needs tools, data, instruments and resources. Key Performance Indicators (KPIs) for instance (refer also to chapter 1.1.3) will be developed in order to compare different proposals. In order to assure effectiveness and success, it is important not to rush through this process but reserve enough time for a good result.

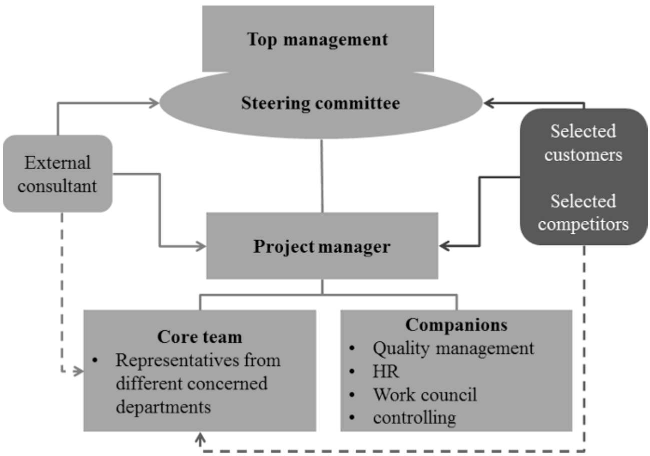

Figure 12: Team structure – change project
Source: by author based on his research and business experience, referring to Noe (2014)

Based on extensive experience of the author in change processes and structures in the automotive sector, Noes (2014) process chart can be confirmed to be used in practice. However in order to be suitable for a wider pool of projects, it was extended by the author adding the groups of "selected customers" and "selected competitors”. Especially in view of the previously discussed innovation processes and in the context of KIBS it can be quiet wise and reasonable to invite and consult customers and competitors on a case by case basis throughout the process or for certain steps. Long lasting experience has shown that “independent views” can be very helpful avoiding silo mentality. One could say that consultants do the same job here. However, these groups can bring practical market views; a consultant (being not as deep in the core business of the organisation) usually is coming from the theoretical perspective. Needless to say, that a high level of trust and cooperation is required here. Also it needs to be evaluated carefully, which level of confidentiality shall be selected. Throughout the process it is up most important to involve and motivate the people and employees; it is important to “take them along” (Zink, 2015).

d) Successful and effective change

The success of change processes strongly depends on whether the organisation does things right. The critical success factors hereby are the smallest group of activities, the organisation needs to successfully handle in order to have success (Noe, 2014; Petersen and Witschi, 2015). This group consist of

- vision,
- mission,
- objectives,
- strategy,
- value chain analysis, and
- tools.

The vision is a clear view of the organisations future. It contains for instance information on the target customer, target market, differentiation versus competition, positioning, quality requirements (i.e. “best in class”), potential business partners, etc. The vision needs to allow the employees to identify themselves with the organisation; it needs to be something special. Questions like “who are we”, “what do we want”, “where are we today and where do we want to go” need to be answered (Noe, 2014).

The mission serves to identify the available potentials for innovation in the organisation. The identification of the strengths and weaknesses of this potential needs to be evaluated throughout the departments (product, production, research & development (R&D), HR, finance, etc.). It also helps to expand the ability of the organisation to learn and to analyse the competition (Noe, 2014).

I terms of objectives, strategic (medium-/long-term) and operational (short-/medium term) targets need to be defined. Objectives need to be measurable and their achievements to be controlled.

The strategy reflects the realisation of vison, mission and objectives into a structure and framework which is able to manage the processes productively.

As the next step, the status quo of the value chain needs to be determined and analysed for potential improvements. Figure 13 shows the value chain process at the example of an innovative energy service, for example in case of a new to market tool to measure and monitor energy consumption, assigning the consumption to each consumer and monitor the development over time, all by one single device at minimal installation effort.

Finally, the right mix of tools needs to be selected in order to achieve the defined objectives. For instance performance measuring, performance improvements as well as benchmarking are options which can be practiced here.

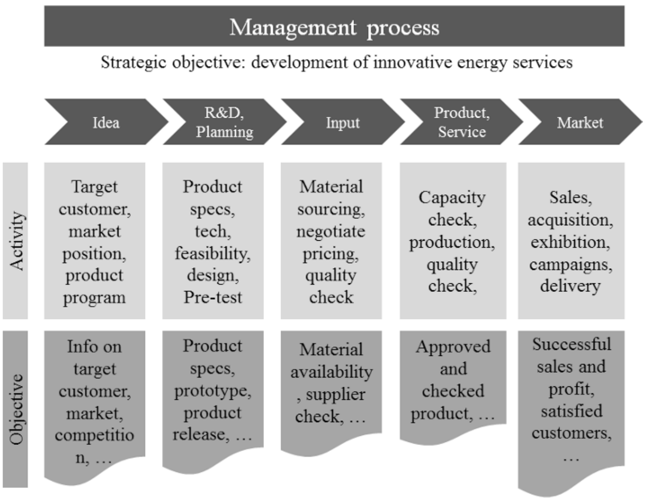

Figure 13: Value chain exemplary on energy services, simplified
Source: by author based on his research and business experience

Successful change relies on an effective change process. As described earlier, this process can be supported by external consultants. However, there is a huge pool of consultants offering their services in the market which makes it difficult for the organisation to identify the "best match". Firstly the consultant needs to be able to proof a defined profile suiting a set of requirements and experience needed to do the job. Mostly, these requirements are not fully known yet at the beginning of the project, making the search for qualified consultants challenging. In addition the consultant needs to meet a set of social as well as methodological competencies, which could be proven on the basis of reference projects. Finally and importantly, there is a cost frame which should be met in order to stick within the approved project budget. The cost factor hereby is a very critical element for small organisations. In addition, there are a few more factors which need to be considered, such as

- time-frame: the consultants need to provide a realistic time frame for the project – which is very difficult to judge. In order to be able to effectively benchmark different offers, a tender process shall to be used during the selection process, ensuring a comparable set of data.
- Own resources: does the organisation have own resources to support the project and does the consultants methodology allow to involve those right from the beginning
- For more ambitious and demanding projects, it might be helpful to involve a team of several (independent) consultants in order to cover all skill levels required in the project.

Besides external consultants, there are several additional factors for success described in literature (Kotter, 1996; Deutinger, 2013; Kreutzer, 2014; Gerth, 2013; Doppler and Lauterburg, 1997; Lauer, 2014; Pescher, 2010; Gerkhardt and Frey, 2006; Noe, 2014; Brauner et al., 2012; ***capgemini consulting, 2015). A selection of those is summarized below.

- Create a sense of urgency
- Establish a coalition in the management team
- Develop vision and strategy
- Enable and empower the employees to participate, contribute and execute
- Push change without losing patience and endurance
- No activity without diagnosis
- Objective focused management
- Communicate actively (dialogue no monologue)
- Select the key persons carefully
- Use a holistic approach, think “out of the box”
- Effective time management
- Process monitoring and controlling
- Create a sense of communality, team spirit, “a crew that wants to win”

Finally change is part of every day’s life. Change can be perceived positively (new opportunity, new exciting project, new phase of life, etc.) as well as negatively (pain, paradigm shift, leaving the comfort zone, “don’t change a running system”, etc.). In the context of the researched changes in energy economics, there is no option for a choice – organisations need to change in order to avoid collapsing. On the other hand, this collapse will come anyway, also without the change – driven by climate change, rising temperatures, effects of green-house- gas emissions, most recently (unfortunately) coming to every one's mind via the refugee crisis. Changes need to be effectively addressed and ideally perceived as opportunities. Also in the context of energy economics and energy efficiency measures, change needs to follow a structured process. As each change is specific, also the change process needs to be customized. There are several tools and process proposals available which can be tailored to the single change project. Energy management offers the PDCA-process (plan-do-check-act) as part of the ISO EN DIN 50001 industry norm which can be found as part of other change management tools mentioned earlier.

Supporting innovative business practices, the change processes is a crucial tool which can be successfully and effectively been managed by considering the success factors concluded previously.

1. 1. 2. Considerations of sustainable energy in today's business concepts

Sustainable energy, defined through renewable energies and energy efficiency, must be a vital part of any energy strategy and contains a huge savings potential; it needs to even be part of any sustainability strategy (Bauernhansl, 2014; Abdallah et al., 2015). "The importance of energy efficiency to attain overall sustainable economic development cannot be relegated to the background. … It is believed that sustainable development with sufficient energy supply can be achieved only if the goal of economic growth and efficiency in energy consumption is balanced. This is because failure to address energy efficiency may lead to a further deterioration of the environment, the impairment of public health, the resource degradation and energy insecurity, which in the long run could lead to slow or declining economic growth." (Apergis et al., 2015)

The options to handle the energy consumption more efficiently are manifold: building envelope, compressed air, lighting, process heat, transport, electric motors, HVAC, etc. Often savings can be achieved already by small measures without investment necessary. But also the use of renewable energies helps to achieve higher energy efficiency, simply through decentralized production ("produce where you need it"-principle) (Wänn et al., 2014), losses of electricity for example over long distances can be avoided (Günther, 2015; Ferreira et al., 2015) and also fossil power stations offer a tremendous potential for energy saving (Palanichamy et al., 2015; Saunders, 2015). As the identification process of energy efficiency potentials required specific knowledge, expert advice is highly recommended. Measures for energy efficiency are mostly requiring investment, which on one hand needs to be funded by the executing organisation, on the other hand is supporting the supplying industries and the bank sector (Bauernhansl, 2014). The capital cost can be absorbed or through a higher product price handed over to the customer (left section of Figure 14). In case other investments are being replaced by energy efficiency investments macroeconomic effects follow through the increase of the overall budget, a process being called crowding-out. Which of those options are preferred by the enterprises in Germany and Romania will be analysed and answered in chapter 5.

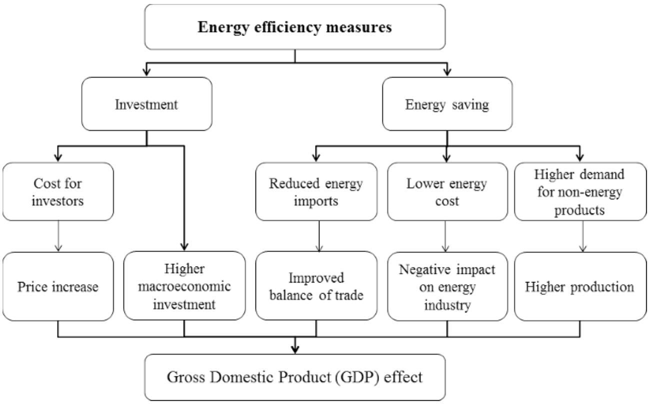

Figure 14: Macroeconomic effects of energy efficiency measures to the industry
Source: *** ewi et al. (2014)

On the other hand (right section of Figure 14), efficiency measures will be leading towards lower energy cost, which on the long-term will be paying out for the capital cost for the investments ending up in an improved balance of trade, a higher production or a negative effect on the energy economics. Consequently energy efficiency measures influence the gross domestic product through its macroeconomic process.

However, there are much more elements affecting the Gross Domestic Product (GDP), considering reduction of environmental impacts, social cost and other benefits of energy efficiency making the structure much more complex, as visualized in Figure 15. These effects can be expanded even more by adding for example the effects of energy audits and energy management systems which make the chart more and more complex by adding correlations into quality and environment management systems. In addition further benefits such as competitive advantages, product and production quality, image effects, increase of employee loyalty and wellbeing, increased profitability, environmental compliance, and many more can be added here. Usually many of those benefits are not being included in the business case calculations and feasibility studies of energy efficiency measures, even they help reducing the return of investment indirectly.

So far the wider impacts of energy efficiency have not been evaluated; the energy commission of the European Union however is in process of developing Europe wide standards for comparing energy efficiency with a first step being done with the EU energy efficiency directive 2012/27/EU dated October 2012 (***EU, 2012), which was transferred into national laws by the end of 2015 (Figure 16).

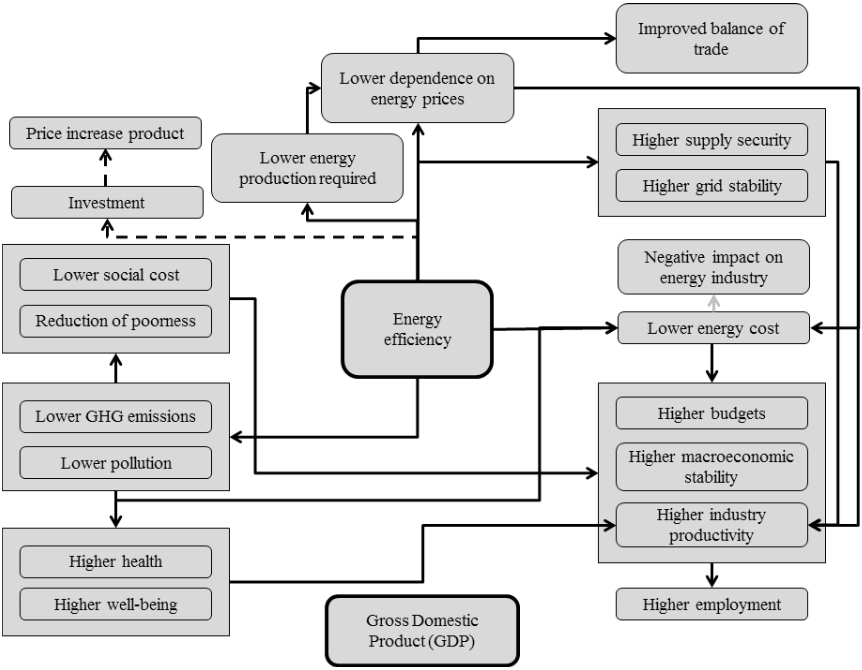

Figure 15: General effects of energy efficiency
Arrows: benefits with solid arrows, disadvantages with dotted arrows
Source: by author

By the directive each of the member states is requested to develop concrete steps in implementing energy efficiency measures. According to §7 the objective is that every member state reduces its energy consumption between 2014 and 2020 by 1.5%.

The implementation status of the European Energy Efficiency Directive varies between the member states. The process of standardization however is not finalized yet, as every member state defines its national standards and procedures differently. Therefore harmonized uniform regulations are urgently required for the European Union (EU) in order to effectively and successfully achieve the climate protection targets.

European Legal Framework	**Directive 2006/32/EC** Energy end-use efficiency and energy services	**Directive 2009/125/EC** European eco-design	**EU ETS** European Union Emission Trading Scheme	**EPBD** Energy Performance of Buildings Directive	**EnEff** Energy Efficiency Directive
National Instruments Germany	**EDL-G** Energy Services and other Energy efficient Measures Law	**EVPG** Energy related products law	**TEHG** Green House Gases Law	**EnEV** Energy Saving Ordinance	**NAPE** National Energy Efficiency Plan

Figure 16: Energy efficiency: legal framework in the European Union and Germany
Source: Wiehl (2014)

This drives a complexity which hardly can be managed by enterprises being operating internationally. Whereas most countries have established the directive, a few are in processing and three still having a long journey in front (Figure 17). In addition, the directive is also differently interpreted and executed (***tenag, 2015). Slovenia for instance defines Small and Medium sized Enterprises (SMEs) differently from the EU putting Slovenian enterprises in a disadvantage compared to the rest of EU. Whereas German and British enterprises need to assign 90% of their energy consumption to their energy consumers, in France this level is at 65% (80% planned for the 2nd audit round) and in the Czech Republic at 100%. In addition the qualification requirements for energy auditors also vary from one EU member state to another (***Beuth, 2014).

Belgium	Finland	Croatia	Austria	Sweden	Slovakia
Bulgaria	France	Lithuania	Netherlands	Hungary	United Kingdom
Denmark	Greece	Latvia	Poland	Cyprus	Slovenia
Germany	Ireland	Luxemburg	Spain	Estonia	Portugal
Italy	Malta	Romania	Czech Republic		
	Level of implementation:		fully	partly	none

Figure 17: Energy Efficiency Directive – status of its implementation in Europe (mid 2015)
Source: Lisson (2015)

The European Environment Agency (EEA) monitored the progress of energy efficiency efforts in Europe by industry sectors showing, that some branches, such as

Chemistry show a tremendous effort in energy efficiency whereas others such as the paper industry were basically stalling during the last years, others, such as the cement industry got worse (Figure 18). Once interpreting this data, it is important to know the base line of the measured energy efficiency. In other words, the shown industries had different levels of implemented and executed energy efficiency strategies, some cared others did not. Obviously realising additional energy efficiency improvements is hard once many energy efficiency measures were implemented already. Once an industry did not care so far and has a bad efficiency profile, it's easier to improve. On the other hand, it is important to understand, that some industries have energy intensive processes requiring a minimum level of energy (i.e. cement industry); for those a further reduction below minimum is almost not possible. Thirdly, the graphs also do not explain the economic development between specific sectors – hence, in times with a high level of utilized production capacity also the energy consumption goes naturally up. Consequently such graphs are to be interpreted carefully. On the other hand it is a major effort to consider all the mentioned aspects in the data structure for such analyses, which might have been one reason for the European Environmental Agency (EEA) to stopping updating those charts.

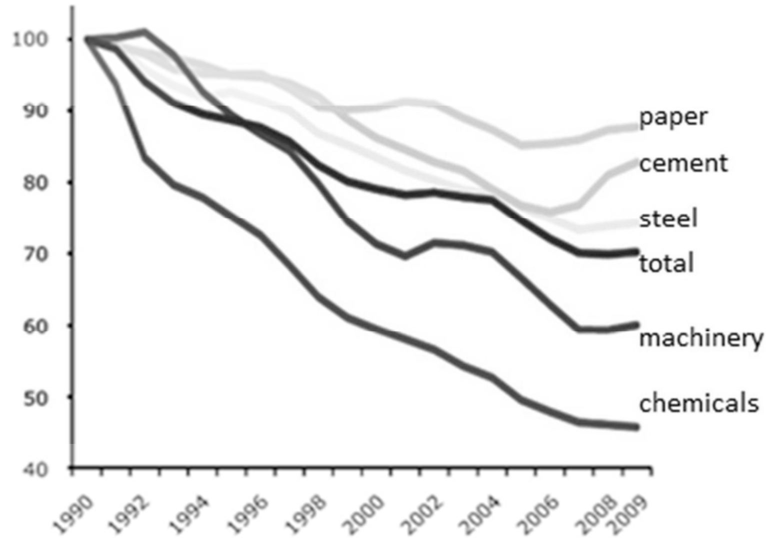

Figure 18: Energy efficiency index in the European Union (EU27)
Source: *** EEA (2012)

Figure 19 illustrates the development and progress being made in Europe in terms of reduction of CO_2-emissions. Comparing the CO_2-emissions from 1990 and

2009, Germany for instance shows here the biggest reduction in direct CO_2-emissons; including the indirect CO_2-emssions however, there is no change. In general this chart shows an improvement in the level of overall EU CO_2-emissions however.

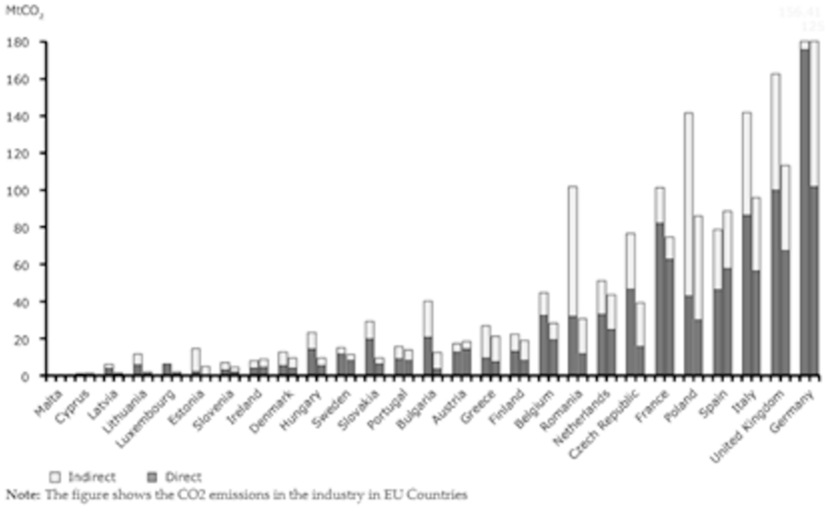

Figure 19: CO_2-emissions in EU-countries 1990 and 2009
Source: *** EEA (2012)

In Germany for instance the installations produced much more emissions compared to other EU countries, hence the potential for reducing the energy consumption through increasing energy efficiency measures seems to be higher than in the remaining countries as shown in Figure 20.

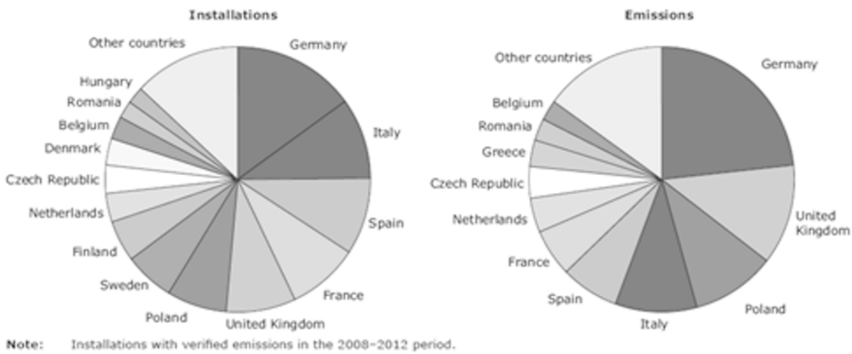

Figure 20: Installations and emissions in EU-countries 2008-2012
Source: *** EEA (2013)

Through a study, the Netherlands Environmental Assessment Agency (Berk et al., 2006) researched several impacts of technological options on various policy objectives. One selected policy objective was the competitiveness, being represented through the two factors EU-innovation and cost.

From an EU-innovation stand-point, most of the effects were rated neutral trending positively, with all items with highest cost and investment requirements being rated positively in terms of innovation (hydrogen, advanced cars, emission control and photovoltaic energy) (Weber et al., 2014). Hereby the technological alternatives were grouped in the clusters carbon capture and storage, efficiency, energy production (nuclear, renewable and fossil) and others (public transport, emission controls, etc.) (Weber et al., 2014). Cost wise, the effects mainly were rated insignificant with a trend to negative.

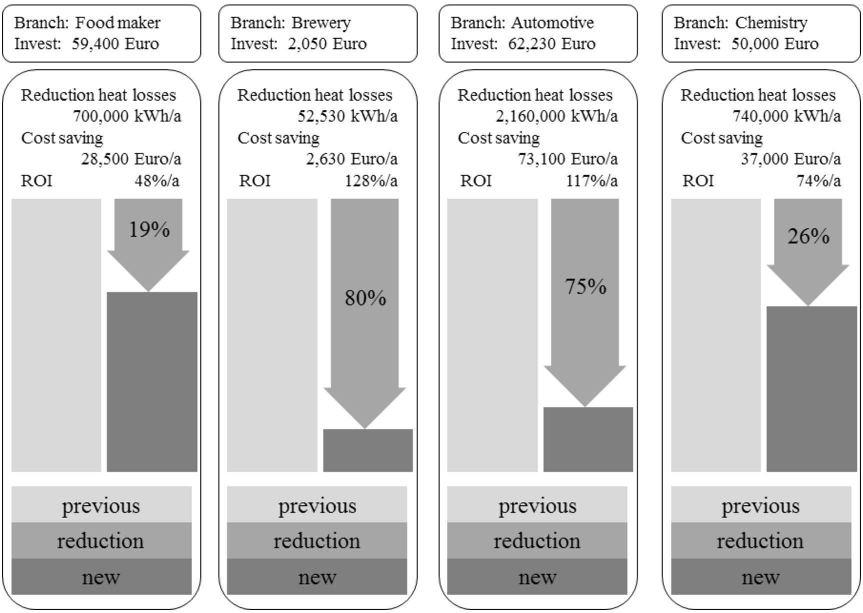

Figure 21: Energy savings through reduction of heat losses, selected examples from Germany
Source: *** dena (2013)

Even being already eight years old, the results of this study are still accurate today. Negatively impacting the competiveness of an economy in the short-term, financial R&D efforts into efficiency measures and innovative energy production are perceived positively in the long-term however, as this invest is going to return through lower cost levels and competitive advantage (Berk, et al., 2006). Energy efficiency measures are an important element reacting to the negative effects of energy price increases. On the other hand, R&D is an important activity in order to keep the level of innovation high (Bureau, et al., 2013; Berk, et al., 2006). As a result a high level of competitiveness and potential market leadership in a key technology will strengthen the organisations stand in a very competitive environment (Weber et al., 2014).

As mentioned earlier, the “Energiewende” (energy transition) is a major project in Germany and energy efficiency is a vital element of it. Energy efficiency thereby offers a substantial chance to organisations to reduce their energy cost on the long-term. At the same time, it institutes business chances for enterprises in the development and highly qualified service sector for new energy efficiency technologies and consulting activities (KIBS). Examples from the Germany industry confirm the sometimes unbelievable savings potentials, four of which are exemplarily illustrated here representing different industry sectors (Figure 21).

As illustrated in Figure 22 the market sectors with the highest energy consumption levels are transport, industry and households; this research will hereby be focusing on the industry sector.

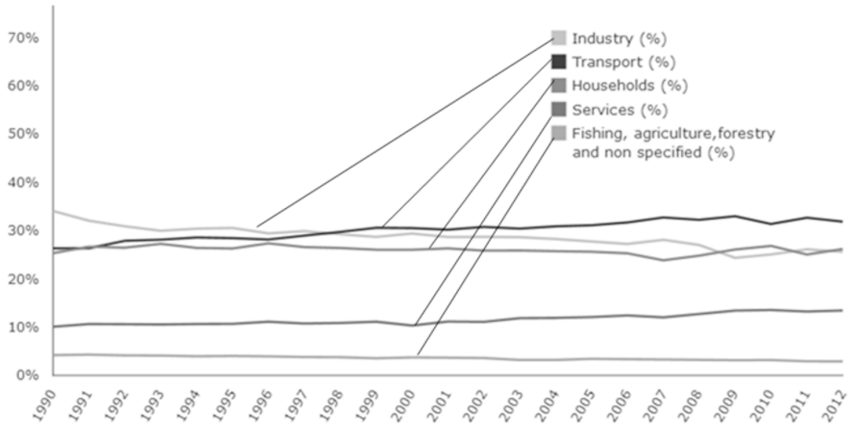

Figure 22: Sector shares of final energy consumption in Europe
Source: *** EEA (2015)

The European Energy Efficiency Directive

The energy efficiency in the industry is being addressed by the European Union through several steps towards the implementation of the EU energy efficiency directive 2012/27/EU dated October 2012 (Figure 23), requiring all member states to transfer energy efficiency into national law (Blesl and Kessler, 2013; Rohde et al., 2015).

Policy	Action	Year
Energy and energy-using products		
Eco-Design Directive (2009/125/EC)	Recast of the Eco-Design Directive 2005/32/EC to extend the scope to other energy-using products	2009
Labelling Directive 2010/30/EU	Recast of the Council Directive 92/75/EEC to extent the scope and align it with the scope of the recast Eco-Design Directive	2010
Directive 2010/31/EU on energy performance of buildings	Recast of the Buildings Directive 2002/91/EC to expand the scope to cover a much larger share of the building stock, to set harmonised MEPS requirements and initiate the development of an EU strategy for low energy buildings	2010
Industrial Emissions Directive 2010/75/EU	The Directive replaces the Integrated pollution prevention and control (IPPC) Directive and several sectoral directives as of 7 January 2014. It creates incentives for the application of best available techniques (BAT) in energy generation.	2010
Energy Efficiency Action Plan 2011	• Leadership role of the public sector to promote energy efficiency • Low energy buildings • Measures in energy generation and energy consumption in industry • Adequate financial support • Energy saving measures for consumers	2011
Energy Efficiency Directive (EED) 2012/27/EU	Repeals Directives 2004/8/EC on Cogeneration and Directive 2006/32/EC on end-use energy efficiency and energy services. Main provisions include: • A requirement for the Member States to establish a long-term strategy for residential and commercial buildings stock; • A requirement for Member States to set up energy efficiency obligation schemes for energy distributors or suppliers, or alternative measures, e.g. a carbon tax, financing schemes, regulations or voluntary agreements; • A requirement to introduce smart metering where proven feasible and financially cost-effective; • A requirement to base energy billing on real consumption and provide complementary information on historical energy consumption; • A requirement to identify the potential for the application of high-efficiency cogeneration as well as for district heating and cooling; • A requirement for Member States to ensure that national energy regulators encourage demand response programmes, and that network tariffs take into account the costs and benefits of energy efficiency measures.	2012

Figure 23: Evolution of the EU policy framework relevant to energy from 2009-2013
Source: *** EEA (2013)

Each national objective is being defined by the member state, resulting in a wide variance of defined targets (Müller et al., 2013). Whereas some countries cap the level of increase of energy consumption, others target the stabilization of their energy consumption. Figure 24 visualizes the final energy consumption in 2011 and the targets for 2020 by member state; the different ambitions can easily be identified.

The European Environmental Agency (EEA) analysed the results, the EU member states achieved so far through energy efficiency measures in 2013. As illustrated in Figure 26, the majority of countries shows some progress in reducing energy consumption, however require specific efforts in order to get back on track.

Several countries make only some progress and require much bigger efforts. Only four countries, namely Bulgaria, Denmark, France and Germany show well-balanced policy packages and make good progress in reducing the energy consumption.

In Germany the National Action Plan Energy Efficiency (NAPE) includes many measures targeting the final objective (***BMU, 2014b). However, according to a study from ***FÖS (2014) there is still a gap that requires attention in order to be addressed (***FÖS, 2014a).

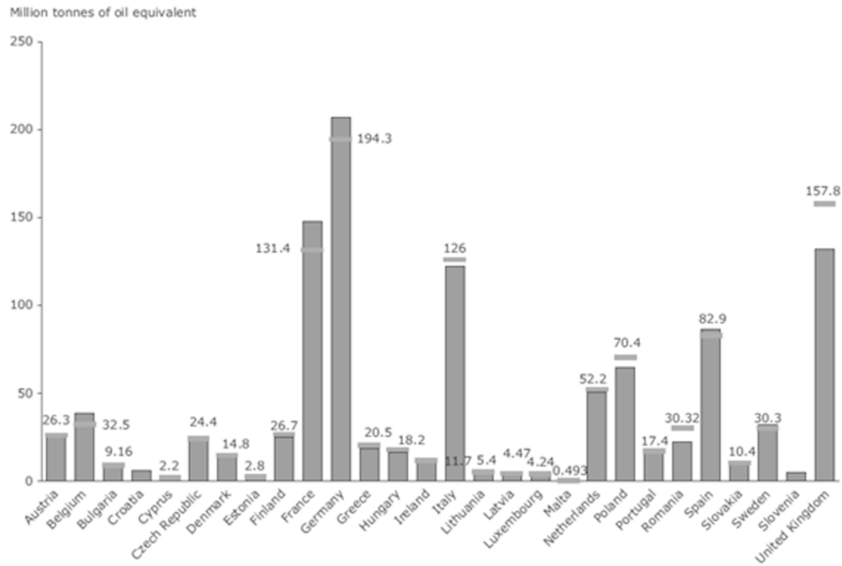

Figure 24: Final energy consumption in 2011 (bars) and the targets for 2020 (lines) by member state
Source: *** EEA (2013)

These gaps were confirmed one year later by the German Initiative of Enterprises for Energy Efficiency (DENEFF). According to their “NAPE-meter” only 182 out of total 446 measures defined by the NAPE to be executed by 2020 to reach the 20% energy savings target were realized by the end of 2015, which is just 41% (***DENEFF, 2015). A study of the mpw-institute, where they analysed the energy service market until 2022, confirms this trend (***ewi, 2015).

Energy concept of 2010	2011	**2020**	**2030**	**2040**	**2050**
Reduction in greenhouse gas emissions (compared to 1990)	**-26.4%**	-40%	-55%	-70%	-80%
Sahre of renewables in gross final energy consumption	**12.1%**	18%	30%	45%	60%
Share of renewables in electricity consumption	**20.3%**	35%	50%	65%	80%
Reduction in primary energy consumption (compared to 1990)	**-6%**	-20%			-50%

Figure 25: Energy efficiency targets and status in Germany 2011
Source: Lendermann (2015) and *** BMU (2015)

Countries	Absolute change PEC 2005–2011 (Mtoe)	Absolute change FEC 2005–2011 (Mtoe)	Annual average change in PEI 2005–2011 (%)	EEA assessment of progress towards improving energy efficiency
Bulgaria	− 1	− 1	− 3.2	↗
Denmark	− 1	− 1	− 0.8	↗
France	− 17	− 14	− 1.9	↗
Germany	− 30	− 22	− 3.1	↗
Austria	0	− 1	− 1.8	→
Belgium	+ 1	+ 2	− 1.1	→
Czech Republic	− 2	− 1	− 3.2	→
Finland	+ 1	0	− 0.8	→
Greece	− 3	− 2	− 0.8	→
Hungary	− 2	− 2	− 1.7	→
Ireland	− 1	− 2	− 2	→
Latvia	0	0	− 1.1	→
Lithuania	− 2	0	− 5.3	→
Netherlands	− 1	− 2	− 1.5	→
Poland	+ 9	+ 6	− 3	→
Portugal	− 3	− 2	− 2.4	→
Slovenia	0	0	− 1.6	→
Sweden	− 2	− 1	− 2.6	→
United Kingdom	− 35	− 20	− 3.3	→
Cyprus	0	0	− 1.1	↘
Estonia	+ 1	0	+ 0.3	↘
Italy	− 16	− 12	− 1.3	↘
Luxembourg	0	0	− 2.6	↘
Malta	0	0	+ 0.4	↘
Romania	− 3	− 3	− 3.7	↘
Slovakia	− 2	0	− 5.7	↘
Spain	− 16	− 11	− 2.7	↘
Croatia	0	0		

Note: PEI: primary energy intensity. Primary energy intensity is calculated as primary energy consumption per GDP (in constant prices, 2005 levels).
Progress is assessed based on the trend in energy consumption and primary energy intensity and the balance of packages of measures in the 2nd NEEAP:
↗ Well-balanced policy package across sectors and good progress in reducing energy consumption and primary energy intensity
→ Some progress in reducing energy consumption but further improvements are necessary either in the implementation or in the policy package or both
↘ Limited progress, further improvements are necessary both in implementation as well as policy package

Figure 26: Implementation progress in energy efficiency by EU member state
Source: *** EEA (2013)

Data from the German federal Ministry of Economy and Energy (BMWi) also confirm this trend, although with slightly different details (Figure 25).

These efforts in energy efficiency are important steps towards the projected objective of lower CO_2-emissions by 2030, as indicated in Figure 27.

For Germany the trend also indicates the right direction. The main contributors until 2012 could be found in industry (-51 mil tCO_2), households (-36 mil tCO_2) and transport (-23 mil tCO_2); in terms of reduction in percent, commerce/trade/services (-48.1%) leads before industry (-33%) and households (-28.2%) (Figure 28).

In Germany different options are available to perform the directions given by the European Energy Efficiency Directive:

- Energy Audits according to DIN EN 16247-1 industry norm
- Alternative systems (energy and environment management systems)

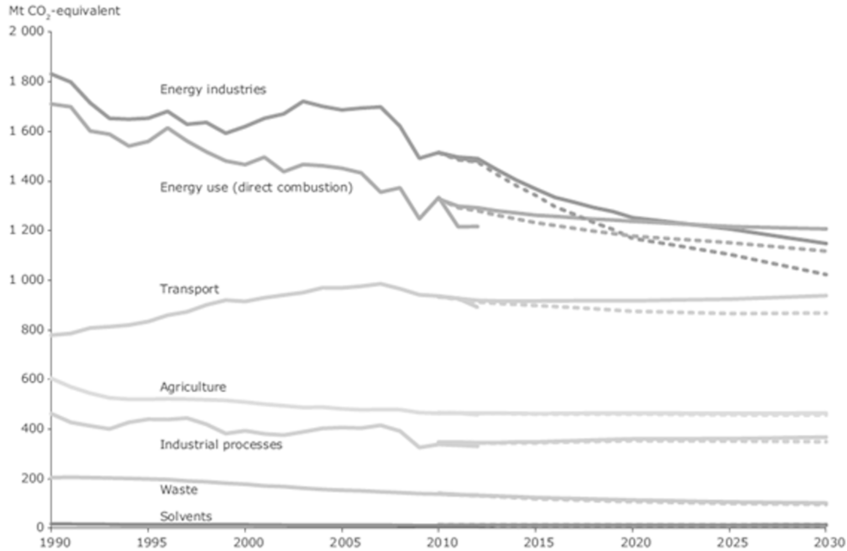

Figure 27: Trends and projections of EU GHG emissions by sector
Source: *** EEA (2013)

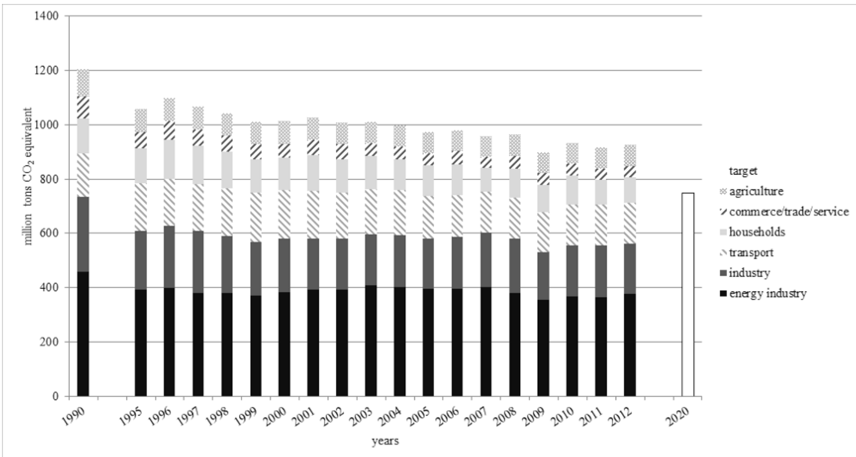

Figure 28: Trends in greenhouse gas emissions in Germany by sector
Source: *** BMWi (2014b)

The selection process for the organizations here is not easy. Figure 29 shows how many factors are to be considered and complicated the energy efficiency landscape can be. The selection process ideally shall be accompanied by an energy specialist/consultant.

	regulation	Mandatory			Refunding								BAFA subsidy
		EDL-G			EEG 2014 exception				energy and electricity tax				EBM
			alternativly	alternatively				alternatively				alternatively	
	frequency	every 4 years 1st by 05.12.'15	yearly	yearly	yearly	yearly	yearly	yearly	yearly	yearly	yearly	yearly	every 2 years possible
SME	not producing	-	-	-	-	-	-	-	-	-	-	-	EA 16247-1 (subsidy up to 8.000 €)
	producing no refunds	-	-	-	-	-	-	-	-	-	-	-	EA 16247-1 (subsidy up to 8.000 €)
	producing electricity < 1 GWh/a	-	-	-	-	-	-	-	EEG exception + attestation	ISO 50001 + attestation	EMAS + attestation	EA 16247-1 + attestation	EA 16247-1 (subsidy up to 8.000 €)
	producing electricity. 1-5 GWh/a	-	-	-	EEG exception + attestation	ISO 50001 + attestation	EMAS + attestation	EA 16247-1 + attestation	EEG exception + attestation	ISO 50001 + attestation	EMAS + attestation	EA 16247-1 + attestation	EA 16247-1 (subsidy up to 8.000 €)
	producing electricity. >5 GWh/a	-	-	-	-	ISO 50001 + attestation	EMAS + attestation	-	EEG exception + attestation	ISO 50001 + attestation	EMAS + attestation	EA 16247-1 + attestation	EA 16247-1 (subsidy up to 8.000 €)
non SME	not producing	EA 16247-1 1st by 05.12.'15	ISO 50001	EMAS	-	-	-	-	-	-	-	-	-
	producing electricity < 1 GWh/a	EA 16247-1 1st by 05.12.'15	ISO 50001	EMAS	-	-	-	-	-	ISO 50001	EMAS	-	-
	producing electricity. 1-5 GWh/a	EA 16247-1 1st by 05.12.'15	ISO 50001	EMAS	EEG exception	ISO 50001	EMAS	EA 16247-1	-	ISO 50001	EMAS	-	-
	producing electricity. >5 GWh/a	EA 16247-1 1st by 05.12.'15	ISO 50001	EMAS	-	ISO 50001	EMAS	-	-	ISO 50001	EMAS	-	-

Figure 29: Energy audit landscape in Germany

Source: by author, chart being used by the author in his respective seminars and trainings

The energy audit process

In Germany two models of energy audits exist. One of which makes energy audits legally binding (for non SMEs) and the other model is set on a voluntary basis (for SMEs).

According to the European Commission, SMEs are socially and economically the dominating size of companies in Europe. In the EU (European Union) SMEs count for 99% of all enterprises and offer jobs to 65 Mio people. SMEs are the essential motor for innovation and the foundation for any national economy (***BMWI, 2014f). With a share on the value creation of the total economy of 24%, SMEs in Germany are amongst the highest in Europe, also being called the hidden champions. Around 54% of them developed a product or market innovation (2008-2010); the European average showed only 34% (***BMWi, 2014f). Consequently, any negative impact on the financial health of the SME sector is to be carefully analysed and taken serious as it would drive any national economy into a disaster (***BMWI, 2014e).

The energy audit process for "Non-SMEs"

In Germany the transfer of the EU energy efficiency directive took place in April 2015 when the EDL-G (energy service law) became effective - 2.5 years after the EU directive became effective. The EDL-G-law requires all enterprises larger than a SME (small medium sized enterprise) to perform a specific energy audit by December 5th, 2015 the latest; in case of failed performance penalties of up to 50,000 Euro are announced (***BAFA, 2015a). The issue that came up mid 2015 in Germany was, that a huge number of enterprises needed to be audited according the EDL-G law; this number of concerned enterprises varies between 50,000 and 90,000 companies in Germany. This extraordinary wide spread of numbers resulted from the absence of a general database listing enterprises by SME status which is argued by different parties (***FÖS, 2015b). In parallel, due to the strict quality requirements for authorized auditors (***BAFA, 2015b), there was not enough audit personnel available in order to fulfil the "sporty" lead-time left until the given deadline - just around eight months (April to December 2015). Considering that it takes a minimum of two weeks in the case of "smaller" enterprises to perform the energy audit correctly and the low number of available qualified auditors, it was mathematically not possible to match the given deadline. In order to allow for a certain relief in this context, the responsible Ministry informed about a fair balance process until end of April 2016. After this deadline, the penalties would be coming without exceptions (***IHK, 2016).

The energy audit process for SMEs"

For SMEs in Germany there is no obligation to perform energy audits; however SMEs can under certain conditions receive subsidies of up to 80% of the energy audit cost, in case they undertake an energy audit voluntarily. This program replaced an older variant and is effective since January 01, 2015.

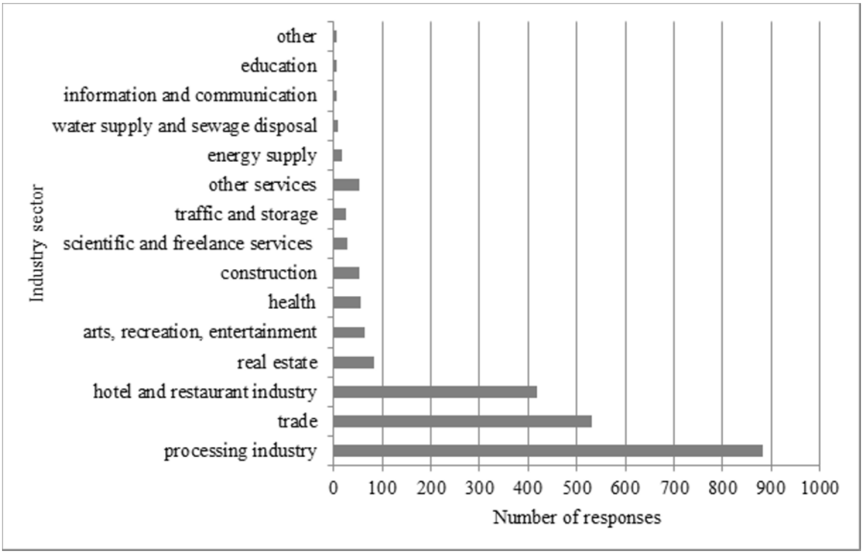

Figure 30: Number of energy audits by industry sector in German SMEs in 2015
Source: *** BAFA (2016)

The support program differentiates between SME with more or less than 10,000 Euro/a energy cost; above this line, max. 8,000 Euro are available as subsidy, below, only 800 Euro. After the first year, the responsible ministry conducted a survey in order to find out how this program performed in its first year (***BAFA, 2016). Accordingly 2,238 subsidized energy audits were performed in German SMEs in 2015 with a strong focus in the processing industry, trade and the hotel sector (Figure 30).

Looking at technologies, LED lighting and heating systems were the mostly proposed energy efficiency measures in these audits (Figure 31). The statistics also revealed that SMEs with low energy cost (below 10,000 Euro/a) only a marginal number of 150 enterprises performed an energy efficiency audit. This was not surprising but below expectations. In order to increase the motivation, the subsidy was increased to 1,200 Euro as of January 1st, 2016. This program change however might not bring the expected increase in performed audits. In order to achieve that, a process linking the subsidies in a more staggered approach to the energy cost would increase the perception of the current system with a more randomly defined break line.

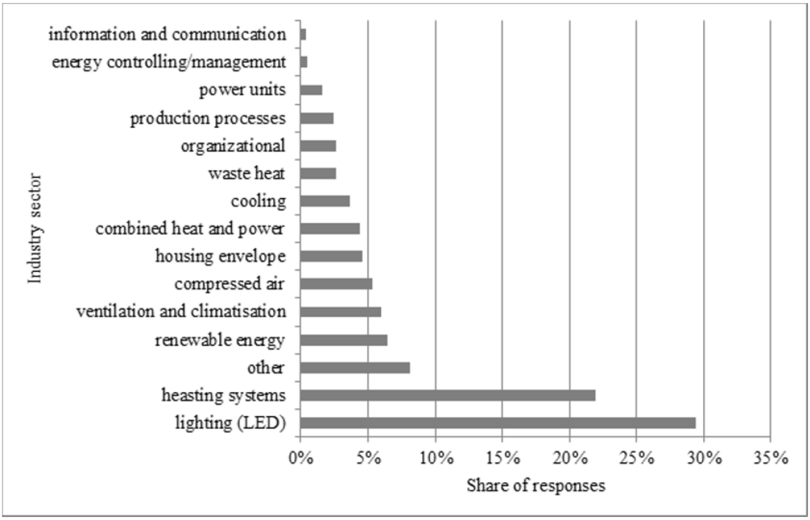

Figure 31: Share of proposed efficiency measures in German SMEs in 2015
Source: *** BAFA (2016)

Alternative Systems to the energy audit process

There are different alternative systems offered in order to comply with the energy efficiency law:

- Energy Management Systems (EnMS) according to ISO 50001 industry norm
- Eco-Management and Audit Scheme System (EMAS)
- Others.

Eco Management and Audit Scheme (EMAS): is a system combining *Environment Management Systems* and *environmental auditing* for organizations intending to improve their environmental performance. These can be enterprises, service providers, administrations and other organizations. Attending certified organizations need to declare its direct and indirect effects on the environment, its environmental performance and objectives. These declarations are assessed by certified experts and need to be update on a yearly basis (Jasch, 2015; Hentze and Thies, 2014; ***BMU, 2014a).

Energy Management Systems (EnMS): usually certified according to ISO 50001industry norm management systems are designed to continuously monitor, control and improve energy efficiency in organizations. Energy management systems can be embedded in existing management systems which eventually already exist in the organizations in the sectors of environment (EMS), quality (QMS), security (SMS), etc. (Figure 32).

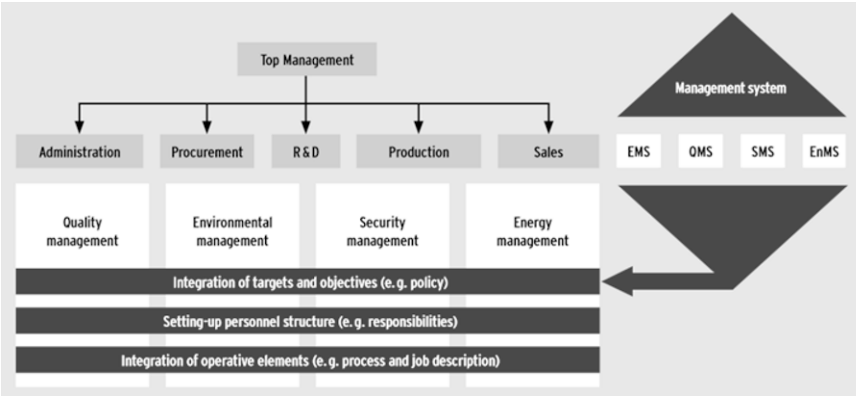

Figure 32: Integration of Energy Management Systems (EnMS)
Source: ***UBA (2012a)

EnMS offer a platform supporting energy efficiency activities by documentation, monitoring and information throughout the organization.

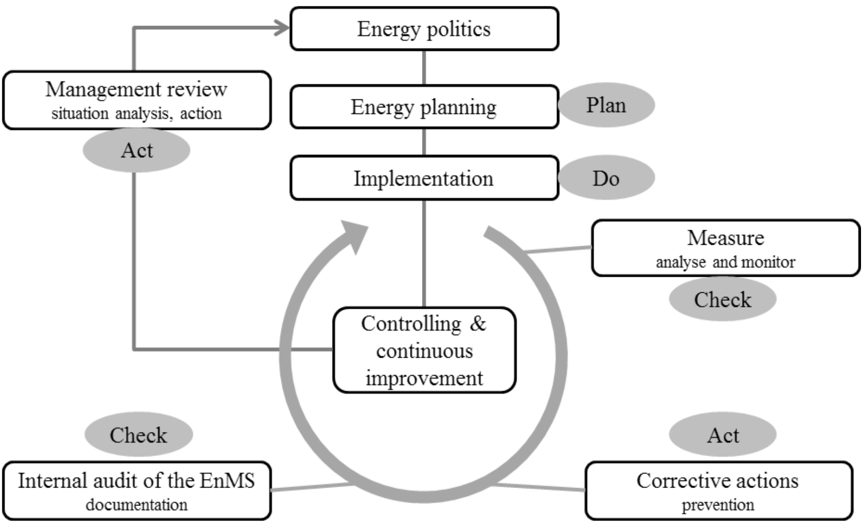

Figure 33: PDCA process of EnMS
Source: author's design, based on ***UBA (2012a)

The advantages of EnMS are cost reduction, protection of the environment, sustainable management, improve the organizations image and allow the use of financial benefits. In addition EnMS are an important tool for the government to register reductions in greenhouse gas emissions for their reporting process to the EU authorities (***UBA, 2012a; Wallikewitz and Schymczyk, 2015).

EnMS strictly follow the PDCA-cycle (Plan-Do-Check-ACT), according to ISO 50001 industry norm (Figure 33). The four phases of this process are characterized as follows (***Beuth, 2011; ***UBA, 2012a; Wallikewitz and Schymczyk, 2015).

Plan:

- Development of the energy policy of the organization by the top management.
- Definition of the energy efficiency targets and objectives
- Definition of roles, responsibilities and processes
- Legal obligation check
- Definition of the energy performance indicators (EnPIs – refer also to chapter 1.1.3)
- Definition of energy management program and action plan

Do:

- Assignment of tasks
- Operational structuring and resources
- Raising awareness and training
- Documentation
- Communication
- Implementation and operational control

Check:

- Monitoring, measurement and data analysis
- Legal obligations check
- Corrective action and prevention
- Internal audits and documentation
- Planning and structuring records

Act:

- Management review
- Situation analysis
- Improvement activities

Management systems (MS) enable enterprises to benefit through refunds of energy and electricity taxes, as well as eventually by the participation of the exception model of the EEG described in chapter 4. Another benefit is the continuous cost reduction. Even a certain investment is required in the installation phase, over the years significant cost reduction by reduced energy consumption but also reduced life cycle cost will pay back the investment quickly (Figure 34). Besides providing cost and energy benefits, EnMS also support the quality assurance process by sending alert messages supported by individually definable process parameters.

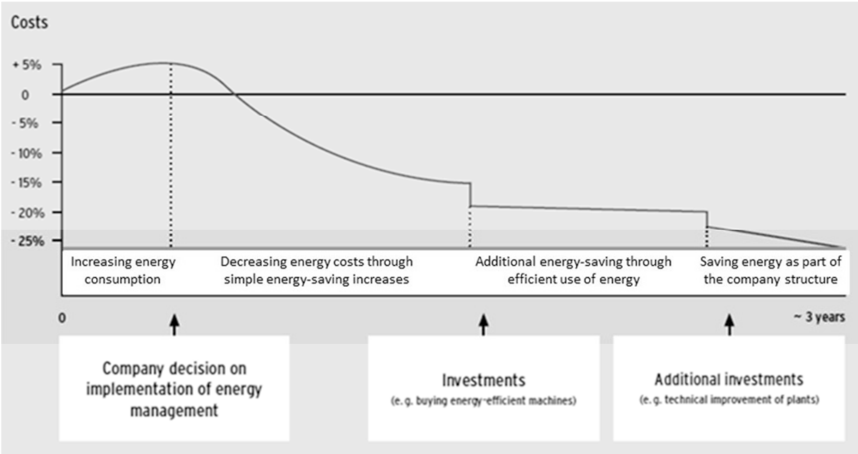

Figure 34: Continuous cost reduction by EnMS
Source: ***UBA (2012a)

Sustainable energy is an important factor not only in today's business world and energy economic systems. Even though, regulations and procedures in the EU are not harmonized between the member states and hinder effective progress in reducing energy consumption. The process of synthesizing and generating deeper insights to the energy savings potentials and installations of renewable energy plants in all regions on earth is urgently required in the process fighting climate change (Kermeli et al., 2015).

1. 1. 3. Characteristics of business performance indicators in the energy economics

In today's global world consumers require and expect a growing level on products and services performance. In addition, an increasing number of regulations include specific requirements for business, human health and environment protection, including energy efficiency. The entirety of these requirements must be followed by any business (Olaru et al., 2014).

In this context, coordination of all players including management is a must. Through this condition it is ensured that all involved parties are working towards the same one major objective. In the literature, this process of project integration is characterized and evaluated as the integration of management systems (Sandru et al., 2014). Hereby it is irrelevant whether management systems in the context of for example quality (ISO 9001 industry norm), environment (ISO14001 industry norm), energy management (ISO 50001 industry norm), energy audits (ISO 50002 / DIN EN 16247-1 industry norms) or combinations are being used (Francesschini et al., 2007).

The current economic context of globalization requires continuous adaptations and improvements as well as efforts to coordinate diverse projects with different objectives. In this context, projects are faced with a hard and global competition within companies but also external. Today's organizations therefore are pushed to carefully analyse every aspect of their decision making processes. Here it is obligatory to implement and use an efficient resources management. The development and use of performance indicators is here an important element setting the targets for the company's project portfolio (Sandru et al., 2014). Resulting from this context, the Key Performance Indicators (KPIs) were developed. Usually performance indicators are developed reflecting financial contexts; however, in order to be able to compare enterprises also in aspects other than financials, also non-financial criteria need be indexed (Schuster et al, 2015; Heesen et al., 2014). This is particularly important once these companies are different in size, organizationally differently structured or even acting in a different branch or sector. In order to manage companies successfully, performance indicators are an irreplaceable, important tool (Posselt, 2014).

a) Performance measurement system

A powerful and adequate performance measurement system can be characterized as follows (Levinson et al., 2002; Giese, 2012):

1. The KPI performance measurement system has to support the projects owners in fulfilling the performance targets.
2. Performance management system is to be an open system, available to and manageable by the project partners
3. Measurement tools are to be distinct, explicit, precise, neutral and measurable with adequate data.

In that context, leading personal through management by performance indicators can be a very helpful tool, once management is successful in winning their employees attention. This can be easier achieved once the team is convinced that the objectives are reachable (Posselt, 2014; Kühnapfel (2014).

In order to gain from knowledge, one needs to assess the available data. This analysis can be done static or dynamic (Botsis et al., 2015; Becker et al., 2014). In contrast to the static approach, the dynamic evaluation analyses the data by comparison against conventional values (Figure 35).

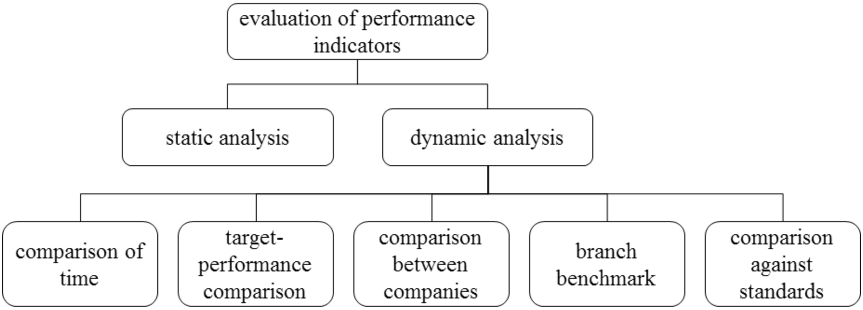

Figure 35: Evaluation of performance indicators
Source: by author based on Botsis et al. (2015)

With the time comparison, data of the same object at different times are compared, such as the energy consumption of a process in summer compared to winter. The target-performance comparison compasres objectives against achieved data, a set-up being used in energy efficiency audits for example.

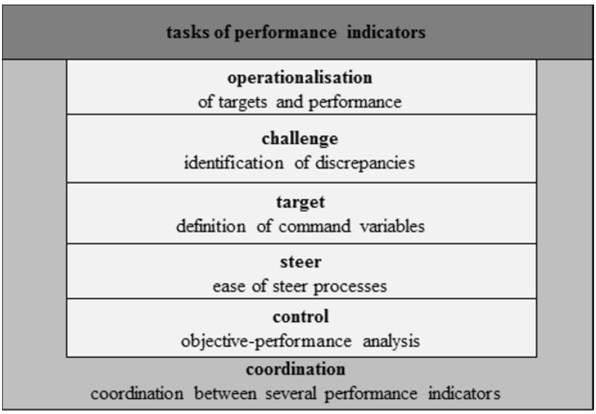

Figure 36: Tasks of performance indicators
Source: by author based on Weber et al. (1995)

The comparsion between companies is used to find out how different companies perform, for instance the energy consumption for comparable processes between several subsidierries can be compared. The branch benchmark is being used to compare businesses within the the same industry sector, hence the energy consumption with the competition could be compared. The comparison against standards finally is being used in order to find out whether standards, such as energy efficiency targets provided by the government are being met.

The tasks of performance indicators can be manifold (operationalisation, challenge, target, control, coordination) as explained in Figure 36.

Today's business environment is characterized by openness, inconsistency and complexness followed by a high degree of instability (Mihic, 2011). The changeable nature of business, going along with changing customer demands, new developed technologies, and more complex structures of enterprises during the last decades resulted in a more and more complex business environment.

b) Multi project management and KPIs

Forced by this increasing demand for flexibility and performance improvements, companies started to implement the project management concept (Hobday, 2000; Mihic, 2011). In the recent years, this concept of project management, shifted from being an operational tool towards being an integrated key element within the strategic structure to be globally competitive (Kerzner, 2011; Sandru et al., 2014).

According to the literature, several approaches on performance indicators all merging to the same objectives are standardized today. The ones mostly used and standardised are summarized in Table 1 four of which focusing on project portfolios.

Table 1: Comparison between project management standards in multi project management
Source: Gilles et al. (2004)

Projects focused	Single Project	Program	Projects portfolios
ICB	X	X	X
PMBOK® Guide	X		
PMCDF	X		
OPM3	X	X	X
AIPM	X	X	X
PRINCE 2	X	X	
P2M	X	X	X

According to the literature, several approaches on performance indicators all merging to the same objectives are standardized today. The ones mostly used and standardised are summarized in Table 1 four of which focusing on project portfolios.

There are several definitions the term of KPI which can be found. However there is no generally approved definition available yet, for example:

- Todorovic et al. (2013): As a first step in defining KPIs, the specific characteristics they should achieve are to be defined.
- Kerzner (2011): The exact understanding is in the meaning of each word:
    - Key – a major contributor to the success or flop of the project;
    - Performance – a factor being qualified, adjusted, measured, controlled;
    - Indicator – a reasonable representation of performance (now and in future).

In that context, it is utmost important that the company uses the performance indicators in order to judge its individual projects as part of the overall project portfolio investment program (Olaru et.al, 2011). This will ensure that in the context of today’s global and complex business environment project decisions are made focusing on strategic goals of the enterprise.

The first step in the project decision process, the strategic objective of the organisation needs to be defined and in a second step through the use of the right KPIs its reach is to be ensured. Classically KPIs are defined by using a management framework such as the balanced scorecards. The KPIs are hereby defined by a dataset used to compare planned against measured.

These datasets are combined to focus on different elements and will establish the structure of the KPIs to be implemented throughout the performance objective analysis process. The indicators in this process can be generically clustered as (Sandru et al., 2014; Kühnapfel, 2014; Gladen, 2014):

- Quantitative indicators – related to budgeted work to be done
- Qualitative indicators – related to the quality issues
- Financial indicators - to measure financial flows
- Quality of work done – to measure waste rates
- Temporal indicators – related to the time schedule
- Output indicators – to measure process activities
- Input indicators - to measure resources needed to achieve the planned outcome

KPIs are high-level snapshots business processes based on predefined measures and are visualized using reports, tables or charts. (Parker, 2012)

KPIs need to create information which is measurable, reliable, and exact and to be usable for corrective actions in case the performance of the process is not in line with the objective defined. According to SR EN ISO 9004:2010 industry norm, such information must take into account (Sandru at al., 2014):

- requirements of customers and other stakeholders
- importance of the products to the enterprise
- efficiency & effectiveness

- effective & efficient use of resources
- financial performance
- legal compliance

Based on these generic primary characteristics, more detailed KPIs need to be developed (Figure 37).

Figure 37: Generic elements of KPI's
Source: Sandru et al. (2014)

Key Performance is defined as ways to frequently measure and control the performance of projects and is different from business typology and investment objectives. It is important to exclude non-controllable fulfilment factors in their definition and to structure them in a meaningful, measurable and understandable way (Drosse, 2014).

Figure 38: Defining elements of KPI's
Source: Sandru et al. (2014)

That’s why the KPIs should follow the SMART criteria. SMART is an abbreviation for a set of criteria reflecting complex objectives. SMART (**S**pecific, **M**easurable, **A**chievable, **R**elevant and **T**ime-bound) stands for elements focusing on objective setting and configuring KPIs, attributed to Peter Drucker's management by objectives concept.

The driving elements of KPIs (Figure 38) thereby follow the PDCA (Plan-Do-Check-Act) principle, also being used in DIN EN ISO 50001 industry norm of energy management systems.

In order to keep individual projects under control, performance measurement is a consistent challenge in companies (Olaru et al., 2014b). The principal issues of project controlling hereby are connected:

- Measuring performance of an entire portfolio of projects
- Prioritisation of secondary objectives
    - Merging these to the main objective
- Comparing dynamic processes with a fix reference

The performed research surveyed models of performance indicators used in a multi project management environment and the performance measurements of project portfolios.

The focus was to define and develop an environment for multi project management allowing for a cross project performance evaluation as well as supporting the decision making process providing a structured and concentrated information analysis (Sandru at al., 2014).

In a multi project environment, a single project can be interpreted as a single piece of the investment portfolio program of the enterprise.

Using primary performance indicators do hereby simply not offer the entire concentrated information needed. Hence a more complex, scope adjustable performance evaluation is required in combination with a weighting system for each of the KPIs in order ensure receiving precise data.

Building a sustainable portfolio of projects, covering the individual objectives of all projects is key and can be reached by a common Work Breakdown Structure (WBS) through its basic tasks (Sandru at al., 2014).

In the daily business, an industrial site generally will focus on

- Forecast analysis (planned vs. actual)
- Project timelines
- Project resources
- Output

and illustrate those in progress curves (Figure 39).

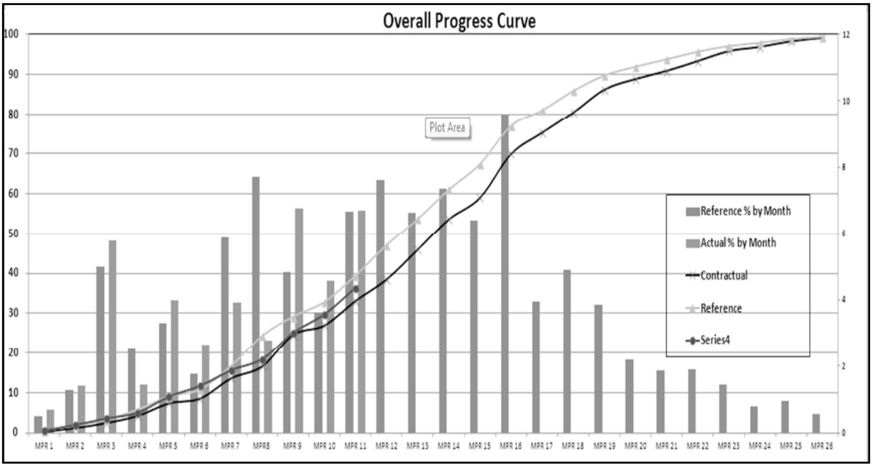

Figure 39: Portfolio, overall progresses curve
Source: Sandru et al. (2014) – diagram here exemplarily, details not important

Whereas an overall project curve serves to illustrate the overall project status and trend, it is suggested to detail out as many S-curves as the number of critical elements, processes or disciplines the project needs to observe. These can be S-curves by output, by time, by department, etc. S-curves hereby give a global overview on the considered scope (Figure 40).

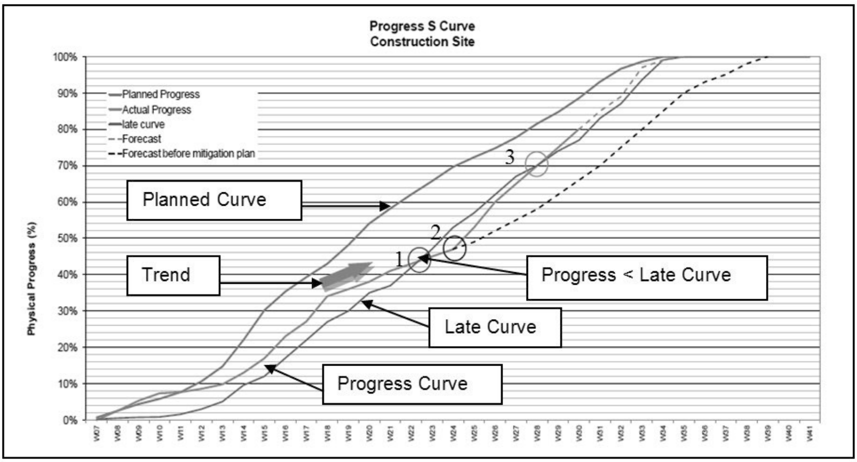

Figure 40: Portfolio evolution analysis based on time related KPIs
Source: Sandru et al. (2014) – diagram here exemplarily, details not important

The arrow indicates the trend of the actual project progress. Pointing towards the line crossing with the late curve (Figure 40), the arrow serves as an indicator towards potentially upcoming problems (alarm bell) (Sandru at al., 2014).

- Circle 1 (analysis point) indicates that the progress is running behind the late curve requiring adjustments in order to get back to right track.
- Circle 2 indicates a trend change – hence to corrective actions show improvements, whereas the dotted curve shows the path without the moderation
- Circle 3 indicates that the corrective action was successful, the project is back on track (between planned and late curve).

It is important to understand whether the project in on track. Therefore the KPI process is an important element for each enterprise.

c) KPIs and EnPIs

In literature, there are many types of KPIs mentioned and explained, such as indicators on liquidity, solvency, flow measures, cash flow rates etc. as detailed out for example by Krause et al., 2010; Dietzfelbringer, 2015; Giese,2012). Those mainly miss out the EnPIs (Energy Performance Indicators) which developed along with the implementation of energy management systems and are a key element in the DIN EN ISO 50001 industry norm (Energy Management standard).

EnPIs hereby indicate the level of energy consume during a specific activity related to a defined reference, i.e. energy consumed [kWh] per produced product [kg].

machine hourly rate = $\dfrac{D + I + M + O + E}{PA}$
D = depreciation = $\dfrac{\text{replacement cost}}{\text{machine life}}$
I = interest = 0,5 x replacement cost x interest rate
M = maintenance = replacement cost x maintenance rate
O = occupancy cost = floor space required x cost x 12
E = energy cost = energy demand x energy cost x utilisation level
PA = planned level of activity = workdays/year x work hours / day

Figure 41: Calculation of machine hourly rates
Source: Stollenwerk (2012)

Table 2: Examples for Energy Performance Indicators (EnPIs)
Source: *** BMU (2012)

Key data	Description	Unit
total energy consumption	absolute	kWh, MWh, Euro
specific energy consumption	$\frac{\text{total energy consumption [kWh]}}{\text{production quantity/units}}$	kWH/PQ kWh/PU
percentage of energy source	$\frac{\text{consumption per energy source [kWh]}}{\text{total energy consumption [kWh]}}$	%
energy intensity	$\frac{\text{energy of a process (field) [kWh]}}{\text{total energy consumption [kWh]}}$	%
percentage of energy from internal circuit	$\frac{\text{energy from internal heat recovery [kWh]}}{\text{total energy consumption [kWh]}}$	%
percentage of renewable energy sources	$\frac{\text{use of reneweable energy [kWh]}}{\text{total energy consumption [kWh]}}$	%
total energy cost	absolute	Euro
specific energy cost	$\frac{\text{energy costs [Euro]}}{\text{production costs [Euro]}}$	%
industry-specific energy performance indicator	$\frac{\text{total energy consumption [kWh]}}{\text{turnover [Euro]}}$	kWh/Euro
specific cost per energy source	$\frac{\text{cost per energy source [Euro]}}{\text{consumption per erngy source [kWh]}}$	Euro/kWh
cost savings	absolute	Euro

The EnPIs on one hand can be used to analyse the energy efficiency of the production process; on the other hand they also can serve as process alert; thirdly they can be an important element in the purchase process of energy as well as energy efficient pre-products, products and/or services (Stollenwerk, 2012; Gladen, 2014); energy cost are an important element in that context (Figure 41). In case the EnPI "energy/produced product" is increasing without producing more produced, this can be an alert for malfunction in the production process hence a signal to avoid the production of low quality products or even waste. According to Schenk et al. (2010), EnPIs are also a crucial element in in the factory planning process.

Using energy management systems (EnMS) EnPIs are an important element. It is important that these are representative enough to be used to track the energy politic statement of the companies' management. It is important to base them clearly on certain system boundaries and defined operating conditions. Generally there are several different EnPIs possible, depending on their primary use (Table 2).

EnPIs can be used in the product development process (plan values) as well as during the production cycle (measures values). As illustrated in Table 3 the EnPI "energy cost/unit" can serve in order to compare energy consumptions per machine or facilities or between different products and provide information for the production planning process. On the other hand, this EnPI can also be used to define and control energy efficiency measures.

Table 3: Energy cost / unit
Source: by author, exemplarily

	product 1			product 2		
	units [kg]	energy cost/unit [Euro/kg]	energy cost [Euro]	units [kg]	energy cost/unit [Euro/kg]	energy cost [Euro]
machine 1	14,500	2,00	29,000	10,000	1,70	17,000
machine 2	6,000	1,50	9,000	7,000	1,80	12,600
machine 3	12,000	1,80	21,000	9,500	1,70	16,150

The EnPI information ordered according to size and evaluated using the ABC-analysis can be used in the management decision process (Lorson at al., 2013).

EnPIs are being used in enterprises, politics and service providers. For enterprises, EnPIs help to control and increase energy efficiency as well as production output, quality and profitability. Governments use EnPIs in order to define and control energy targets, to check whether substitution conditions are met and to compare branches. Service providers use EnPIs in order to identify energy reduction potentials, to proof energy reduction results, as quality proof (efficiency targets of products) and proofs during the certification process of energy management systems (EnMS). Usually EnPIs depend and rely on different determining factors, such as the context, a machine is being installed for. In this context, EnPIs are being used to represent single products or processes, but also product / process groups up to entire facilities/ companies.

In general EnPIs shall be usable to monitor the energy consumption of a defined system. In this context the timely development of energy consumption is being controlled. The energy consumption of the system is being compared with itself over time. A second objective of EnPIs is to support the evaluation of the energy consumption of a defined system. In this case the energy consumption of the system is being benchmarked with other comparable systems (see also Table 3). The overall objective of EnPIs is to control and evaluate the energy consumption of an entire system. As for example a system "production" contains of several sub-systems, EnPIs for each of the relevant subsystems need to be defined. For each of the subsystems, their sub-efficiency will be defined. Adding all the sub-efficiencies up will result in the energy efficiency of the defined system. During this process, it is important to understand the influence of external factors, which cannot be influenced by the system. Those can be for example outside temperature and outside humidity which have an influence on the performance of heating or cooling systems for instance. Comparing heating or cooling systems using established EnPIs it is therefore important to know and understand these external factors and to include these parameters in the calculation of the EnPIs (Figure 42).

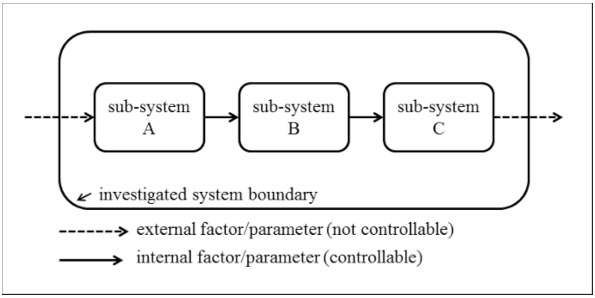

Figure 42: EnPIs and system parameters
(Source: by author)

As mentioned, the objectives of EnPIs are (Gladen, 2014):

- to evaluate the energy relevant effort
- to compare the energy consumption with other systems.

Based on the author’s experience, the efficiency of several additional areas can be improved by combining the benefits of EnPIs (Figure 43).

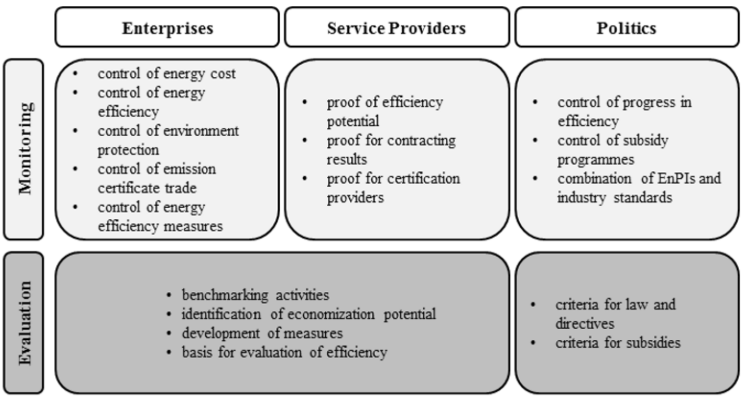

Figure 43: Benefits of EnPIs
(Source: by author)

	S - strengths	W - weaknesses
O - opportunities	focus on chances matching the strengths of the company, i.e. positive market share development	eliminate weaknesses in order to benefit from new chances, i.e. speed up launch of energy efficient product
T -threats	focus on strengths in order to fend threats, i.e. prepare in time for new legal energy efficiency requirement	Develop defence strategy to avoid weaknesses to develop towards threats, i.e. hire energy manager

Figure 44: SWOT analysis by the example of energy efficiency
Source: by author based on Stollenwerk (2012)

EnPIs as any other performance indicators can also be used to support strategic management decisions, usually being visualized through SWOT-analysis. The SWOT is an acronym for strengths, weaknesses, opportunities and threats (Stollenwerk, 2012). In this SWOT-analysis its four elements are opposed to each other indenting to identify focus areas for a future strategy, which also forced by legal directives in more and more companies includes a focus on energy efficiency and energy management. Figure 44 for example illustrates exemplary a SWOT-table using the example of energy efficiency.

d) The EFQM model

The EFQM-model of the European Foundation for Quality Management (EFQM) presents an excellent frame for an integrated CSR management (Olaru et al., 2011b; Lotter and Braun, 2014) and as such it also can be used in the context of energy management systems. Through its elements, it illustrates in an easy way which levers an organization needs to pull in order to perform on all its levels and how these levers can be controlled. The model is based on eight pillars with the objective to provide excellent results in view of performance, customers, employees and society through a leadership (Figure 45).

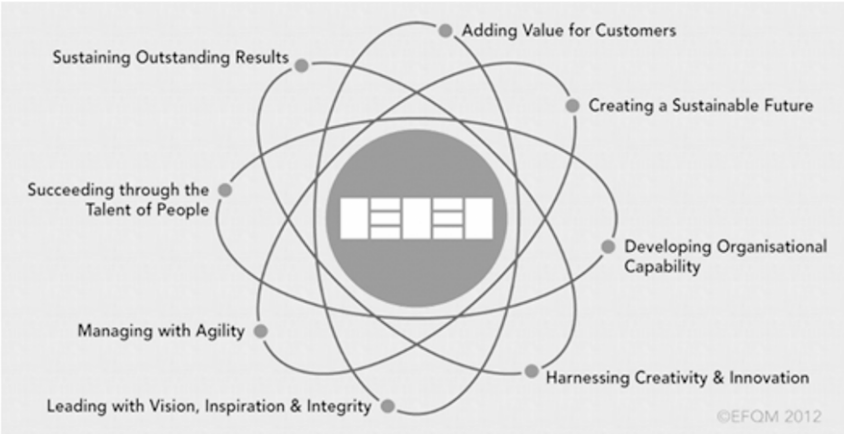

Figure 45: Fundamentals of the EFQM model
Source: *** EFQM (2016a)

The EFQM model provides 3 main pillars (learning, creativity and innovation) and 9 criteria (enablers and results) (Figure 46). The EFQM model provides an excellent base for an integrated CSR management, as it allows catching and registering processes and their results followed by a structured review process. By that it enables excellent results on an economic, ecological and social basis.

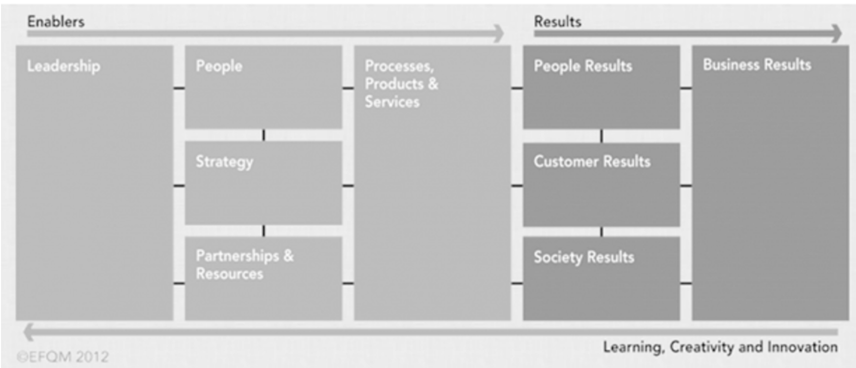

Figure 46: Criteria of the EFQM model
Source: *** EFQM (2016b)

1.2. Actual approaches and perspectives in the development of sustainable energy strategies

1. 2. 1. Definition of energy economics

Energy economics combine production, distribution and use of energy by societies. By that it's strongly related to energy engineering, politics, ecology, economy, etc. As such several disciplines nowadays come on focus while debating energy economic issues: climate change and policy, sustainability, risk analysis, security of supply, energy audits and energy efficiency, energy policy, energy management, specialization on energy services, e-mobility and sustainable transport, renewable energies, load management to name the mostly used terms (Sweeny, 2013; Kanndemir and Görgülü, 2010).

1. 2. 2. Factors of energy economics influencing responsible business practices

As mentioned climate change became to be one of the key words today and will be even more important in the very close future. The global warming effect is increasing, undoubtable being pushed also by the energy use and green-house gas emissions worldwide. The *"5th Climate Change 2014 Synthesis Report*" of the IPCC confirms the human influence with a probability of 95-100% to be the main factor of the temperature increase on earth since the 20th century (*** IPCC, 2014).

The human influence was confirmed in the heating of the oceans and the atmosphere, the changes in the global water cycles, the rise of the global average sea-levels as well as the decreasing levels of snow and ice on earth. As a consequence the IPCC claims a 100% resignation from the use of any fossil energy sources. In Germany for instance brown coal power plants contribute substantially to a high level of green-house gas emissions, as a study by the DIW[2] revealed (Reitz, 2014).

The world energy demand is mainly satisfied using fossil sources, releasing masses of green-house gases to the atmosphere in a much shorter time as it took them to be stored (Weber et al., 2014a). In 2013, the quantified atmospheric concentration of CO_2 in the Northern hemisphere reached a level of 400ppm (Figure 47), a value which was lastly achieved in the era of the Pliocene, which was three Mio years ago (Fell, 2013; ***BMU, 2015).

[2] DIW = Deutsches Institut für Wirtschaftsforschung e.V., Berlin – German Institute for Economic Research

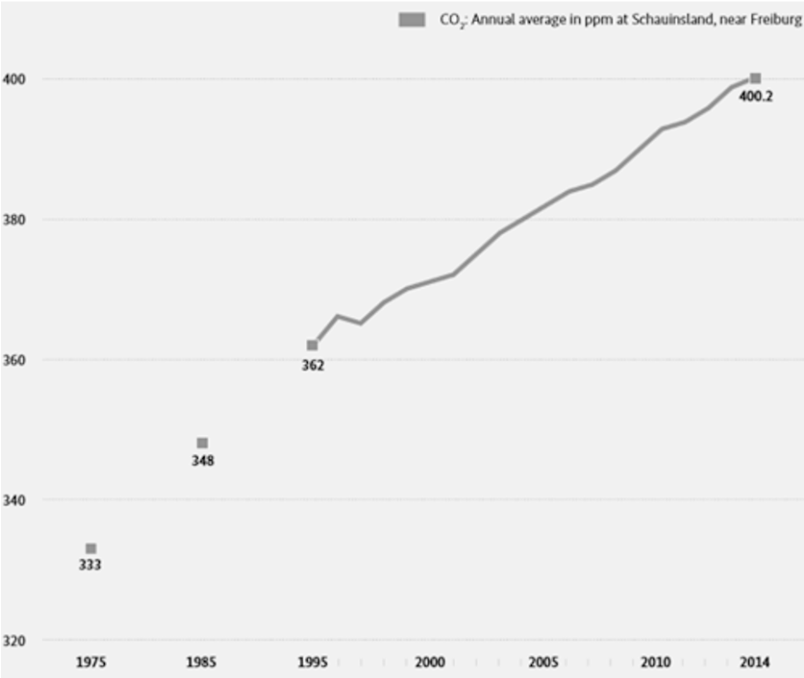

Figure 47: Development of the CO_2 concentration in the atmosphere (German city of Freiburg)
Source: *** BMU (2015)

As a physical effect, the temperature on our planet (Figure 48) follows the atmospheric CO_2 concentration with a short time delay (Schabbach et al., 2012).

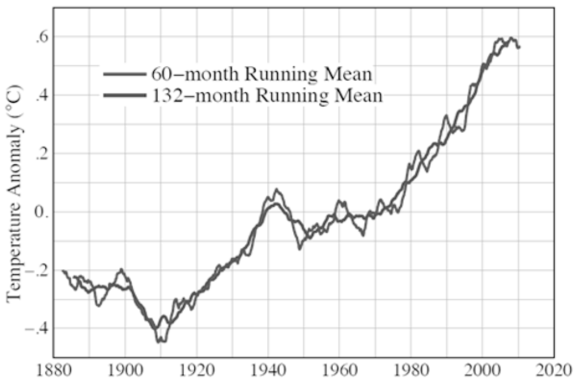

Figure 48: Global average temperature anomaly relative to the 1951-1980 base periods
Source: Wara (2014)

Prior the industrialization, this atmospheric CO_2 concentration levelled at 280ppm, in other words, since the industrialization, the atmospheric CO_2 concentration rose dramatically - grown to a level which urgently requires corrective action to keep planet earth in a liveable condition (Weber, 2015), factors with crucial influence on energy economic strategies.

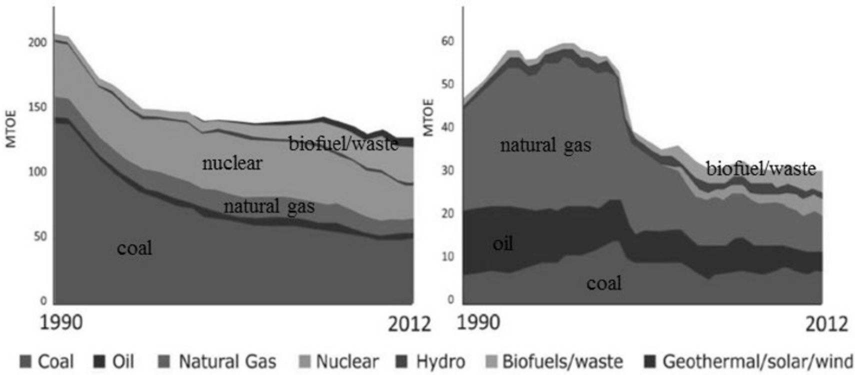

Figure 49: Comparison of energy production mix in Germany (left) and Romania (right)
Source: Calota (2015)

A comparison of the German and Romanian energy production mix shows how different the countries produce their energy. Whereas in Germany coal is the main CO_2 emission source, it's a mix of oil, natural gas and coal in Romania (Figure 49).

With the energy consumption and along going green-house gas emissions and pollutions being a main driver of climate change, strong efforts need to be put on the main energy consumers. Those are identified as the household, transport and industry sectors, with transport serving both, household and industry sectors (Figure 50). The energy demand hereby can effectively be reduced introducing energy efficiency measures and energy management systems. By sourcing the energy demands left after implementing efficiency measures through renewable energy sources, the CO_2 emissions could almost be zeroed out (Weber, 2015).

According to a study from 2011 (*** Greenpeace, 2011), the energy potential through renewable energy sources could have supplied over 3,078 times as much energy as the energy demand on earth in 2003. As a side effect the dependency from other countries supplying fossil energy, which can become a serious issue in times of political unrest and instability (Kausch, et al., 2011; Barbian, 2001; Mükusch, 2011) could have been eliminated. For example, 54% of Germany's primary energy consumption is based on gas and oil with 94% of which being imported (Andruleit, et al., 2013). In addition, fossil energy sources are ultimate and with the increasing energy demand on earth, this effect will strengthen going forward (Kausch et al., 2014; Schabbach et al., 2012). Based on the fossil energy sources known today and the energy demand of 2013 on earth, the fossil energy sources will end in around 76 years (averaged) (Andruleit, et al., 2013).

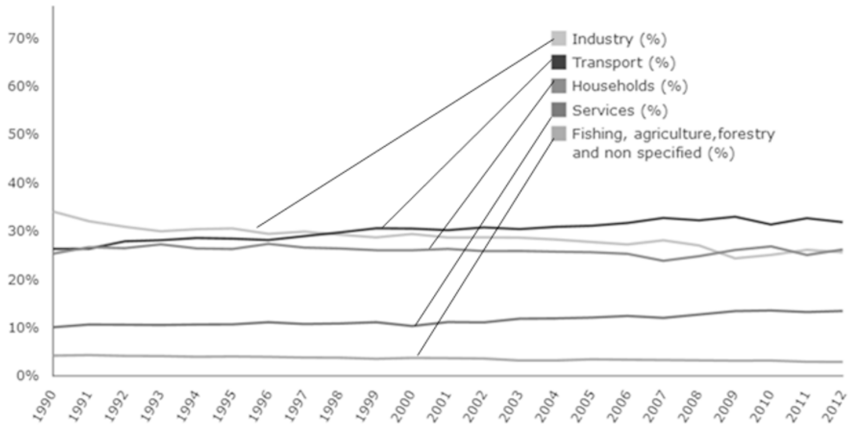

Figure 50: Sector shares of final energy consumption in Europe
Source: *** EEA (2015)

On top, there is a risk factor linked to fossil and nuclear energy sources driving towards increasing social cost (health, insurance, weather extremes, etc.) (Langeheine, 2012; MacDonell et al., 2014). The social costs caused by electricity production (Table 4) are substantial, led by the use of brown coal. The emissions of brown coal power plants in Germany are hereby responsible for a calculated loss of 33,000 years of life, statistically around 3,100 dead persons per year, as a study by the University of Stuttgart, Germany revealed (Preiss et al., 2013). In addition, a recent study by Kiesewetter et al. (2015) confirms that particulate matter (PM) has remained a critical issue for European air quality and will not become under control in close future. PM, emitted mainly by coal power plants and fossil powered transport, is one of the main causes for lung cancer.

Turning this trend into a reduced energy demand on earth and a "green" energy production for the remaining energy demand is a critical path for the strategy of future climate protection and sustainability – this is being recognized and acknowledged generally. Without reductions of green-house gas emissions and global warming, far beyond todays activities, global warming will guide to massive, global and irreversible changes in the climate on earth by the end of the 21st century (*** IPCC, 2014). Already now in 2015, the effects of global warming can be experienced in

Germany – the summer 2015 showed with temperatures around 40°C new heat records since weather data are being recorded. Clinical studies revealed, that due to the consequences of climate change new kinds of pollen invade Germany and cause major issues to allergic persons (*** DWD, 2015). Furthermore the DWD (German Weather Agency) expanded its early-warning-system by newly installing heat warnings for high in-house temperatures (due to the historic climate and temperatures, air-condition systems are not popular in Germany).

Table 4 Social cost resulting from electricity production, Germany [€cent$_{2010}$/kWh$_{el}$)]
Source: *** UBA (2014)

Electricity production by	Emissions to the air	Green-house gas	Total social cost
Fossil energy			
Brown coal	2.7	8.68	10.75
Stone coal	1.55	7.38	8.94
Gas	1.02	3.90	4.91
Oil	2.41	5.65	8.06
Renewable energy			
Water	0.14	0.04	0.18
Wind	0.17	0.09	0.26
Photovoltaics	0.62	0.56	1.18
Biomass	1.07	2.78	3.84

In the context of a constantly growing world population, the human race will naturally secure its current level of economic wealth, in case economic growth is attended by a reduced use of short and expensive resources including energy. Consequently, economic growth is to be disconnected from the shift from fossil and nuclear towards the integration of renewable energies (Weber, 2015; MacDonell et al., 2014; Wellmer, 2014).

This will on one hand ensure a more cost effective production of energy henceforward, and simultaneously reduce the level of the before mentioned "social cost". Social cost put pressure on to the national economies through

- increasing cost for coping with more and more extreme forces of nature,
- increasing health cost (for example increases the pollution through coal and nuclear power plants cancer and the cost going along with it),
- Cost, caused by the consequences of increasing emissions of greenhouse gas etc.

Resulting from these scenarios, there are good reasons for a worldwide energy transition, such as (Weber, 2015):

- Responsibility towards future generations;
- Climate protection and nature preservation;
- Security of supply (in general not just of energy), competitiveness and cost stability;
- Booster for economic growth and employment (*** BMU, 2012a; *** BMU, 2012b);
- The increased level of public participation.

In the context of the ongoing cost discussion, the prevention cost need to be seen jointly with the cost savings through the benefits from these measures. In the year 2007, the economic effects of climate change for Germany were estimated to almost 1bn. Euro until 2015 and 406 bn. Euro by 2050 (***DIW, 2007). A study by the EU (***EU, 2012a) estimated the yearly cost through climate change for all Europe to 20 bn. Euro in 2020, 90 -150 bn. Euro in 2015, and 600-2,500 bn. Euro in 2080, depending from the level future green-house gas emissions. Adaptations and preventing measures however can help reducing these costs substantially, as the study laid out.

Adaptation to climate change generally covers measures helping to reduce the vulnerability from effects of climate change (*** EU, 2012a; Hennicke, 2010), which can be clustered as:

- Technological measures, such as protection against rising sea-levels, energy efficiency measures, etc.
- Behaviour changes, such as sustainable water and energy consumption, etc.
- Knowledge measures, such as researching the development of climate change and potential effects of the introduction of technical measures and behaviour changes etc.
- Political measures, such as stronger critical values, enforcements to energy efficiency measures, etc.
- Shifting to renewable energies
- Carbon capture and storage

In this context, economical models help to identify the correct ecological measures to counter fight climate change through cost-benefit-analysis.

Potential measures were intensively analysed by the study. For Germany exemplarily three sectors are summarized as follows (***EU, 2012a):

- Traffic/Transport
  - New road covers
  - Adaptations to stronger heat variations
- Industry
  - Prevention from heat caused productivity losses through more air-conditioning
  - Information about climate change
- Energy
  - Designing the power grid for extreme weather
  - Cooling of thermal power stations

Surprisingly, no energy efficiency measures, shifts to decentralized, renewable energy production or development of new energy efficient products were included in this study.

In their study performed back in 2009, Jacobson and Delucchi (2009) came to the conclusion, that renewables could cover the world's energy demand in twenty years already and turn fossil fuels to be completely needless. In addition they calculated the estimated cost for the worldwide energy supply until 2030 and conclude that shifting to renewables by 2030 is half in cost compared to staying with fossil sources (Figure 51).

Estimated cost for the worldwide energy supply [US$]	
oil gas coal electricity	3,350-4,475 bn 550-830 bn 150-300 bn 1,490-2,150 bn
total/year	5,550-7,750 bn
total: year 2010-2030 (+20% per year)	200,000 bn
total: shifting to 100% renewable energy by year 2030	100,000 bn

Figure 51: Estimated cost for the worldwide energy supply until 2030
Source: Jacobson and Delucchi (2009)

In order to cool planet earth down, the principle of geoengineering is trying to shade the planet in order to reduce the major effects of human made climate change. As confirmed by many studies, artificial interference into the complex natural systems of our planet comes along with unknown risk. A study of the Max-Planck-Institute revealed that as a result of higher air temperatures, the atmosphere can store much more water, consequently the level of rain would be reduced drastically on earth (Kleidon et al., 2013). In the same year, the findings of this study were confirmed by a second study in this research field (Tilmes, 2013). As one consequence, the world community decided end of last year in Paris to limit the increase of the temperature on earth to a level of 1.5 degrees. A variety of measures are required in order to achieve that, all of them with a critical influence to energy economics and related responsible business practices.

1. 2. 3. Explanation of selected tendencies in sustainable energy systems

a) Information Technology (IT) in the context of energy economics

Information technology (IT) plays an essential role in today's life, privately as well as in business. In order to remain competitive in the market organisations have to increase their productivity and flexibility and need to improve their processes to be more efficient in terms of energy and resource consumption.

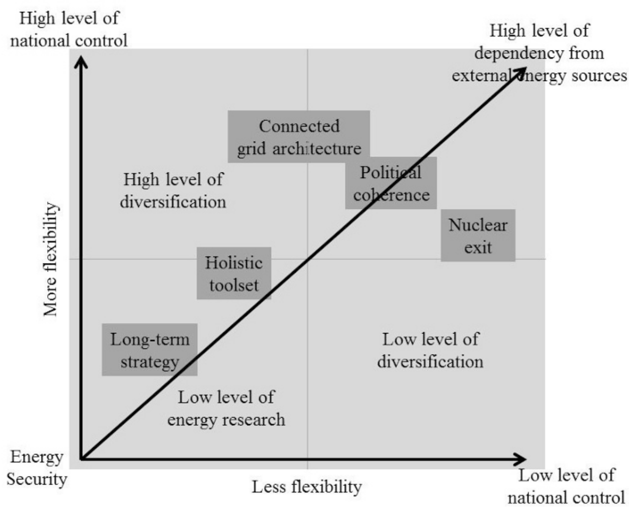

Figure 52: Future of energy security, IT components highlighted
Source: by author based on Mükusch (2011)

Simultaneously the market demand requests for a higher product diversity and individualisation. This development is challenging the way organisation used to operate by increasing the level of computerizes processes and systems. In the global context, market success and competitiveness of organisations will intensely depend on their IT-skills. On one hand this is valid for the development process and for managing the change process; on the other hand IT security is rapidly developing to be a key concern and risk for many organisations. For that reason and due to their complexity IT-services are often outsourced (Burr, 2014). The future of the energy security was described by Mükusch (2011) in its complexity and the view from the energy economical view point. Newly added is the IT-component being represented in several of the shown elements (highlighted, Figure 52). In order to ensure energy security, politics, economy, society and industry need to globally co-work.

Regarding the effects of the energy transition in Germany only limited data is available as development and progress of the energy transition and related energy efficiency results can so far not be accessed by the federal statistics department. In order to ensure a sustainable monitoring and publishing of these data, the IT framework urgently needs to be improved (***ewi, 2014). In addition smart metering becomes an increasingly important role in managing the power grid, power security and grid stability (Di Nucci, 2014) coming along with a huge dependency on Information technology.

Information security management

With the changes in the energy economics during the recent years, the production of renewable energies became an important element of the national economics worldwide. A new sector of business with a large number of enterprises in the wind, photovoltaic and biogas industry developed in a short period of time.

The operation of such plants and businesses heavily depends on a high level of information and communication technologies (ICT). In the global context of cybercrime in particular energy power pants, as crucial elements of todays' business and life, require a specific level of protection against cyber-related risks. (Hohan et al., 2014).

Some of this risk can be addressed by ICT, establishing monitoring and surveillance opportunities to also safeguard against external risks. An additional risk element developed with the remote connection of the power plants via internet (Rinaldi et al., 2001). The smart energy grid is a new potential target for terrorism as well as industry spying. The responsible US agency for cyber emergency reports significant increases in cyber-attacks (***ICS-CERT, 2013), in particular in the energy sector (Hohan et al., 2014), as visualised in Figure 53.

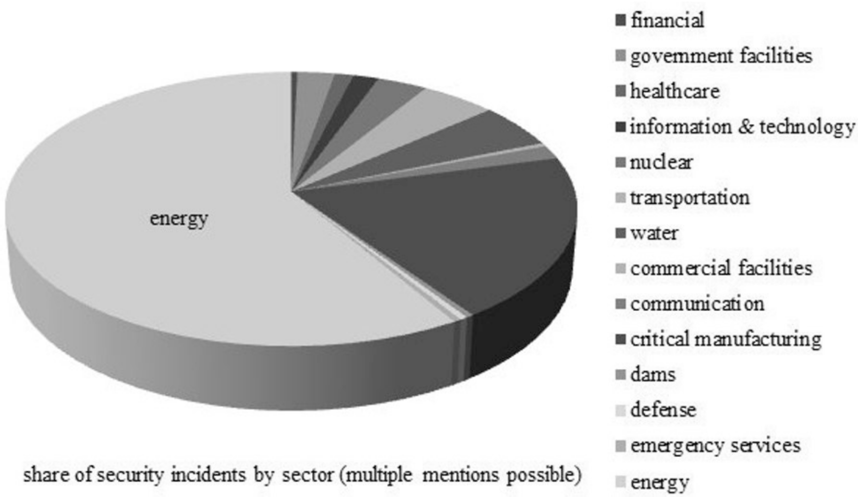

Figure 53: Security incidents reported by origin of incident
Source: ***ICS-CERT (2013)

Hohan et al. (2014) describe the main sources of vulnerability for Energy Industrial Control Systems as follows:

> “ • People. While the industrial sector prides itself on a highly skilled workforce focused on automation systems, such expertise does not translate into adequate expertise in security of industrial IT networks (Fernandez, 2013). Lack of (or insufficient) available specific ICT security expertise can result in improperly configured, insecure systems, but also in a low organisational awareness of the risks, both at management and operational levels.
>
> • Network access vulnerabilities. SCADA systems are traditionally designed to operate in isolated environments. The requirements for remote access to data led to increased interconnection of SCADA and business systems and increased openness of industrial control networks, often leaving industrial control networks vulnerable to network-level attacks.
>
> • Communication vulnerabilities. Also a legacy of the origins of SCADA systems, communication protocols are specifically designed for operation in low-bandwidth, high-interference transmission media. The focus for industrial control systems being availability, integrity of data communications, and costs, these are being achieved at the expense of the confidentiality and authenticity requirements, normally achieved through encryption techniques.

- Off-the-shelf devices and systems. The generalisation of supporting ICT technologies was accompanied (and partially driven) by the availability of cost-efficient, off-the-shelf devices and systems. Such systems are often installed and fully functional with default configurations, leaving open known vulnerabilities for attacks. Such vulnerabilities were for instance the enabler of Stuxnet (computer worm from 2010), probably the most famous attacks targeting Industrial Control Systems, which exploited known vulnerabilities in the Siemens S7-300 Programmable Logic Controller (Langner, 2011).

- Physical security vulnerabilities. Due to remoteness of Industrial Control Systems devices, direct physical interference is harder to prevent, detect and respond to. Such interference can go unnoticed for long periods, generating misleading data or offering pathways for complex attacks.

- Organisational vulnerabilities. Lack of clear policies, resource allocation and proper planning, operation, verification, and improvement procedures result in improper addressing of relevant risks. Also, a lack of visibility of ICT related risks at management level (very often the case in such industrial organisations built around specific technologies with very specific associated risks) lead to a lack of clear objectives and allocation of resources of ICT security."

The context and the correlation of attacks and vulnerabilities were summarized in Figure 54.

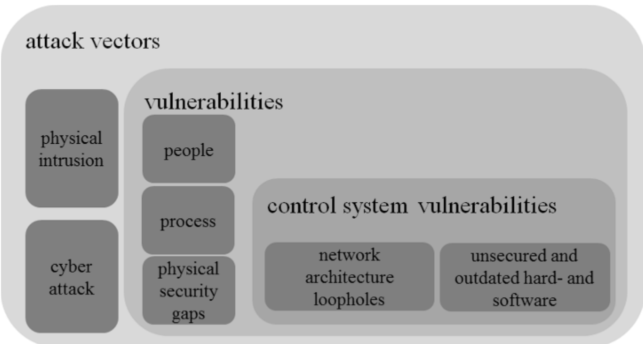

Figure 54: Correlations between cyberattacks, vulnerabilities and control systems
Source: by author based on Fernandez (2013)

The attack vectors usually are caused by competitive, economic, social or political reasons. Those cannot be controlled by the organisation. Vulnerabilities the organisation could have influence on are people, processes and physical security (access control, unsecured gates, etc.). The vulnerability of control systems cover networks, unsecured remote access through tablets, smart-phones, laptops, USB sticks, etc.

In this context Hohan et al. (2104) researched the state of the art on cyber security of smart grids and developed based on existing guidelines and the specific level of required protection a framework for an information security management for grid-connected renewable power plants. The study revealed that the energy sector is a potential primary target.

Another example for potential cyberattacks is the electric transport sector – in particular automobiles. More and more vehicles are equipped with wireless internet connection, car-to-car-communication and car-to-device-communication (= communication with traffic control and management systems) features. An additional cyber-risk which becomes more and more important is electric-drive vehicles, also connecting the transport sector with the smart-grid sector. Electric vehicles often have telephone SIM-card installed in order to be reachable for the manufactures for battery research; in addition they are being charged via cable or induction – both potential "entry tickets" for cyberattacks (Bettzieche, 2015). Successful attacks to vehicles from BMW, VW, General Motors, Fiat-Chrysler, and Tesla are reported (Bettzieche, 2015). Consequently car manufacturers need to react to such developments with much shorter development cycles. As this is a serious challenge for the manufacturers, some are liaising already with specialized B2C companies (KIBS) in order to address this threat.

Besides the transport sector, also the building sector is concerned by potential cyberattacks. Smart home concepts and integration of homes into the smart grid concept open the same challenges as being described for the transport sector (Bettzieche, 2015).

The commonality between the cited examples smart grids, electric transport and smart homes is their connection to the power grid. This closes the loop to the earlier describes sector of the PV-power generation plants. These are all connected and through that, the risk for attacks to the national power grid is increasing more and more through its complexity.

In general, any internet access point to the energy grid, be it smart home, electric car, remote controlled PV and wind power plants are possible attack points and require security devices prior installation. So far most smart meters in Germany provide the access point only (Quaschning, 2016).

Information technology

The innovation cycles of today's products and services are rapidly developing towards shorter and more demanding processes. Also the products and the services need to match much more ambitious requirements in order to survive in the market (Russwurm, 2013).

Especially the energy sector has high level requirements to be fulfilled. Supply security on one hand but also efficiency measures in order to reduce cost and save the environment. In today's production, integrated automated processes need to be efficient (including energy efficiency), flexible and productive which only can be realized through measuring and control technologies (software) (Russwurm, 2013). Looking at the KIBS energy sector, tailored service concepts are developing to become the all-dominant success factor. The integration of such services can be simplified, if they build up on the database of concerned process steps.

IT-systems are increasingly dominating today's industry. Hereby information security management, energy monitoring and energy service systems are closely linked. In this context information security is the basis not only to secure energy power plants, but also assuring data security in monitoring and control processes in the industry. Whereas the electrical energy sector is already a high-profile target for cybercrime and cyber terrorism, the increasing access to the industries energy monitoring service sector opens the doors to criminals also to the industry, consequently both areas need to be seen in context. As the industry in the context of demand-side-management gets more and more connected to the energy grid, attacks to the industry can indirectly harm the energy grid and cause problems with the grid stability and even blackouts.

The monitoring tools and monitoring software analysed and benchmarked in the study primarily focuses on user friendliness, easy to access and providing data for the energy management process. The tools focusing on energy audits instead are standalone systems which are not directly connected to the industries IT system. Energy data from the industry can be used, however not via an automated process, instead the data needs to be uploaded individually. By that, these tools do not provide any access to the IT-system and the energy grid of the organisations. The only concern here is that sensitive data such as energy consumption, energy efficiency, energy cost, KPIs etc. could be accessed via those portals.

Going forward, the energy audit systems will certainly be closer connected to the industries IT and energy management systems in order to allow for automated process and quick system analyses "at a click of a button". As a result from the interviews with the experts on the Frankfurt energy efficiency fair 2015, the sector is focusing already on the combination of IT security and energy management and audit systems. New innovative products and services shall be close to enter the market.

Monitoring the energy transition currently still is an issue, due to missing access to data. In order to ensure a sustainable monitoring and publishing of these data, the IT framework between industry and the federal statistic authorities urgently needs to be improved.

b) Sustainability in transport

In today's world, transportation is an indispensable element of private as well as business related activities. On the other hand transport is also being criticized for the damage and implications it does to the environment (Joumard and Gudmundsson, 2010; McManners, 2014). These impacts are described and analysed in many studies, which through development of KPIs, as also described in chapter 1.1.3, tried to help identify measures to support improving this situation (Surugiu et al., 2015; Marin et al., 2014). In parallel many activities and efforts were undertaken to reach a higher level of sustainability and effectiveness. I this context Marin et al. (2014) state: "It is interesting to note that the environment is not only a limit for future development, but also a source of new opportunities for the local development. A healthy life and working environment, in a place where insecurity and air and sound pollution have been reduced, can increase the economic, social and cultural attractiveness of that territory."

Transport still consumes (and will in future) a huge share of resources while meeting also the requirements of economy, society and environment (Abdallah et al., 2013). As outlined in Figure 55, transport is with a share of more than 30% of the energy consumption the biggest energy consumer in Europe in 2012, followed by the industry and households with 25%. The environmental impacts are hereby in direct correlation with their infrastructure, their emissions and the energy consumption (Rodrigue, 2013). Consisting of noise emissions, health impacts, consequences on landscapes, ecosystems, wildlife and the society, these environmental impacts of transport also contribute to pollution and climate change (Doll et al., 2008) and require a stronger focus on its efficient use of energy (Bauernhansl, 2014).

On the other hand transport is an essential factor for economic growth, global markets, supports effective production and distribution of goods. The relationship between energy consumption, economic values and impact to climate change through CO_2 emissions was investigated in studies on the example of road transport (Kolb et al., 1995) and in general by Ziolkowska and Ziolkowski (2015). They found out that several elements of the transport process impact sustainable energy consumption most. Those were identified as vehicles, road conditions and surface, drivers (Surugiu et al., 2015). The effects of transportation to the environment measured by its CO_2 emissions hereby mostly match the levels of its energy use. Hereby it is of upmost importance which kind of transportation is being used.

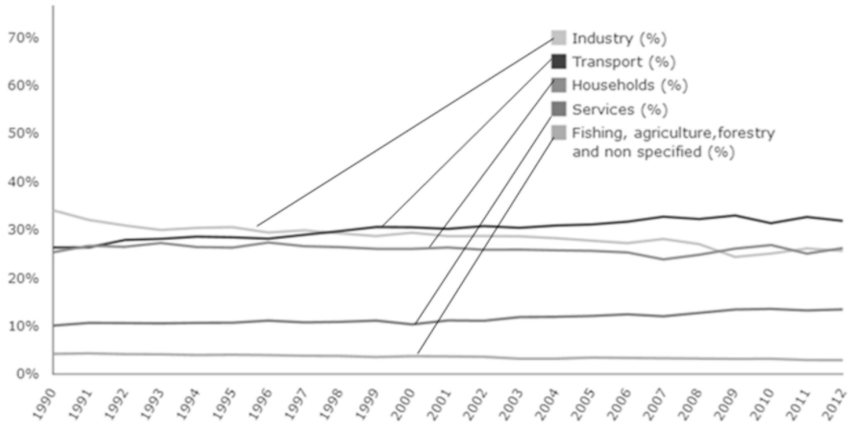

Figure 55: Sector shares of final energy consumption Europe
Source: *** EEA (2015)

Related to road transport, a study conducted in 2013 revealed that the use of alternative propulsion systems, such as gas, electric drives, hybrids, etc. would contribute an important part towards reducing the levels of green-house gas emissions in transport (***ewi, 2013). But there are more ecological benefits, alternate propulsion systems provide, such as lower noise levels and reduced levels of air pollutants. The fact that such propulsion systems however are not better established in the market is related to a lack of information on one hand and higher cost and a marginal infrastructure for energy supply on the other. The cost element hereby could be eliminated by improved financial benefits such as tax reductions, the infrastructure challenge by installing a wider supply grid. The study confirms in addition, that the benefits of alternate propulsion systems outweigh conventional drives. Political obstacles need to be overcome in order to see a wider spread of such systems coming (***ewi, 2013).

Sustainability in transport

Transportation consists of generally four main sections: road transport, rail transport, sea transport, air transport. In Europe road transport is consumes by far the most energy, followed by international sea shipping and rail transport (

Table 5). According to the data, the year 2007 shows a peak year for road, air and rail transport (2008 for sea shipping and domestic) with a decreasing trend in the following years which is expected to continue (Surugiu et al., 2015 (updated); Bretzke, 2014).

Table 5 European energy consumption by transport mode [Mega Tons Oil Equivalent (MTOE)]
Source: *** EEA (2015b)

YEAR	INTERNATIONAL SEA	RAIL	ROAD	DOMESTIC	INTERNATIONAL AIR	DOMESTIC AIR	TOTAL
2002	45.949	8.214	305.674	38.724	6.852	6.909	412.321
2003	46.409	7.994	308.194	39.786	7.097	7.787	417.267
2004	49.807	8.119	314.716	42.827	7.400	7.833	430.701
2005	52.063	7.937	315.893	45.079	7.758	7.995	436.725
2006	54.699	7.597	323.537	46.584	7.772	8.690	448.879
2007	54.929	7.719	330.077	47.839	8.431	8.344	457.339
2008	55.757	7.545	325.224	49.153	7.960	6.959	452.598
2009	50.164	7.194	317.142	45.712	7.202	6.856	434.270
2010	50.619	7.316	316.545	44.993	7.020	6.539	433.031
2011	50.241	7.224	313.778	46.401	6.635	6.166	430.445
2012	46.479	7.227	307.552	45.231	6.320	5.728	418.537

Peak years highlighted in grey

In the context of sustainability as well as energy effectiveness and economy, shifting goods from road to rail results in better fuel (=energy) consumption, lower CO_2 emissions and a higher level of productivity (=economy) (Spraggins, 2010). This benefit is reduced once more fuel efficient trucks are being used, especially as trucks still being required for getting the goods from factory to rail and from rail to the customers (Brehends, 2012).

In that context, the International Energy Agency proposes a set of several criteria to be considered simultaneously during the development of KPIs for sustainable transport (Surugiu et al., 2014):

- Support the use and development of transport technologies with better energy efficiency, such as bio fuels, electric motors (powered by renewable energies), hydrogen fuel cell, hybrid vehicles
- Implementation of behaviour changes towards lesser fuel consumption
- Selecting the most sustainable transportation alternative
- use of larger carriers (minimizing the number of trucks)
- introduction of lower speed limits
- introduction of traffic management systems
- introduction of fuel management systems

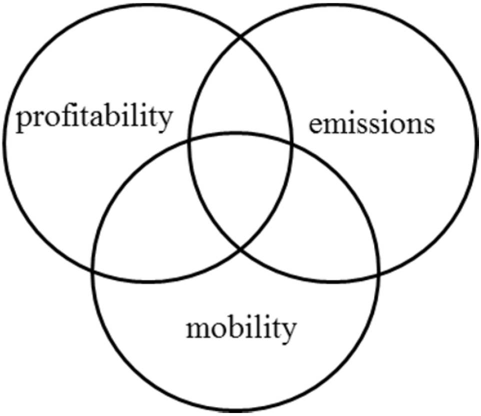

Figure 56: Three dimensions in transport
Source: Bretzke (2014)

A research conducted by Marin and Weber (2014) identified four types of policies helping to achieve a sustainable development in the transport sector, confirming the criteria listed before:

- Policies focusing on demand, aiming behaviour changes in transport such as a) variable transport cost realized by road taxes, fuel taxes, fees for peak periods, etc., b) the use of regulatory measures, such as standardizing exhaust emissions, noise reduction, speed limits, etc., c) different transport modes, d) communication and information campaigns
- Policies focusing on offer, aiming for example a) more efficient management of existing transport modes, b) traffic management measures, c) more traffic lanes, d) increasing frequency, etc.
- Technological policies, for example a) focus on new more efficient technologies, b) automation solutions such as automatic speed control, c) traffic light management, d) car to car and traffic light communication, etc.
- Physical planning policies, such as redistribution of activities to influence the mobility system

Leading to a lower level of greenhouse gas emissions and lower levels of noise emissions, for the transport sector energy efficiency and a proper fuel management finally could be confirmed to be a highly effective regulatory screw of achieving and sustaining long-term objectives towards minimizing global warming and sustainability. However, the intensity these levers can be used are defined also by the correlation between its three elements economy, mobility and low emissions (Figure 56). Options for energy efficient technologies in transport were summarized in (Table 6).

Table 6: Overview of energy-efficient technologies by mode of transport
Source: by author, based on *** BMWi (2010)

	mode of transport				
technology	maritime shipping	inland shipping	rail	road	aviation
alternate fuels (H_2, gas, bio)	c	u	c	c	c
lightweight construction			u	c	c
hydrodynamics	u	u			
aerodynamics			c	c	c
braking/heat energy recovery	u		u	c	
alternate drive technologies	u			c	c
diesel direct injection	u	u	u	c	
hybrid technology			u	c	
fuel cell	c	u	c	u	c
efficient capacity increase	u		u	u	
speed optimisation	u		c	u	u
load optimisation	u	u	u	u	u
driver training			u	c	
optimised logistical processes	u		u	c	u
optimised infrastructure	u		u	u	u
intelligent telematics	u		u	u	u

legend: c: commercial realisation, u: under development, no claim to be exhaustive

In order to reflect the importance of the transport with regard to energy efficiency sector, in Europe transport was included in section four of the European industry standard “DIN EN 16247” by the technical committee “CEN/CLC/JWG 1 - energy audits” (***Beuth, 2012). This industry standard was created as energy audits can support organizations identifying energy efficiency potentials in their business. In the case of energy management systems (EnMS), energy audits are as essential part of the DIN EN ISO 50001 industry standard a mandatory element throughout the process. Due to the mobility of transportation elements (cars, trucks, etc.), auditing the energy status of transport is a specific challenge. In order to compensate this fact, the industry norm DIN EN 16247-4 describes and balances the processes and procedures in transport, which are different for each of the fore mentioned elements of transport (road, rail, sea and air) (Figure 57).

Aspect	Road	Rail	Air	Sea
planning, logistics, route	x	x	x	x
air coefficient	x	x	x	x
rolling restistance	x	x		
other disturbing resistances	x	x	x	x
combustion loss	x	x	x	x
weather conditions	x	x	x	x
surrounding temperature	x	x	(x) frost	(x) frost
vehicle / carrier age	x	x	x	x
accessability / flexibility		x	x	x
load capacity	x		(x)	

Figure 57: Specific aspects of the elements of transport
Source: by author based on *** Beuth (2012)

Road vehicles are characterized by a high level of accessibility and mobility and can be fuelled at any place / country during their normal operation; on the other hand, empty drives are frequently unavoidable. The energy audit needs to include indications on several conditions such as air pressure in the wheels (***Beuth, 2012). The norm provides specific requirements how each of the transport elements needs to be audited.

In the case of sea transport, each vessel of the company needs to be inspected, in case all vessels are identical, the inspection of one shall be representative. The auditor is required to check the general condition of the vessel, the main engine, as well as the management processes required to run the ship. In minimum, the following evaluations are to be performed (***Beuth, 2012):

- Power of the vessel
- Power of main and auxiliary drives
- Load
- Differentiation between electricity sourced from the land grid, energy consumption in the harbour as well as on tour
- Lighting
- Fuel quality and supply systems
- Rotating machines
- Boiler and steam systems

For inland water transport in addition traffic jams before water gates are to be considered.

The example of sea transport was selected in order to demonstrate how complex and comprehensive an energy audit for transport is. This results in very specific requirements for the audits process of transport operations, defined by chapter 4.2 of the Norm DIN EN 16247-4; the most relevant demands are outlined below (***Beuth, 2012):

- There is high level of coordination required in order not to interrupt or disturb the operational processes. The organization as well as auditor therefore needs to coordinate and harmonize each party needs and duties very detailed.
- The auditors require direct access to the personnel being responsible for thefollowing areas:
    - Planning of logistics and route management
    - Operational business (transport management)
    - Maintenance
    - Technical purchasing (sourcing of the transport carriers)
    - Human resources (qualification of the workforce)
    - Operators (main influence on energy consumption)
    - Finance (access to energy bills and data)
- The data collection is also specific for transport sector. Several elements need to be considered:
    - Criteria for the planning of transports
    - Descriptions of the selected routes and the planning criteria therefore
    - Inventory of the entire transport fleet
    - Transport specific requirements regarding training
    - Criteria for the carrier specifications
    - Mileage or operating hours of the carriers
    - Rate of utilization for the last year

During the energy audit, the collected data is to be verified and evaluated. Based on the findings, proposals for energy efficiency measures and improvements are to be developed and calculated in terms of their financial feasibility. Specific key performance representing all kinds of transport being used within the organization are to developed and used; examples are: consumed energy / distance; consumed energy / distance x net weight); consumed energy / (distance x number of passengers). The proposed measures finally are to be prioritized to support a proper management decision process.

Transport is a critical element in the energy consumption in Europe followed by the industry. With the implementation of the EU energy efficiency directive and its implementation in national laws of the member states supported by the DIN EN 16247-4 industry norm (***Beuth, 2012), energy efficiency measures are a vital part of todays' management decisions and business processes and good progress was already achieved. For further improvements in future, the development of new energy efficient technologies, as well as alternate propulsion systems such as hybrids, electric drives, and others needs to be pushed.

1.3. Today's classification of knowledge intensive business services (KIBS) in the energy business

In the context of changing energy economics in Germany, Knowledge Intensive Business Services (KIBS) play an important role. KIBS operating in the field of energy audits require a special high level of specialized skills being legally mandated (***BAFA, 2015b; 2015c). In general, KIBS cover a wide spread of business sections, mostly requiring a high level qualification (Miles, 2001; Osterloh and Boos, 2001). Services in general are structured in three main phases: potential orientation, process orientation and result orientation (Haller, 2015). Energy services hereby mostly are provided in the process and result orientation phases. The potential orientation phase tends to be neglected; however it shall always be considered also as in the early production development process the basis for the future energy consumption of a product is set. Even some of the KIBS are operated a specialized departments with the company (Bartussek, 2013. However, most of them are outsourced so the companies can focus on their core businesses, instead of having to maintain a very specialized team, as an example can the IT services be named (Burr, 2014).

Outsourcing hereby is defined as a combination of outside, resource and using, combined meaning the use of outside resources (Ortner, 2015; Haller, 2015). This outsourcing strategy reduces extra effort, extra personnel, extra budget and a special focus on the continuous development in the market (Esser and Seiter, 2015). Sourcing these specialized services from outside ensures the organization receives a high quality and in relation to technology and regulations an up-to-date service by the KIBS (Weber at al., 2016). Bröker (2014) as wells several other authors (Willocks and Lacity, 2006; Barthelemy and Quelin, 2006; Shah and Bandi, 2003; Howells, 2006; Chiesa, Manzini and Pizzurno, 2004) identified KIBS in the sectors of business process (such as research and development), information technology, technical support services, and others. Catoiu et al. (2016) and Miles et al. (1994) arranged these in two sections (Table 7).

Table 7 Grouping of KIBS
Source: by author, based on Miles et al. (1994)

KIBS group 1	KIBS group 2
* Management consultancies	* Information Technology services (IT)
* Environmental services	* Technology intensive business process services
* Legal services	* Financial services
Accounting and Bookkeeping	* Research and development services (R&D)
Marketing services	* Telecommunication services
Human Resource services	* Technical engineering services
Public Relations services	

Traditional KIBS such as information technology services, technical engineering services and research and development were listed, KIBS in the area of energy as we know them today however did not exist at the time yet. Some of them however, either have strong relations to field of energy or belong to today's energy sector KIBS (both marked with "*" inTable 7) (Weber et al., 2016).

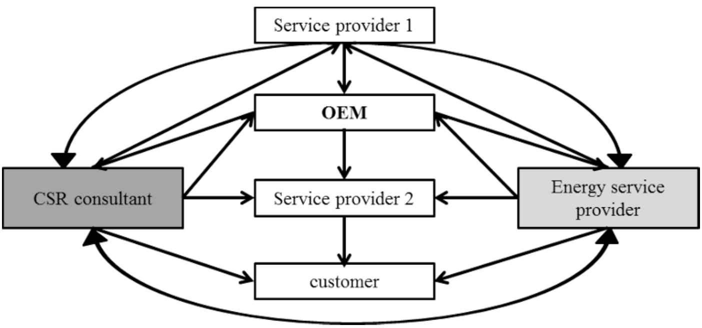

Figure 58: Energy and CSR KIBS in the context of Industrial Service Networks
Source: by author based on Esser and Seiter (2015)

As such, industrial services historically are well established sections in the producing industry. As Esser and Seiter (2015) found out the share of industrial services on the total revenue of the German machine and plant construction sector is around 20%. On a European level, almost every producing company offers industrial services. These numbers relate to the traditional industrial production branches. The energy sector however just recently developed to be part of the industrial services sector. As it is a very specific sector, it cannot be integrated into the traditional industrial services, but no industrial service provider can exist without the energy services sector. As a logical consequence traditional industrial service providers and the energy service providers need to co-work. With that a new variant of the concept of industrial service networks was created. As Figure 58 illustrates, there can be very close relations between industrial service providers, manufacturers, energy service provider and the customers. The wind energy market can be taken here as an example. KIBS focusing on servicing wind mills need to be highly specialized as Weber (2015d) confirms. On the other end, also CSR consultants are valid examples of KIBS in this context. Besides cross organizational special knowledge they also need to be trained and skilled in organizational relevant subjects form the areas of environment and social (Lotter and Braun, 2014). As such they are directly connected to the energy service KIBS and serve as a kind of key coordinator /umbrella for all environmental aspects.

Some of the OEMs producing wind mills also have service departments. However, looking at the number of around 35,000 installed wind mills in Germany alone (2014) there is a strong and increasing demand for KIBS servicing wind mills. Those need to be in close contact and communication with the OEM, the operator as well as with the grid operator in order to ensure that no financial losses at the operator side occur nor grid instability would jeopardize the regional power supply. As Tantau and Nichifor (2014) confirm, new sustainably business models in the wind industry in order ensure sound investment prospects of enterprises in the wind energy business.

Due to the complexity of the energy sector in terms of “frequently changing” national regulations and procedures, especially in the international context such networks and partnerships play an important role (Müller-Seitz, 2015; Engel et al., 2015; Bröker, 2014). This importance is resulting from the aforementioned complexity in each national market and the differing regulations between the markets, forcing the producing company to focus on their core business and letting the energy service sector be handled by nationally specialized KIBS. Müller-Seitz (2015) as well as Hogreve and Velleuer (2015) underline the complexity of managing, steering and controlling such networks (Figure 59), especially once there are more than two partners involved.

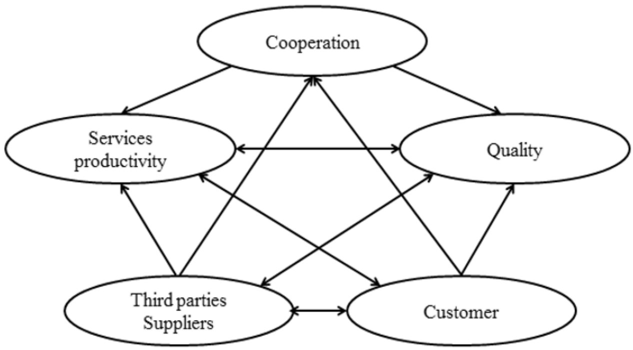

Figure 59: Actors and influence factors in Industrial Service Networks
Source: Hogreve and Velleuer (2015)

Hogreve and Velleuer (2015) define the fundamental management functions of Industrial Service Networks as design, activation, mobilization and synthesis. Their model describes these factors for managing Industrial Service Networks from viewpoint of the producing company and the prospect of the network. Even though they mention the need for creation of trust in the network as well as for establishing a network wide knowledge base, they are not explicitly mentioning confidentiality agreements and the process of handling this network wide knowledge, but mention the demand for additional research focusing on the differentiation of the provided services (Hogreve and Velleuer, 2015).

Especially in the context of energy services, the energy KIBS need to experience "open books policies" with the companies they consult. This includes receiving financial data, exact process information, historical as well future strategy information – all very sensitive data which needs to be carefully and trustfully be dealt with; in particular once competing companies are members of the networks, so called branch-networks.

In Germany, such branch-energy-efficiency-networks exist and their formation is under certain conditions even sponsored by the federal government. Seiter and Marquard (2015) conclude in their research that incentive schemes can be a central steering instrument in managing Industrial Service Networks. Being in process of setting such a network in the automotive car dealer sector up, the author's practical experience shows that governmental incentives are indeed a magic element during the designing process of such networks in the energy services sector. His practical knowledge also confirms that once the right partners are being brought together, strict rules and guidelines are defined and precisely followed, competitors can become cooperation partners.

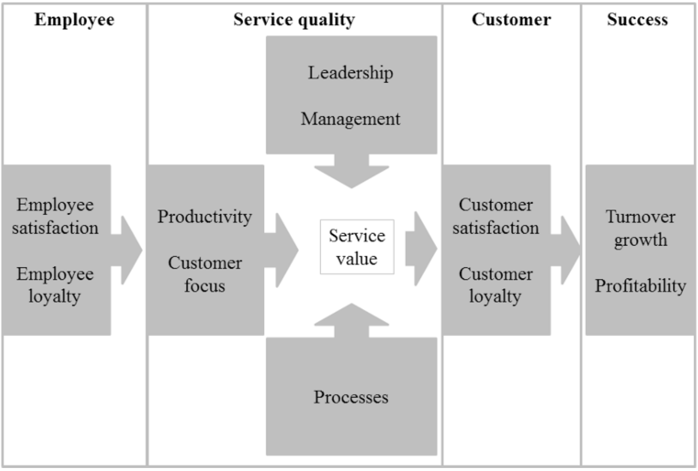

Figure 60: Service value chain
Source: Eller (2015)

In any of the shown scenarios, service quality and customer focus factor are key for a successful set-up a KIBS network as Eller (2015) and Meffert et al. (2015) point out. Only if all elements work nicely together, the success of the set-up can be ensured on the long-term (Figure 60). Hereby the employee section only works out successfully, if the internal service quality (such as work surrounding, training options, employee recruitment process, compensation, etc.) supports the employee satisfaction. This though will lead into employee loyalty and performance which both are closely connected and influence each other. The customer loyalty on the side is a result from the customer's satisfaction, turning into repurchases and recommendations of the service provider (Eller, 2015; Bruhn and Hadwich, 2015).

KIBS as Energy Consultation Services in Germany

Today's energy economics is characterized by a complex legal structure, resulting in the need for intensive management consultation as in terms of process, technology as well as legal. As a result several law offices in Germany developed also to KIBS in the energy sector, being specialized on the approval processes for power plants, which is extremely complex in the case of wind and solar PV power generation. Another area of activity for them is the sector of contracting (Weber et al., 2016).

With the growing number of decentralized renewable energy plants, on the other hand, the management of virtual power plants, the management of the power grid and the operation processes became more and more complex. Accordingly, smart and flexible software and hardware packages are required in order to keep the power system steady and stable, requiring specialized KIBS. As more and more power generation plants grow decentral, they need to be connected to the grid, require special alarm systems to avoid illegal access, damage to the system and theft. Consequently highly specialized KIBS in the area of telecommunication are required to care of that. Another sector for KIBS in the energy context is informatics, as special tools and software are required to ensure a stable power grid and protection from cyberattacks (Hohan et al., 2014).

In literature KIBS are being differentiated from other services by two attributes: intangibility and interaction (considered by Den Hertog, 2000; Miozzo and Grimshaw, 2005; Grimshaw and Miozzo, 2006; Miozzo and Grimshaw, 2006; Leiponen, 2005; Leiponen 2006;). Hereby intangibility describes the evaluation process of the services provided by KIBS. With no objectivity in the process, both, the KIBS service receiver as well as the service provider need to develop a high level of trust and goodwill. On the other hand, as both partners depend on each other, interaction describes during the developing process of the service product the need for close cooperation between the KIBS service provider and service receiver (Kohleick, 2008).

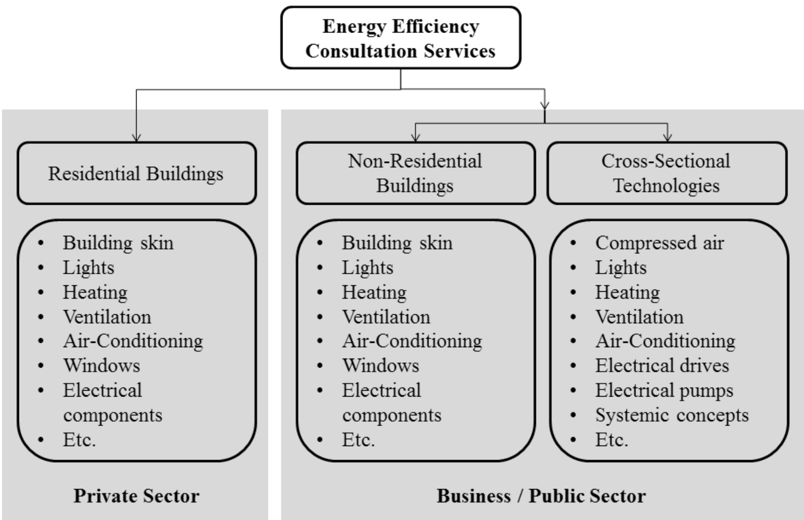

Figure 61: Energy Efficiency Consultation Services in Germany
Source: by author based on his research, ref. to Weber et al. (2016)

In the context of outsourcing services to KIBS, Cuganesan at al. (2006) and Barthemely (2003) describe the risk to fail as well as the potential success of the outsourced business service. The risk for failure hereby is higher, in case the outsourcing organization benefitting more from the deal as the KIBS. ***Deloitte Consulting (2005), ***Outsourcing Times (2005) and Preston (2004) researched that around 50% of the outsourced KIBS faced an early end by being insourced again.

In Germany Energy Efficiency Consultation Services exist for some years already. Herby two main services can be identified: buildings (residential and non-residential) and cross-sectional technologies (industry). In the case of customer groups, also two groups can be found: private households and enterprises (Weber et al., 2016).

As Figure 61 lies out, the Consulting Sector in the area of energy efficiency in Germany benefits from three areas of business activities with specific requirements as a result from this constellation resulting from the different requirements in each of the pillars.

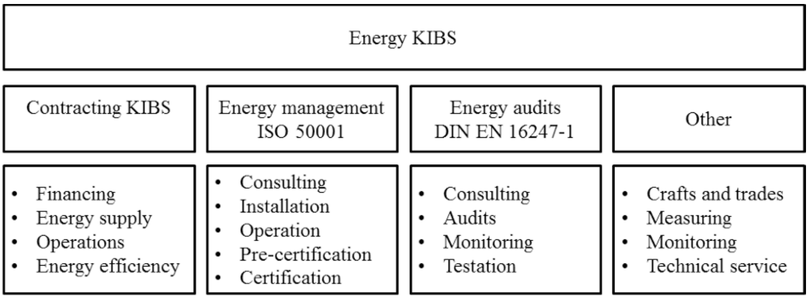

Figure 62: Kinds of energy KIBS
Source: by author based on his research

Public buildings hereby differ from residual homes as they serve as working places. As such they need to fulfil besides the energy efficiency policy also additional requirements such as workstation requirements in terms of light intensity and quality as well as industrial safety regulations (Weber et al., 2016).

The European Energy Efficiency directive (2012/27/EU) was implemented by the German government in 2014 with the *National Energy Efficiency-Action Plan (NEEAP) 2014* becoming effective. Consequently, the market for KIBS in the area of energy services in Germany was reorganized. This new layout supported a further transparent, competitive and manifold development of the energy services sector.

Going along, the energy service sector was composed by three several main segments (***BMWi, 2014c):

1. Contracting services
2. Energy management services
3. Energy audits / energy consultancies

On top, a much wider network of specialized services (KIBS) connected to the aforementioned sectors, such as:

- Communication technology
- Facility management
- Network engineering
- Software development
- Insulation services for buildings
- Monitoring, measuring and metering services

Each of these services can only survive in coexistence and cooperation and require their own special set of knowledge themselves (Weber et al., 2016) (Figure 62).

Contracting KIBS

Contracting is in accordance to the DIN 8930-5 industry norm defined as, dealing on its own account, the temporal and areal defined transfer of responsibilities regarding energy allocation and supply to a third party. Four types of energy contracting are laid out (***BMWi, 2014c; Weber et al., 2016):

- Financing Contracting: the contractor funds, plans & builds an energy production site. He benefits through the provided financial service. The system is being operated by the contracting partner.
- Energy Supply Contracting: the contractor funds, plans, builds and operates an energy production site. The contracting partner receives the energy at beforehand agreed conditions.
- Operating Management Contracting: the contactor operates an already existing power production site.
- Energy Saving Contracting: the contractor funds, plans, executes and operates measures on energy efficiency. The contracting partner benefits through a beforehand agreed share of the saved energy cost.

With a share of 84%, Energy Efficiency Contracting was the contracting version mostly setup in Germany in 2014. Growth rates of 8 to 14%, make contracting to the growing business models in the energy services sector in Germany (***Prognos et al., 2013; ***VfW, 2015; Weber et al., 2016).

Energy management services KIBS

The industry norm ISO EN DIN 50001 defines energy management services globally. The services in this sector comprise energy management systems for production processes, buildings as well as for combinations of both, software development, evaluation and measuring of energy consumption data, concept development, installation of energy management systems and certifications as well as consulting (***Prognos et al., 2013). According to a study the number of 3.240 certified energy management systems was registered by March 2014 in Germany. This reflects around 1% of the registered enterprises registered in Germany at that time (***BMWi, 2014c).

Energy audits / Energy consulting KIBS

There is no central register administering consultation services in Germany. In lieu thereof a variety of databases is on the market for energy consultants and auditors to register. As being independently operated, some of them concentrate on certain sectors such as industry, or buildings, others combine several. Consequently, one searching for a consultant is being challenged during the process of identifying a qualified energy efficiency expert. With the beforehand mentioned implementation of the EU Energy Efficiency Directive, two databases operated by German authorities in charge of managing the energy audit process (BAFA and dena), developed to be the place to go to find a qualified energy expert. Prior being listed in these databases, energy consultants and auditors had to proof qualification and experience following a clear set of requirements. In addition, only these auditors are, according to the EU Energy Efficiency Directive, accredited to apply for governmental subsidies supporting the execution of energy efficiency measures of their customers. On top and under certain conditions, their consultation service is proportionately being subsidized by the government. (***BAFA, 2015e).

During an energy audit, information of the actual energy consumption profile of industry processes, buildings, and/or industry sites is being systematically collected in order to quantify potential energy efficiency measures. In a next step, these need to be evaluated and the results are to be summarized in a specific report (***BMWi, 2014c). Energy audits are also obligatory requirement prior installing certified energy management systems according to the DIN EN ISO 50001 industry norm. Details for energy audits in general are defined in the DIN EN 16247-1 industry norm.

According to Prognos et al. (2013) the market of energy consulting service providers in Germany is mastered by the small enterprises (75% of which with up to five employees). Their latest research revealed that in 2011 around 370,000 to 410,000 energy consultations were managed in Germany resulting in an estimated turnover between 264 and 457 Mio. Euro (***BMWi, 2014c). Surprisingly, subsidized energy audits were with 19,271 in the same year at a much lower level with a decreasing trend. In addition, 95% of the energy audits were done in the building sector, leaving only 5% for the industry sector (***BMWi, 2014c). KIBS specialized on energy audits in buildings however face a very competitive price market and struggle making any profit (Weber et al., 2016). I order to turn this decreasing trend around and to motivate companies to put more effort in energy efficiency activities the subsidy program was renewed with January 2015.

BCOT analysis of energy KIBS

In general businesses are being evaluated by using the traditional SWOT analysis, detailing out their strength (S), weaknesses (W), opportunities (O) and threats (T). In the context of energy KIBS, strength are more benefits (B) and as weaknesses the cost (C) factor is dominant. Therefore, ***ewi (2014) studied several energy related businesses in their BCOT-analysis (benefits (B), cost (C), opportunities (O) and threats (T). Focusing on the energy KIBS in their study, the sectors of smart metering and energy efficiency monitoring can be identified. In all those they identified the lack of qualified employees as a key threat. The qualification element is also a key cost factor, as special knowledge needs to be acquired. This cost factor concerns hereby employers as well as future employees. In consequence this leads also to higher personnel cost as higher qualified employees require higher salaries. As an example for higher education cost Eiselt (2012) refers to the heating sector where the correct execution of a hydraulic calibration of heating systems is legally required. Other costs occur through the necessary installations of hard- and software for proper smart metering and energy monitoring processes. These threats and cost however face certain benefits. The market demand for high energy efficient products is rising on one hand; legal regulations require the installation of monitoring systems on the other hand. In addition, effective monitoring and smart meter systems also help the producer in his own manufacturing processes to reduce energy consumption ergo cost. Own research by the author confirmed these findings.

In Germany, the implementation of the European Energy Efficiency Directive (2012/27/EU) followed a two-group approach differentiating SMEs and non-SMEs. In October 2014 the German Directive for Energy Efficiency Consulting for SMEs was legally approved and became effective January 2015. This concept replaced and improved the previously available KfW-program for SMEs. It ensures that energy audits to SMEs under certain conditions are now supported with 80% of the consulting fee. In the first wave, this subsidy program was approved until end of 2015 only, being recently expanded for another four years. Besides the general procedures for energy audits, the directive also precisely defined the required sets of qualification, experience and requirements for energy auditors. Accordingly, the auditors need to validate their qualifications through diplomas as well as a professional work experience and history, backed-up by relevant reference projects throughout the last three years (***BMWi, 2014d; ***BAFA, 2015c).

Mid-April 2015, the novel of the German law for energy services (EDL-G) for non-SMEs became effective. It defines the set-up, auditor qualification requirements and procedures for energy audits for non-SMEs in Germany (***BAFA, 2015d). Legally, all concerned companies were to perform an energy audit latest by December 5th, 2015 (***BAFA, 2015e). These EDL-G energy audits have to be renewed every four years, a chance for KIBS in the energy business.

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Sustainability and Energy Management
Innovative and Responsible Business Practices for Sustainable Energy Strategies of Enterprises in Relation with CSR
Weber, G.
2018, XXIII, 269 p. 182 illus., Softcover
ISBN: 978-3-658-20221-7