Obstacles to Energy Efficiency
The incentive mismatch between the industry and the Energy Efficiency Directive
Obstacles to Energy Efficiency
The incentive mismatch between the industry and the Energy Efficiency Directive

By

L.S. de Kleijn

in partial fulfilment of the requirements for the degree of

Master of Science
in Management of Technology

at the Delft University of Technology,
to be defended publicly on Thursday July 9, 2015 at 14:00 PM.

Supervisor: Dr. ir. R.M Stikkelman, TU Delft
External supervisors: Dr.-Ing. C.-P. Hälsig, Fluor B.V.
Dr. J.C. Göebel, Fluor B.V.

Thesis committee: Prof. dr. C.P. van Beers, TU Delft
Dr. ir. R.M Stikkelman, TU Delft
Dr. S.T.H. Storm, TU Delft

This thesis is the public version. Confidential information has been removed.
Preface

This Thesis is the final step of my MSc programme Management of Technology at the TU Delft. During my Bachelor in Mechanical Engineering I have developed an interest in the energy challenge of the upcoming decennia; hence my thesis is about the obstacles to energy efficiency in which my interests in technique, business and the energy challenge are combined.

My close collaboration, during my internship, with the Engineering, Procurement, Construction and Maintenance (EPCM) company Fluor supported me in the best way possible. Moreover, the interviews that I have conducted with industry players suited my thesis and personality well, because it made my working environment dynamic. Evaluating the information from the interviews and connecting it to the academic theory was an interesting challenge, which was for me the ultimate learning experience of the master programme.

The many persons that contributed to this Thesis and to whom I am grateful are thanked in a special chapter near the end of my Thesis.
I hope that my Thesis will enrich the readers’ knowledge, the same way as it did mine; both practically and scientifically.

L.S. de Kleijn
Delft, June 2015
Executive Summary

This Thesis report is part of the 2-year MSc programme ‘Management of Technology’ at the TU Delft. To finish this programme an individual research related to business and technology has to be conducted. By means of this thesis about the obstacles to energy efficiency (done in close cooperation with the company Fluor B.V. Amsterdam) the MSc programme is completed.

The starting point of this Thesis was the observation that the industry in Europe is experiencing difficulties to reach the 20% increased energy efficiency target (EC, 2014a) of the 2012/27/EU Energy Efficiency Directive (EED) of the European Union (EU) (EEA, 2013). The main aim of this research was to identify the obstacles faced by the Dutch refining and (petro)chemical industries in reaching the target of the EED. These industries were of interest because their continuous processes are highly energy intensive (Blok, Hofheinz, & Kerkhoven, 2015; CBS, 2014; Kampman, de Buck, & Croezen, 2011). By identifying the obstacles that these industries face several recommendations could be made to enhance the EED in order to reach its target. This was also an objective of this research.

An exploration of the problem identified that the influences on the industry's decision making process, which cause obstacles in reaching the EED's target, were unknown. It was assumed that the regulators have social incentives and the industry economic incentives, which results in an incentive mismatch. The presence of an incentive mismatch is one of the core assumptions of the Principal-Agent Theory (PAT), which has been used to analyse the results. The PAT has never been used before to analyse a whole industry chain, creating scientific relevance.

The obstacles to energy efficiency were identified by means of 23 qualitative interviews with companies and organizations from the whole industry chain, e.g. regulators, R&D organizations, operating companies, etc. The analysis using PAT identified that the industry consists of both hierarchical relationships and network relationships, which have different characteristics. The PAT is, after making a unique combination of many adjustments as suggested by independent scholars, suitable for identifying these relationships. However, the industry's network relationships result in seven shortcomings that make the PAT unfit for further analysis. These shortcomings have been described and they identified two gaps in the academic literature. One concerns the uncertainty with regard to the correctness of the claim of many scholars that organizations can be analysed by means of the PAT. The second concerns the assumption that the industry chain can indeed be analysed as an organization.

An analysis of the EED and the Dutch legislation was performed to identify the areas of overlap and gaps with the industries’ decisions and the legislation's implications. The EED approaches the industry as if it is just hierarchical, is only consisting of operating companies and is motivated by economic incentives alone. By this study this approach of the EED is proven to be insufficient to remove the largest obstacles to energy efficiency. The most important obstacles that were identified are risk, costs, profits, market demand, regulation and existing cultures in the industry. Most of the obstacles are social (non-monetary/behaviour/habits) in nature, which is not in line with the original study's assumption and to the EED's approach. Six recommendations have been made to overcome these obstacles that aim to create an industry and a society wide energy efficiency culture. Most of these proposals require future research to come to an action plan.
Contents

EXECUTIVE SUMMARY ........................................................................................................ VII
TERMS AND ABBREVIATIONS .......................................................................................... XIII
LIST OF FIGURES ................................................................................................................ XV
LIST OF TABLES .................................................................................................................... XV

1. INTRODUCTION ................................................................................................................ 1
   1.1. GENERAL PROBLEM DESCRIPTION ........................................................................ 1
   1.2. PROBLEM ANALYSIS .............................................................................................. 2
   1.3. PROBLEM STATEMENT .............................................................................................. 5
   1.4. OUTLINE OF THE REPORT ......................................................................................... 5

2. THEORETICAL FRAMEWORK ........................................................................................... 6
   2.1. SCOPE ......................................................................................................................... 6
   2.2. INCENTIVE MISMATCH ............................................................................................... 7
   2.3. POSSIBLE APPLICABLE THEORIES .......................................................................... 7
   2.4. PRINCIPAL-AGENT THEORY ...................................................................................... 8
   2.5. THE PRINCIPAL-AGENT MODEL’S CHARACTERISTICS ........................................... 9
   2.6. CONCEPTUAL MODEL ............................................................................................... 10
   2.7. RESEARCH QUESTIONS ............................................................................................. 12
   2.8. RELEVANCE OF THE RESEARCH ........................................................................... 13
   2.9. CHAPTER SUMMARY ................................................................................................ 13

3. RESEARCH METHOD .......................................................................................................... 14
   3.1. DESK RESEARCH ....................................................................................................... 15
   3.2. EMPIRICAL DATA COLLECTION ............................................................................... 15
   3.3. DATA ANALYSIS ....................................................................................................... 16
   3.4. ANALYSIS OF RESULTS AND EVALUATION .......................................................... 18
   3.5. CHAPTER SUMMARY ................................................................................................ 18

4. ENERGY EFFICIENCY LEGISLATION .............................................................................. 19
   4.1. EUROPEAN ENERGY EFFICIENCY DIRECTIVE ...................................................... 19
   4.2. DUTCH NATIONAL POLICY ....................................................................................... 21
   4.3. RESPONSIBILITIES ...................................................................................................... 25
   4.4. MAIN INCENTIVES FOR INDUSTRY ......................................................................... 25
   4.5. APPLICATION OF INFORMATION REGARDING THE LEGISLATION ......................... 26
9. EVALUATION OF THE SUITABILITY OF THE PAT & OVERALL EVALUATION ........................................ 76
  9.1. CONCLUSION OF ANALYSIS WITH THE PAT ................................................................. 76
  9.2. SCIENTIFIC CONTRIBUTIONS ......................................................................................... 79
  9.3. OVERALL EVALUATION OF THE RESEARCH ............................................................. 79
  9.4. CONTRIBUTIONS TO PRACTICE .................................................................................... 83
  9.5. LESSONS LEARNED FROM THE RESEARCH ............................................................... 83
  9.6. CHAPTER SUMMARY ..................................................................................................... 84

10. CONCLUSIONS AND RECOMMENDATIONS ........................................................................... 85
  10.1. CONCLUSIONS ............................................................................................................. 85
  10.2. RECOMMENDATIONS FOR FUTURE RESEARCH ...................................................... 88

REFERENCES ............................................................................................................................. 91

APPENDIX
A. LEGISLATION OVERVIEW ................................................................................................. 95
B. INTERVIEW QUESTION LIST .............................................................................................. 97
C. ELUCIDATION OF THE QUESTIONS .................................................................................. 100
D. INTERVIEWEES .................................................................................................................. 102
E. INFORMATION ABOUT FLUOR .......................................................................................... 103
F. ACCOMPANYING LETTER ................................................................................................. 104
G. CODE TAXONOMY ............................................................................................................ 105
H. CODED INTERVIEW SUMMARIES ...................................................................................... 109
I. CODE FREQUENCY ............................................................................................................. 110
<table>
<thead>
<tr>
<th>Term or abbreviation</th>
<th>Explanation as used in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Author, year)</td>
<td>Reference to external source</td>
</tr>
<tr>
<td>[chapter.section.subsection]</td>
<td>Reference to internal source</td>
</tr>
<tr>
<td>Activiteitenbesluit</td>
<td>Activities Decree</td>
</tr>
<tr>
<td>Agent</td>
<td>The one that must execute the assignment of the delegator, who is the principal.</td>
</tr>
<tr>
<td>Ambiguity effect</td>
<td>Choosing a project with a known outcome over a project with an uncertain outcome.</td>
</tr>
<tr>
<td>BAT</td>
<td>Best available technique</td>
</tr>
<tr>
<td>BuZa</td>
<td>Ministry of Foreign Affairs</td>
</tr>
<tr>
<td>CHP</td>
<td>Combined heat and power (WKK)</td>
</tr>
<tr>
<td>Consultants</td>
<td>Companies that only provide advice to their clients, they do no engineering work.</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>Economic incentive</td>
<td>An incentive directly related to economic benefit or harm.</td>
</tr>
<tr>
<td>EEP</td>
<td>Energy efficiency plan</td>
</tr>
<tr>
<td>EIA</td>
<td>Energy investment allowance (energie investerings aftrek)</td>
</tr>
<tr>
<td>ENEMS</td>
<td>Energy management system, which is a system that commits the whole company to becoming more energy efficient.</td>
</tr>
<tr>
<td>Energieakkoord</td>
<td>Energy Agreement</td>
</tr>
<tr>
<td>Energy audits</td>
<td>A research into a company's energy consumption</td>
</tr>
<tr>
<td>ETS</td>
<td>Emissions Trading Scheme</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EZ</td>
<td>Ministry of Economic Affairs (Ministerie van Economische Zaken)</td>
</tr>
<tr>
<td>I&amp;M</td>
<td>Ministry of Infrastructure and Environment</td>
</tr>
<tr>
<td>License to Operate</td>
<td>License that is granted by the authorities of the society that is directly affected by the business’ operations.</td>
</tr>
<tr>
<td>MEE</td>
<td>Long-Term Agreement regarding the energy efficiency of mainly ETS enterprises (Meerjarenafspraak Energie Efficiëntie)</td>
</tr>
<tr>
<td>MJA3</td>
<td>Long-term Agreement 3 (Meerjarenafspraak 3) regarding energy efficiency of mainly non-ETS enterprises</td>
</tr>
<tr>
<td>MJP</td>
<td>Multiannual energy efficiency plan (meerjarenplan)</td>
</tr>
<tr>
<td>Moral hazard</td>
<td>Opportunistic behaviour due to not experiencing negative consequences of one's actions.</td>
</tr>
<tr>
<td>Mtoe</td>
<td>Million tons of oil equivalent, the amount of energy that is generated when burning one million ton of oil.</td>
</tr>
<tr>
<td><strong>Nash equilibrium</strong></td>
<td>The outcome of the strategy companies employ is less than the maximum outcome resulting from employing another strategy.</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>NEEAP</strong></td>
<td>National energy efficiency action plan</td>
</tr>
<tr>
<td><strong>Operating companies</strong></td>
<td>Companies that operate the production plants and factories.</td>
</tr>
<tr>
<td><strong>Opportunistic behaviour</strong></td>
<td>The agent opportunistically benefits by pursuing its private goals, which induces a cost on the principal.</td>
</tr>
<tr>
<td><strong>PAT</strong></td>
<td>Principal-agent theory</td>
</tr>
<tr>
<td><strong>Principal</strong></td>
<td>The one that delegates his assignment to another, who is the agent.</td>
</tr>
<tr>
<td><strong>Regulators</strong></td>
<td>All governmental agencies</td>
</tr>
<tr>
<td><strong>ROI</strong></td>
<td>Return on investment</td>
</tr>
<tr>
<td><strong>RVO</strong></td>
<td>Rijksdienst voor Ondernemend Nederland (Netherlands Enterprise Agency)</td>
</tr>
<tr>
<td><strong>SME</strong></td>
<td>Small and medium enterprises</td>
</tr>
<tr>
<td><strong>Social incentive</strong></td>
<td>An incentive not directly related to economics. Limiting climate change by reducing the costs of negative externalities is also included.</td>
</tr>
<tr>
<td><strong>Split-incentives</strong></td>
<td>The one that bears the costs of the investment is not the same as the one that is getting the benefits of the investment.</td>
</tr>
<tr>
<td><strong>Transfer agents</strong></td>
<td>Engineering companies and engineering, procurement and constructing (EPC) companies</td>
</tr>
<tr>
<td><strong>Vendors</strong></td>
<td>All companies that can be related to equipment providers, equipment manufacturers and trading companies.</td>
</tr>
<tr>
<td><strong>Wet Milieubeheer</strong></td>
<td>Environmental Management Act</td>
</tr>
</tbody>
</table>
List of figures

Figure 1: Pay-off matrix. ......................................................... 9
Figure 2: Conceptual model. ...................................................... 11
Figure 3: Research framework. .................................................. 12
Figure 4: Visual overview of the research method and its relationships .................................................. 14
Figure 5: Visual representation of the legislation regarding energy efficiency ............................................ 26
Figure 6: The obstacles to energy efficiency as perceived by the interviewees of the industry. .......................... 29
Figure 7: The different motivation levels of the participants, ............................................................................. 30
Figure 8: Chart that clarifies which relationships are mentioned in each interview. ........................................ 31
Figure 9: The principal-agent relationships in the group of the regulators. ..................................................... 32
Figure 10: The principal-agent relationship of the universities. ................................................................. 33
Figure 11: The principal-agent relationship of the R&D organizations, .......................................................... 34
Figure 12: The principal-agent relationships of the vendors group. ............................................................. 35
Figure 13: The principal-agent relationships of the transfer agents. ............................................................ 35
Figure 14: The principal-agent relationships of the operating companies. .................................................... 36
Figure 15: The two principal-agent relationships of the consultants. ........................................................... 37
Figure 16: The two principal-agent relationships of the branch organizations. ............................................. 37
Figure 17: An example of a network overview. ................................................................................................. 100

List of tables

Table 1: A snapshot of the manual coding procedure as advised by Saldaña (2013). ........................................ 17
Table 2: Overview of the goals of the industry in percentages ........................................................................... 27
Table 3: Overview of the identified obstacles in percentages ........................................................................... 28
Table 4: Goals of the EU and the industry ........................................................................................................... 40
Table 5: The exogenous influences on the decisions made by the industry. ......................................................... 46
Table 6: Recap of the analysis of Section 6.1 up to and including Section 6.3. .................................................. 48
Table 7: Summary of the gaps between the legislation’s implications and the decision making process ................................................................................................................................. 71
Table 8: Overview of combining the gaps and the proposals for enhancement .................................................. 75
Table 9: Conclusions of the areas of overlap between the legislation and industries’ decisions ....................... 86
Table 10: Overview of the analyzed legislation .................................................................................................. 95
Table 11: Overview of the interviewees ............................................................................................................... 102
Table 12: Applied code taxonomy based on the article by Cagno et al. (2013). .................................................. 105
Table 13: Sequence of the companies’ coded interview summaries .................................................................... 109
Table 14: Industries’ obstacles code frequency. .................................................................................................. 110
Table 15: Industries’ goals code frequency. ....................................................................................................... 111
Chapter 1: Introduction

The general problem as known by society with regard to energy efficiency is described in Section 1.1. Next Section 1.2 analyses the general problem to confirm that it is a problem worth researching and to identify whether the problem can be made more specific. Section 1.3 introduces the problem statement with regard to this research and Section 1.4 provides a brief outline of this report’s content.

1.1. General problem description

Fossil fuels are becoming exhausted, greenhouse gases are causing serious danger to the climate of the earth, and the West Antarctic glaciers melting rate has tripled during the last ten years (NASA, 2014). These are only three of the many negative consequences of excessive energy demand and consumption. However, people require energy for their basic needs like food and clean drinking water, but also for more luxurious goods like cars. More importantly, energy is essential to keep the economy going. In the upcoming years, global energy demand is predicted to increase, i.e. by 56% in 2040 with respect to 2010 (EIA, 2013). This causes an additional problem, because nowadays the world population already demands more energy resources than the earth can generate (WWF, 2014). To be more exact, humans currently demand 1.47 planets (Borucke et al., 2013). This emphasizes that a solution for the anticipated excessive energy consumption has to be found quickly.

The European Commission (EC) acknowledged the problem and became actively involved in making policies to stimulate the market share of renewable energy sources already around 1997. One example is the Renewable Electricity Directive 2001/77/EC, which is a directive about the share of electricity that has to stem from renewable energy sources (Klessmann, Held, Rathmann, & Ragwitz, 2011). Throughout the years several directives regarding the use of renewable energy sources emerged that had to limit the causes of climate change.

The Energy Efficiency Directive (EED), also known as 2012/27/EU, is a relatively new European directive and is part of the so called 20-20-20 targets. The latter entails that greenhouse gas emissions have to be lowered by 20% with respect to 1990 levels, that 20% of final energy consumption has to be renewable and that energy efficiency has to be increased by 20% (EC, 2014a) compared to projected efficiency over 2007-2020 (EC, 2015a). All three targets are to be obtained no later than 2020. However, the latter objective, increasing energy efficiency, is experiencing serious difficulties. Model runs done by the European Commission showed that only 9-10% industrial energy efficiency will be reached by 2020 if the current trend continues (EEA, 2013). Because industries are one of the largest energy consumers in the world (Palm & Thollander, 2010) enhancement of the EED apparently is required (EC, 2013b).
1.2. Problem analysis

That the industry is predicted not to reach the 20% energy efficiency goal of the EED causes a problem that is worth further exploration, which is done in this section. What is energy efficiency, what work is already done by other scholars regarding this topic and is it worth it to study the general problem in detail? These questions will be addressed in the following subsections.

1.2.1. Energy efficiency

Taking the Energy Efficiency Directive 2012/27/EU (EED) as a starting point, it is important to know what energy efficiency is. First of all it concerns electricity consumption, fossil fuel consumption, raw material usage and any other form of energy consumption in the production process. The concept of energy efficiency implies that the lowest possible amount of energy ought to be consumed during a particular process. Different measures exist to determine energy efficiency. The most general and frequently used measure is to divide the useful output of a process by the energy input (Giacone & Mancò, 2012; Patterson, 1996). Also, most processes become more efficient if the output increases. In other words, the energy per product produced decreases if the output of a factory increases. The total energy consumption can nevertheless be higher than before, because of the increased production. Hence, becoming more energy efficient does not necessarily result in lower energy consumption on a total scale.

The difference between potential energy efficiency and the energy efficiency measures that are actually being implemented by the industry is referred to as an energy efficiency gap (Backlund, Thollander, Palm, & Ottosson, 2012; Jafarzadeh & Utne, 2014; Jaffe & Stavins, 1994a; Newell, Stavins, & Gerarden, 2015). The energy efficiency gap is exactly what the EED addresses. The EED takes as a fact that techniques are available that would reduce current energy consumption (Palm & Thollander, 2010). These techniques are known as Best Available Techniques, abbreviated to BAT (Letser, Desroches, Ke, & McNeil, 2013). Moreover, the EC made a document that specifies in detail which techniques are meant by the BAT claim. Industries appear to be hesitant to apply BAT, resulting in an energy efficiency gap. This entails that the EED target of 20% increased energy efficiency is at risk.

1.2.2. Energy efficiency obstacles

Scholars have done much work in the identification of potential obstacles towards adopting energy efficiency measures. A few examples of possible obstacles are the following: financial capability of the firm or consumer, lack of sufficient regulation and policies by the government, lack of proper information, and the lack of available technologies (Cagno, Worrell, Trianni, & Pugliese, 2013; Chai & Yeo, 2012; Worrell, Bernstein, Roy, Price, & Harnisch, 2008). But despite of the abundance of barrier analyses, the energy efficiency gap remains. Moreover, overcoming the energy efficiency gap seems to be more complicated than one might expect. For why are industries still hesitant to overcome the barriers to increase energy efficiency, if the correct barriers are addressed and in case implementation of energy efficient technologies, like BAT, can be done in a cost-effective fashion (Backlund et al., 2012; DeCanio, 1993)? According to DeCanio (1998) it is even possible to increase profits by implementing energy efficiency measures.

Maximizing profits under perfect information is seen, by managerial theorists, as a driver of firms’ decisions that leads to rational behaviour (Himmelweit, Simonetti, & Trigg, 2011). Following this line of reasoning and since the industry consists of many firms and
organizations, these firms and organizations are expected to make decisions that will maximize their profits. This would mean that industries that have the opportunity to implement cost-effective energy efficient technologies, but choose not to apply them, are not rational. They create the so called ‘efficiency paradox’ (DeCanio, 1998; Fri & Savitz, 2014; Jaffe & Stavins, 1994b; Newell et al., 2015). Concluding that firms are simply behaving irrational because they do not apply energy efficiency measures is too short sighted. Hidden factors could be influencing industries’ decisions regarding energy efficiency potential; factors that challenge the assumption of perfect information. These hidden factors are then the obstacles to increase energy efficiency.

As mentioned, industries consist of several organizations. And an organization is not an individual, but consists of many individuals (DeCanio, 1993). These individuals are human beings who have certain behaviours expressed in their actions, opinions and decisions. These actions, opinions and decisions are likely to vary by individual, creating a complex process that distorts the information supply. Not all information will be known by all, nor will each individual have identical motives. As a result, it is understandable that firms do not maximize value, but rather make suboptimal choices (Porter & van der Linde, 1995) and involve in ‘satisficing’ (Simon, 1959). The latter indicates that firms operate on a level that is lower than the theoretically highest possible level, because they are unable to maximize value. Firms look for satisfactory outcomes instead (Himmelweit et al., 2011).

Satisficing is a phenomenon that assumes bounded rationality, meaning that people act on the constrained level of resources they have available, like capabilities, information and time, instead of complete resources (March, 1978). The decisions made are satisfactory to those who made them, but they could neglect a more profitable option (Himmelweit et al., 2011). Some people prefer short-term benefits over long-term benefits (Laibson, 1997), indicating that organizations may not want to invest in the energy efficiency techniques that are more expensive in acquisition than ‘old’ techniques, but nevertheless more cost-efficient in the long-term. Also the ambiguity effect could play a role (Camerer & Weber, 1992), which means that a known outcome is preferred over a new uncertain one, i.e. the new energy efficiency technique. These factors, which would limit organizations to operate on the theoretically optimal level, can be seen as market failures. Market failures offer the government a valid reason to intervene (Jaffe & Stavins, 1994b).

1.2.3. Regulation

The decision making processes within firms are the sum of the decisions made by the individuals within that organization. According to Olson (1965) some sort of coercion is required to have these individuals act in the common interest of the organization. This line can be drawn further to the level of decisions made among the different organizations of the industry chain. The larger the group, the more likely it is that the collective interest will not be reached without outside inducements (Olson, 1965). Government interference in the form of regulation, being the coercion, has to ensure that the individual members act in the common interest of increasing energy efficiency. Moreover, Porter and van der Linde (1995) argue that regulation leads to innovation. The more stringent the regulation, the greater the innovation produced. According to them regulation would also lead to more corporate awareness about environmental innovation and it would reduce the uncertainty coinciding with these investments.
The EED could be seen as the governmental regulation to help firms transfer from the satisficing level towards the collective interest and theoretical optimum, i.e. more energy efficient. Government interference has led to positive results with special transition policies in the past (Kemp, 2010), implying that the EED could achieve the same. In order to be successful, it is important that the EED addresses the fault lines in the decision making processes among companies, which are for a large part social processes contradicting the assumption of perfect information (DeCanio, 1998).

1.2.4. Decision making
Regulation, however, has a drawback. The government has a certain objective it wants to obtain by its regulation, which is that industries adopt energy efficiency measures. But, to obtain its goal, the government has to delegate the related tasks to the industry members, since it does not own the plants and factories itself. These industry members, however, can have other goals than the government has and they have probably different objectives between themselves. These objectives can even be conflicting. Moreover, the government will also experience difficulties in measuring how much effort the individual industry members make in reaching the collective goal. This leads to information asymmetry (Laffont & Martimort, 2002) between government and the industry members, because not all information that is known by the latter is known by the former.

It can be concluded that decision making processes within industries are not solely characterized by satisficing due to bounded rationality (Simon, 1959). Although obstacles to energy efficiency can be related to satisficing behaviour, conflicting objectives and information asymmetry among the several actors are most likely to cause obstacles as well. These latter two aspects are the two most important features of the incentive theory (Laffont & Martimort, 2002; Miller, 2005a; Waterman & Meier, 1998).

According to Palm and Thollander (2010), research in the energy efficiency gap should focus on social negotiations and agreements, because that is the road to understand attitudes, norms and routines concerning firms’ actions and decisions. And Rose (2014) argues that the behaviour of employees are to be improved in order to become more sustainable, because behaviour is shaped by the organization. Moreover, an analysis of Fortune 500 companies in workforce diversity and climate change concluded that companies that have a workforce consisting of more women and a stronger European presence are more likely to take measures against climate change (Ciocirlan & Pettersson, 2011). These reasons, and the issues of conflicting goals and information asymmetry, strongly indicate that research regarding the influences on organizational decision making could help to understand why the EED is not able to reach its target and what measures can be taken to turn the tide.
1.3. Problem statement

From the analysis regarding the general problem can be concluded that one important issue with regard to the energy efficiency gap is currently not addressed. This issue concerns the decision making process of the industry and the influences on that process. It is argued by some scholars that such influences could cause the energy efficiency gap, but it has never been researched. This observation leads to the following problem statement:

*The influences on the industry’s decision making process, which cause obstacles in reaching the EED’s target, are unknown.*

1.4. Outline of the report

The outline of the report is as follows: the theoretical framework of this report is described in Chapter 2 in which the scientific relevance of this research and the research questions also become clear. Next the research method is explained in Chapter 3. Chapter 4 provides information about the energy efficiency legislation with regard to the EU and the Netherlands. The empirical results are shown in Chapter 5 and the interpretation of these results is included in Chapter 6. Next Chapter 7 provides an overview of the areas of overlap and gaps between the industries’ decisions and the energy efficiency legislation’s implications. Chapter 8 does several proposals to help the EED reach its target and Chapter 9 includes a detailed evaluation of the research, which also includes an explanation of the scientific and practical contribution of this research. The report concludes with Chapter 10 in which conclusions are done and recommendations for future research are made.
2. Theoretical framework

This chapter explains the theoretical framework of this study. Section 2.1 describes the scope of this study and Section 2.2 explains the concept of an incentive mismatch. Next Section 2.3 briefly mentions what theories were considered for application in this research. Section 2.4 and 2.5 describe why the industry’s struggle to comply with the EED’s target can be seen as a principal-agent problem. Subsequently Section 2.6 illustrates the conceptual model after which Section 2.7 introduces the research questions. Section 2.8 describes the expected relevance of this study and section 2.9 concludes with the chapter’s summary.

2.1. Scope

As mentioned, the European Union as a whole is experiencing difficulties in achieving the industrial energy efficiency goal stated in the EED. This can lead to initiatives to adjust the policies in the future (EC, 2013b). This research’ focus is, within this area, on the Member State the Netherlands, which is also having trouble to reach the objective set for the industry (ECN, 2014).

The concept ‘industry’ is quite broad, asking for a specific definition regarding this research. Oil and natural gas are the most important resources to satisfy final energy consumption. Crude oil has to be processed first before it is ready for consumption, which is done by refineries (EC, 2013a). Refineries consume most of the energy in the petroleum chain and, according to research by Committed to the Environment, could save up to 19% of the energy that they consume (Kampman et al., 2011); hence, it is interesting to know which obstacles the refining industry faces. The refineries produce the raw materials for the chemical and petrochemical industries, which themselves use significant amounts of energy as well (Blok et al., 2015; CBS, 2014). Therefore these industries are included in this study too. The refining, petrochemical and chemical industries can be generalized as process industries.

Within these industries a chain of actors is of interest. In order to get the industry more energy efficient, the EED aims to influence the decisions of operating companies, which are the companies that have the factories and production plants. But these companies are not influenced by the directive and legislation alone, because they employ other companies, like engineering companies, to realize their production plants. But the engineering companies are dependent on the solutions available on the market, which are developed by research & development (R&D) organizations, technology providers, consultants and universities. And these solutions are commercialized by equipment manufacturers, which provide the solutions to the engineering and operating companies. Summarizing, the decisions made by the operating companies are the result of interplay of influences of several actors and are therefore analyzed as a whole. From this point on, this chain of actors is spoken of when ‘industries’ or ‘the industry’ is mentioned. Moreover, this chain of actors is the unit of analysis of this study.
Although it might be interesting to know which new techniques and technologies are under development and whether or not this would enhance energy efficiency, this is outside the scope. Financial investments are also outside the scope. Investments would be specific to a certain project and company, making them of little value for the research objective. Also the law establishment of the EU or the Netherlands is outside this study's boundaries. It would only make the analysis complex and time consuming, without providing significant value in return. Of course there is the possibility that the collected data identifies these points as reasons for specific decision making behaviour. In that case it will be noted, but no further analysis will be done within this study on these aspects. Future research would then be the solution.

2.2. Incentive mismatch

As mentioned, the unit of analysis for this study is the chain of actors in the industry, which is a large group. The government wants to increase energy efficiency for the benefit of the environment and has delegated its task to this large group. The legislation, being the EED, should leave these actors no choice but to implement energy efficiency measures. However, it is expected that the industry is mainly interested in having a positive return on investment (ROI) in order to stay in business and that it has to make a profit for its shareholders. Increasing energy efficiency would therefore not be its direct goal, because energy efficiency investments have often a longer payback time than traditional market driven investments. Hence, it is anticipated that this common energy efficiency objective, which is enforced by the EED, does not align with the individual goals of the several actors of the industry.

Due to the many actors involved that have different personal goals they want to achieve, the failure of achieving the common energy efficiency goal is a multi-actor problem. The individual actors are expected to prefer that others within the group bear the cost of obtaining their common goal (Olson, 1965), because they then opportunistically benefit by avoiding the required investments (Porter & van der Linde, 1995) and can focus on their personal goals instead. As a result, all parties as a group are acting too little to reach the EED target, which is an important reason the energy efficiency gap exists. Because of the information asymmetry, meaning that the industry knows more than the government, the government is expected to have trouble to identify the causes of the problem and to solve it with proper regulation. By identifying the goals, obstacles and relationships among the different actors it becomes clear what drivers these actors have for their decisions. Only then a proper incentive contract, which is the legislation that aligns the goals of all actors, can be made that fulfils its purpose. It is anticipated that the EED currently suffers from an incentive mismatch, i.e. the endangered environment versus the highest ROI, leading to the energy efficiency gap.

2.3. Possible applicable theories

Several theories are considered for application in this research. One of the best applicable theories that could analyse the whole industry chain, which consists of several actors, is the process management theory. This theory is applicable to situations in which multi-actor decision making takes place, which seems to fit an industry well. However, the industry is expected to be hierarchical with regard to its decision making process and the process management theory eliminates that characteristic entirely. Hence, it was not selected. The
principal-agent theory has been identified as the best theory to apply in this research, because it takes account of the legislation (EED) as a contract and tries to explain what issues can arise from such a contract. In other words, it should have the capacity to explain the decision making process of the industry from legislation up to and including the actions of the companies, which fits the scope of this study.

2.4. Principal-agent theory

The principal-agent theory (PAT) has two core assumptions regarding a relationship between a principal and an agent. One of the two core assumptions is that the principal and the agent have a goal conflict (Laffont & Martimort, 2002; Miller, 2005a; Mitnick, 1992; Shapiro, 2005; Waterman & Meier, 1998). In other words, the principal's goal is not similar to the goal of the agent, which causes a problem. The principal has the formal authority, but due to its dependency upon the agent the principal can only use this authority to enforce incentives on the agent to reach its goal. Furthermore, the agent is considered to be more risk-averse than the principal (Miller, 2005a).

The second core assumption of the PAT is that the principal suffers from information asymmetry (Laffont & Martimort, 2002; Miller, 2005a; Shapiro, 2005; Waterman & Meier, 1998) due to a “lack of knowledge about the agent’s preferences and abilities, difficulties in monitoring the agent’s behavior, and uncertainty about the impact of the agent on the task” (Scholz, 1991, p. 121). In other words, the principal has not complete information about what the agent does; the agent knows more than the principal. The purpose of the PAT is to align the incentives of the principal and the agent to get the agent’s actions in line with the principal’s preferences (Miller, 2005a). Aligned incentives should reduce the possible negative effects of the information asymmetry, like the moral hazard.

A moral hazard exists when the agent has the tendency to behave immoral as a consequence of the information asymmetry that exists between the agent and the principal. Only the agent has a moral hazard, due to the top-down responsibility of the PAT (Miller, 2005a). In case the moral hazard materializes, the agent does not comply with the actions the principal wants him to do and hence, is shirking (Miller, 2005a, 2005b; Waterman & Meier, 1998). This potential loss of control is one of the essential elements of the PAT (Mitnick, 1992; Scholz, 1991) and imposes a cost on the principal (Waterman & Meier, 1998).

Due to the costs the shirking agent imposes on the principal, the principal tries to overcome this threat. But the higher the level of information asymmetry and the more the goals of the principal and the agent conflict, the higher is the chance that the agent will shirk. Furthermore, overcoming these difficulties to reduce the shirking coincides with its own costs (Waterman & Meier, 1998). One option to reduce the moral hazard is by rewarding the good efforts or achievements of the agent. If a long-term relationship between the principal and the agent exists, the agent will be less inclined to shirk due to the loss of future rewards (Miller, 2005b).

The aspects of goal conflict, information asymmetry, moral hazard and rewards will be explained by the example of a transportation company owner, the principal, who prefers his drivers, the agents, to drive as economically as possible. These drivers however, the agents, do not pay the fuel themselves and have little incentive to invest effort in the boss’ goal. To solve this problem, the principal introduces an incentive contract (Himmelweit et al., 2011).
in which it obliges its agents to pay for their own fuel by means of a flexible compensation structure. The lesser the amount of fuel used, the higher is the fuel compensation. This motivates the agents to drive as economically as possible in order to get high fuel compensation. However, it also creates a moral hazard, meaning that the driver is inclined to behave opportunistically (IEA, 2007). The truck driver could exaggerate his achievements to make more money out of the deal when no appropriate form of control would be present. After all, only the truck driver knows his actual fuel consumption and the principal can only logically reason what it would be, which signals a case of asymmetric information. Hence, an incentive contract can lead to immoral behaviour of the agent of which the principal bears the costs.

2.5. The principal-agent model’s characteristics

For several reasons the principal-agent model is expected to help with the analysis of organizational decision making. The most important reason is that its characteristics of information asymmetry and conflicting goals should explain the different incentives of the members of the industry, providing a clarification why the current EED is insufficient. It can be applied to both the firm level and the industry wide level, but in this research the focus will be on the latter. In addition, its connection with economic theory is a foundation for many energy efficiency barrier analyses (Cagno et al., 2013) and policies in general (Jaffe & Stavins, 1994b). Firms are expected to have an urge to behave rational, i.e. enhancing profits, and the principal-agent model should be able to explain why they make decisions that lead to a theoretical sub-optimal outcome.

Another important characteristic of the PAT is split incentives as a consequence of asymmetric information. Split incentives result from the incapability to observe or experience the results of a measure that has been decided for (Venmans, 2014). In other words, it is expected that no stimulant to implement energy efficiency measures exist as long as the companies within an industry are not accountable for these energy savings. Transparency is key (Venmans, 2014). Closely related to split incentives is the issue of the aforementioned moral hazard, because lack of accountability could lead to opportunistic behaviour. In the classical PAT, which is often about a relationship between a buyer (principal) and a seller (agent), opportunism entails that the seller benefits at the cost of the buyer due to asymmetric information (Himmelweit et al., 2011) (the seller of a car, for instance, knows more than the buyer).

Another way to frame the problem is to use the prisoners’ dilemma. If company A decides to comply with the EED and company B does the same, their payoff is maximum, also called Pareto efficiency (Himmelweit et al., 2011), because they save energy and thereby long-term costs (DeCanio, 1998). This maximum pay-off is shown in the upper left box of Figure 1. If company A decides to comply and B defaults, B has a larger short-term payoff than A, assuming that energy efficiency investments are profitable in the long-term but more expensive during purchase. Company A loses competitiveness because of the higher initial costs of the energy efficient investments, while company B produces much cheaper in the old fashion, as can be seen in the lowest left box. The opposite is true in case company B complies and A defaults, which is the upper right box of Figure 1. And in case both

<table>
<thead>
<tr>
<th></th>
<th>A Comply</th>
<th>A Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>B Comply</td>
<td>(3, 3)</td>
<td>(0, 5)</td>
</tr>
<tr>
<td>B Default</td>
<td>(5, 0)</td>
<td>(1, 1)</td>
</tr>
</tbody>
</table>

Figure 1: Pay-off matrix.
companies decide to ignore the EED, the payoff would be as the status quo making them both worse off than in case they both comply, but better off than in case only one company complies. This means that they have a dominant strategy of ignoring the EED, because that leads to the highest payoff in anticipation of what the competitor does. This is a Nash equilibrium (Himmelweit et al., 2011), because the outcome is less than the maximum outcome. It is expected that firms are reserved to apply energy efficient techniques if their competitors are not implementing them either.

Applying the PAT to understand why the refining and (petro)chemical industry is facing obstacles to make the transition the EED targets has scientific relevance, because the PAT has never been used to analyse a complete industry chain. Hence, the theory will be tested for its suitability. Nearly thirty years ago Tirole (1988) wrote that the PAT has developed considerably in the fifteen years preceding the publication date of his article. And the developments did not stop. Many applied the PAT to sociology, politics and organization theory and argue that the PAT cannot be applied to an organization without modifying the model (Mitnick, 1992; Tirole, 1988; Waterman & Meier, 1998), which could also hold for the analysis of the EED.

One modification of the PAT is the extension to a principal-supervisor-agent model (Brandt & Svendsen, 2013; Tirole, 1986). The principal, the European Union Commission, ‘hires’ the supervisor, the Dutch government, to check if the agents, the actors in the industry, implement the EED. Combining the two theories is said to provide a good basis for understanding why companies make the decisions they do, because it reflects business reality better than the PAT alone (Brandt & Svendsen, 2013). And it should help to relate the companies’ decisions to the implications of the EED legislation afterwards as well. This latter step is necessary to obtain useful insights and to be able to give relevant recommendations. As far as known, this has never been done before for the EED problem.

In summary can be stated that applying the PAT, probably in its modified form, is most likely a sufficient model to analyse the EED problem. Nevertheless, it is not entirely certain that the PAT can be applied in such a fashion that it provides the answers to this research, because several other scholars experienced difficulties with the theory (Mitnick, 1992; Tirole, 1988; Waterman & Meier, 1998) and because no evidence has been found regarding application of the theory to analyse an entire industry chain.

### 2.6 Conceptual model

As Olson (1965) argued, economic incentives are not the only drivers of decisions in organizations. Other sociological and psychological goals can also play an important role, like previous experiences. This research is taking these elements into account, while studying the companies in the industry chain. Profit enhancing incentives are economic incentives like the return on investment, business growth, minimizing costs and increasing competitiveness. These incentives are expected to be influenced by the following aspects: a preference for short-term benefits, competitors’ actions, the ambiguity effect, a possible moral hazard created by the legislation and split incentives. These aspects are expected to be sufficiently analysed by the principal-agent model.
Also, these aspects create flows of information that influence as a whole the decisions of an industry. And the Dutch legislation based on the EED and its overview of Best Available Techniques influence industrial decisions as well (Porter & van der Linde, 1995), at least when the correct measures are addressed. Industrial decisions, in their turn, transform the stream of information in an action of either becoming more energy efficient or not. This leads to the conceptual model of Figure 2.

![Conceptual model](image)

The vertical arrows represent a flow of information and the horizontal arrow an action. The EED and the decisions made in organizations determine what decisions are taken by the industry as a whole. The industrial decisions either lead or do not lead to an increased energy efficiency transition.

The conceptual model depicted in Figure 2 is part of the research framework of Figure 3. In order to perform the research, theories about the principal-agent model, prisoners' dilemma, and decision making of companies are required. These theories are already explained in the previous sections and resulted in the composition of the conceptual model that is shown in Figure 2. From the conceptual model it can be concluded that information about the EED is required. This information is openly available for the public. Information about decision making regarding the EED, however, is harder to find and could be obtained by interviewing specialists in several companies of the industry chain. The overview of the research framework of Figure 3 mentions only four companies, but this is purely for illustration purposes. The results from these interviews will be analyzed. Subsequently, these results will be compared with the implications of the EED, from which conclusions and recommendations can be derived.

To summarize, the conceptual model implies that interviews with companies are necessary to gather the required information for conducting the research. But the insights from these interviews may also influence the composition of the conceptual model. There is, consequently, interplay of information between them, also shown in the research framework by the double-headed arrow. From this interplay, an analysis is performed that leads to the results. The results in their turn form the basis for the conclusion and the recommendations.
2.7. Research questions

The conceptual model that is introduced in Figure 2 of the previous section forms the basis of the research. It links several concepts which are reflected in the research questions. The aim of the research is to identify the obstacles the industry faces in reaching the energy efficiency target that is set by the EED. Furthermore, recommendations to enhance the EED will be made that should solve the problem. This leads to the following main question of the research:

- What obstacles is the industry facing in reaching the energy efficiency target of the Energy Efficiency Directive?

In order to answer this question, the decision making process of the actors in the refining, petrochemical and chemical industry will be researched. This decision making process will then be compared with the implications of the Energy Efficiency Directive, in order to understand why the target of 20% increased energy efficiency is experiencing difficulties. Three logical sub questions are therefore as follows:

1. Which policy instruments to enhance energy efficiency are included in the Energy Efficiency Directive?
2. Which policy instruments to enhance energy efficiency are included in the Dutch legislation?
3. What are the influences on the process of decision making among the selected organizations regarding energy efficiency decisions?

And to come to conclusions, the following questions have to be answered:

4. Is the principal-agent theory suitable for analysing the influences on the process of industrial decision making?
5. What are the areas of overlap between the legislation’s implications and the industries’ decisions?
6. What gaps can be identified between the legislation’s implications and the industries’ decisions?
7. What recommendations can be made for enhancing the EED?

2.8. Relevance of the research
This research is expected to have practical relevance, because it should show how the policies with regard to energy efficiency can be reshaped to make them more effective. Furthermore, the environment should benefit from this research as well, because increased energy efficiency often results in fewer emissions. Also the industry itself is expected to benefit, because this research should help to overcome the obstacles it faces. The relevance to science concerns the PAT, because this theory has never been applied to analyse a complete industry chain. Insights that are obtained by means of this application will contribute to the overall academic knowledge base. Hence, this research is anticipated to have both practical and scientific relevance.

2.9. Chapter summary
This chapter has identified the unit of analysis, which is the industry chain with regard to the refining and (petro)chemical industry. It has also described a possible explanation for the following problem statement:

Problem statement:
The influences on the industry’s decision making process, which cause obstacles in reaching the EED’s target, are unknown.

This chapter described that in this research the working hypothesis is that an incentive mismatch exists between the EED and the industry, i.e. the endangered environment versus the best return on investment, which would be the cause of the problem. Analysis by means of the PAT should identify whether this assumption is valid, although a chance exists that the PAT is not applicable. This leads to the following scientific problem of this research:

Scientific problem:
It is unknown whether the principal-agent theory is suitable for analysis of the decision making process of a whole industry chain.

This chapter provided a brief introduction regarding the PAT and it described the conceptual model, the research framework and the research questions. The answers to the research questions should lead to obtaining the objective of this research.

Research objective:
To identify the obstacles the industry faces in reaching the target that is set by the EED and to make recommendations to enhance the EED in order to reach its target.
3. Research method

A rather extensive description of the research method is explained in this chapter and corresponding appendixes, because the replicability of a research is very important. Figure 4 is a visual overview of the connections between the different steps of this research. The content regarding the Desk research is described in Section 3.1 and the content concerning the Empirical data collection is explained in Section 3.2. Next Section 3.3 provides a description of the Data analysis and the steps regarding the Analysis of the results and Evaluation are explained in Section 3.4. The last section, Section 3.5, gives a brief summary of this chapter’s content.

Figure 4: Visual overview of the research method and its relationships
Chapter 3: Research method

3.1. Desk research

To figure out why the EED is not reaching its goal the relevant legislation had to be collected and studied, which was done by means of a desk research. The information deriving from this research was required to compare the industries’ decision with the implications of the legislation. The research approach regarding the desk research is explained in this section.

The European directives 2004/8/EC and 2006/32/EC were the starting point regarding the legislation study, which can be seen as the precursors of the EED. Also the EED itself, directive 2012/27/EU, was analysed. References and policy instruments in these documents formed the basis for further analysis. Additional browsing via Google.com was performed by using search terms linked to the EED and implications, reports, progress, 20-20-20, etc. This process continued until a complete overview of the relevant legislation was obtained. The Ministry of Economic Affairs (EZ) was contacted to get a clearer overview of the Dutch energy efficiency policies.

An overview of all documents that were collected, which are related to the EED, is included in Appendix A. Further, Chapter 4 explains in detail what the outcome of the legislation analysis is. The collected documents related to the EED, the understanding gained from these documents and the characteristics of the principal-agent model, i.e. conflicting goals and asymmetric information, formed the basis for the questions that were asked in the interviews. These interviews were the means of data collection with regard to the decision making process.

3.2. Empirical data collection

The final question list that was used in the interviews contains 16 questions and is shown in Appendix B. The subsequent appendix, Appendix C, explains in more detail why each question was included in the interview.

The applied research strategy was to first ask questions about the company and subsequently work energy efficiency into the conversation. Easy-to-answer questions would make the interviewee feel comfortable and he or she was expected to answer the questions about energy efficiency issues and financial matters more freely, as a result. The last part of the interview touched upon legislation implications in a general fashion. Proposed energy efficiency measures by the EED were included as well, being the energy audits, BAT and energy efficiency management systems (ENEMS). These measures and the Dutch energy efficiency policy are explained in detail in Chapter 4.

As mentioned, Appendix B shows the list of the interview questions in its final form. Initially it was also planned to focus on the decision making process within the individual companies, but due to time constraints of both the conducted interviews and the thesis period this element was left out. Hence, no questions were attributed to this topic.

Select interviewees

While the interview questions were being formulated, the possible interviewees were selected in parallel. The goal was to interview multiple companies in each industry group, i.e. authorities, universities, R&D organizations, vendors, transfer agents, technology providers, operating companies, consultants and branch organizations. The list of the
companies that were being interviewed is included in Appendix D. As the list reveals, interviews were conducted with at least one company in each group; the technology providers exempted. Note that Appendix D provides brief explanations of what the companies do as well.

Internet browsing was one of the methods applied to find possible interviewees. It led to the identification of possible interviewees at universities, governmental organizations and branch organizations. All parties were contacted and agreed to participate. Another method was to make use of the network of Fluor, which was the host of this research. This approach resulted in many contacts. Appendix E provides more information about Fluor and why its expertise coincides with this research. The third method that led to contacts was by means of the interviewees themselves.

**Approach interviewees**

As soon as the first list of interviewees had been completed, the potential interviewees were contacted by e-mail. The e-mail explained in short the purpose of the research and why their contribution was of utmost value. The e-mail had a page attached that explained briefly the background of the research and the topics that the interview would touch upon. This accompanying letter is included in Appendix F. The interview questions were not provided.

**Conduct interviews**

The interviews took place at the offices of the companies that were being interviewed. This was considered best, because the interviewees would not have any additional costs or difficulties but the time they had to make available for the interview. Each interview took about 1.5 hours and started with the unofficial question about any concerns or questions the interviewee may have had. It was made clear that all information deriving from the interview was sent back to them and that without their official approval nothing was done with the collected information. The interviewer took notes in order to merge the information in one digital document later on. The interview was recorded with the interviewee’s approval, for back-up reasons.

**Process interviews**

As soon as the interview was finished the prospective steps were told once again to the interviewee. Within three days the interviews were digitalized in a Word document and the drawing of the network was transformed into a, sometimes simplified, chart in Office Visio. Both documents were sent back to the interviewees for their official approval. As soon as the interview process was officially finished, the confirmed data could be analysed and the recording was deleted.

**3.3. Data analysis**

The confirmed interviews provided rich information, but required further analysis to come to results. The data analysis was done manually as is advised by Saldaña (2013) for first time qualitative researchers. The first step comprised highlighting all the data of each interview that was considered to be relevant for the means of this research. Subsequently, the data was put in a concise form into a table, in which each column corresponded to an interview question. The preliminary emergent codes, which are summarizing keywords, were written down directly as well. This process was repeated until all 23 interviews were preliminary coded. These emergent codes would need further analysis later on. Examples of
emergent codes are ‘risk averse’, ‘payback time’, ‘decision making power’ and ‘lack of motivation’. A snapshot of one of the coded interviews is shown in Table 1. The codes marked red are the ultimate codes, which were determined later on.

Table 1: A snapshot of the manual coding procedure as advised by Saldaña (2013).
The codes shown in red are the final codes, which are formulated by means of the coding taxonomy shown in Appendix G.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw data</td>
<td>risk management, Operating Companies prefer proven solutions, others must test technology first</td>
<td>more exposure positive stimulant</td>
<td>positive effect on own company, Operating Companies not motivated, government must demand it</td>
<td>government must improve info sharing process energy efficiency</td>
<td>BAT not promoted well by government/EU</td>
</tr>
<tr>
<td>Preliminary code</td>
<td>opportunistic, risk aversion</td>
<td>split incentive reduction</td>
<td>Highly motivated own company, possible policy, lack of motivation OC</td>
<td>information asymmetry, unclear policy</td>
<td>lack of distribution</td>
</tr>
<tr>
<td>Code</td>
<td>risk</td>
<td>split incentive</td>
<td>regulation, culture</td>
<td>diffusion</td>
<td>diffusion</td>
</tr>
</tbody>
</table>

Category reliability is very important, which means that the categories should be validated by multiple coders that independently code the data. No obscurity is allowed regarding coding the data. In other words, categorization consistency is required and at least 80% of the coding decisions must be agreed upon to have a satisfactory result (Sekaran & Bougie, 2013). However, this validation approach could not be applied in this research. In order to formulate valid codes previous work about energy efficiency obstacles was collected that contained valid coding schemes (taxonomies).

The article by Cagno et al. (2013) contains an extensive overview of existing valid taxonomies regarding energy efficiency barriers. It was decided to take this article as the starting point of the coding scheme. Since the interviews contained more information than only the obstacles to energy efficiency, the article’s categories were extended when required. Additionally, some codes were reformulated to better fit the empirical data of this research, which was another consequence of the wider focus of the interviews. The code taxonomy that was applied to analyse the data is included in Appendix G. The taxonomy clearly shows which categories have been added and reformulated by means of a solid underline and interrupted underline, respectively. Extra information about the taxonomy is given on the page following the overview of the code taxonomy.

The penultimate step was to transform the preliminary codes into the actual codes. In order to weave the codes per interview together, brief summaries of each interview were made by specifically using the coded words. The coded words were written in uppercase letters, as shown in Appendix H. This code weaving method is recommended by Saldaña (2013), an experienced qualitative researcher who has published many books, in order to get an overview of how the independent codes relate. Moreover, it is argued that it makes further analysis easier. The overall impression regarding the companies’ motivation for energy efficiency is noted below each brief summary in Appendix H.
The final step of the data analysis comprised making an overview of which codes were supported by whom, as to be able to draw conclusions later on. Appendix I contains two tables in which the frequency of each code is clearly visible. The first table shows the obstacles to energy efficiency and the second table the goals that the interviewed companies have. A colour scheme of red, green and black was used to indicate negative, positive, and neutral information, respectively. Information that was only considered to be an obstacle/goal was always noted in black.

3.4. Analysis of results and evaluation

As soon as the data was fully coded the results could be analysed for interpretation. This step was required to be able to compare the results of the decision making process with the studied legislation in order to find the areas of overlap and the gaps. The identification of the gaps led to the proposals of enhancing the EED. These steps enabled the phase of the evaluation regarding the suitability of the PAT. After all, at the beginning of the research it was not clear whether or not the PAT could be applied. A critical reflection of the PAT contributed to the last step of the evaluation phase, which was to come to conclusions and to make recommendations.

3.5. Chapter summary

This chapter explained the research method that has been applied. First the relevant legislation was collected and analysed to get the required data regarding the legislation. Interviews were conducted to get the data regarding the decision making process in the industry chain. The empirical data was coded and the results of the coding step were interpreted, which formed the input for the comparison with regard to the legislation. The areas of overlap and gaps regarding the decision making process of the industry and the legislation's implications could be identified as a result. This step enabled the evaluation of the suitability of the PAT. The latter step was required to come to conclusions and to make recommendations.
Two of the research questions concern the legislation regarding energy efficiency. The most important aspects the European Energy Efficiency Directive contains are described in Section 4.1 and Section 4.2 explains what the Dutch national energy policy entails. Next Section 4.3 touches upon the responsibilities in the Dutch governmental system and Section 4.4 describes the main incentives of the legislation to the industry. The concluding section, Section 4.5, takes a bit more distance from the legislation instruments that are described in this chapter and summarizes brief their relationships. A visual representation of these relationships is given in this last section as well by means of Figure 5, which is a figure that can help the reader to put the content of this chapter into context.

4.1. European Energy Efficiency Directive

The Energy Efficiency Directive is an answer to the difficulties the European Union (EU) is experiencing in reaching its 20% increased energy efficiency target that was set in March 2007. This target was part of the European strategy to create new jobs and sustainable growth, in order to boost economic growth and to limit climate change (Europa Nu, 2015b). But in 2011 the EC acknowledged that the current state of progress would not be sufficient to reach its target. Additionally, it adopted a Low Carbon Roadmap that same year, which also emphasized the importance of energy efficiency by restraining carbon emissions. The latter two reasons led to the formulation of the Energy Efficiency Directive (EED), which has to result in obtaining the 2020 target. Moreover, it has to continue to stimulate energy efficiency improvements even beyond 2020 (EU, 2012; SER, 2013).

The purpose of the EED is to formulate specific tools that must guide member states in increasing their energy efficiency levels (EU, 2012). The most important measures mentioned are the following:

- Energy audits;
- Energy efficiency management systems (ENEMS);
- National energy efficiency action plans (NEEAP).

Due to the strong relationship between emissions and energy efficiency, i.e. less energy consumption often leads to lower emissions, also the emissions trading scheme (ETS) and the Best Available Techniques (BAT) are mentioned. However, the EED limits itself to emphasizing that the EED must not interfere with the directives related to ETS and BAT. The policy measures mentioned in this paragraph are explained in detail in the next subsections.

4.1.1. Energy audits (article 8)

An energy audit entails that the company researches its energy consumption. The audit must be executed by an objective expert, which can be a consultant, an independent authority or an internal specialist. When the first or the last option is used, Member States must think of a scheme to assure the quality of the audit. The purpose of an audit is that
companies can take targeted action to increase their efficiency levels. The EED emphasises the importance that small and medium enterprises (SMEs) must be stimulated to undergo energy audits as well. Non-SMEs are obligated to undergo an audit, but are freed from this obligation in case a certified ENEMS is already in place. The condition for this exemption is that the ENEMS contains an energy audit (EU, 2012).

4.1.2. Energy Efficiency Management Systems
Energy efficiency management systems require the commitment of the whole company to become more energy efficient. It requires top management to create an energy efficiency strategy, to set targets, to define a policy, to make a planning, to undergo energy audits, to develop technologies, and to make sure improvements are implemented, that all employees are committed, that benchmarking is done, and that evaluation takes place, among many other commitments (EC, 2009).

ENEMS can be applied as either a certified ISO system or an unofficial system, which still contains above described elements. It should not be confused with EMS, which is an environmental management system. Such a system entails a similar structured approach to improve overall performance, but in this case with regard to environmental issues (EC, 2009).

4.1.3. National Energy Efficiency Action Plan
Each Member State had to submit its NEEAP to the EC by 30 April 2014. Every 3 years later a new NEEAP should be submitted. This action plan contains the improvement measures regarding energy efficiency, the achieved energy savings and anticipated future savings. The EC has provided a template in 2012 which Member States can use for their NEEAP (EU, 2012). The Netherlands makes use of this template.

The Member States must also provide a report of their yearly progress. This document and the NEEAPs are part of the assessment done by the EC. Member States may receive recommendations based on their progress and targets (EU, 2012).

4.1.4. Emissions Trading Scheme
The emissions trading scheme (ETS) is introduced by the EC in 2005 to reduce the amount of Greenhouse gas emissions. Operators of Greenhouse gas emitting installations get a certain number of permits from the national government. These permits determine the amount of CO₂ that can be emitted without penalties. These permits can be traded between operators and across Member States’ boundaries, what some companies will do when they emit less than what is allowed. The buyers are companies that emit more than their permits allow, because they risk getting a penalty otherwise (Europa Nu, 2015a). Since 2008 the Netherlands, among other Member States, also included N₂O emissions in the scheme. By decreasing the amount of permits allocated yearly each April and limiting the share of free allocation, the emissions have to be reduced in all Member States in the upcoming years. The third trading period started in 2013 and will run to 2020. In this trading period less responsibility is given to the national governments, which is taken over by the EC (EEA, 2011).

4.1.5. Best Available Techniques
The BAT documents are part of the Integrated Pollution Prevention and Control (IPPC) Directive 2008/1/EC and formulated by the EC in collaboration with the industry to reduce emissions. More than 30 documents focus on a different industry each. It first explains in
general terms what the basic principles of the industry are. Also the general processes and technologies are explained. It concludes with a thorough explanation of all techniques that are performing best regarding emission levels at time of writing. These documents are a guideline for companies and authorities, because application of other techniques is allowed, as long as emissions levels are equal or lower (EC, 2009, 2013a).

4.2. Dutch national policy

Article 3, paragraph 1, of the EED provides Member States the choice to set their own national energy efficiency target, within certain boundaries. All the individual national targets should add up to a total energy consumption of 1474 Mtoe, which is equal to obtaining the European 20% energy efficiency target (EU, 2012). The Netherlands has chosen to increase energy efficiency via a final energy consumption target. This means that Dutch energy consumption has to be reduced with 482 PJ before 2020 to comply with the demands of the EED. This corresponds to yearly energy savings of 1.5% (ECN, 2013; Kamp, 2013-2014).

The measures to obtain the yearly savings are described in the EED, but do not necessarily require succession. Measures regarding reporting and doing research, for example, concern only the EC. And some measures are already incorporated in existing Dutch policies. Moreover, the Netherlands have no additional policies adopted as a result of the EED (Kamp, 2013-2014). The Dutch energy efficiency policy currently exists of the following instruments:

- Energy investment allowance (EIA);
- MJA3 and MEE covenants (longterm agreements);
- Energy tax;
- Wet Milieubeheer;
- Energieakkoord;
- Wet implementatie EU-richtlijn energie efficiëntie.

These instruments are explained in the following subsections.

4.2.1. Energy investment allowance

The EIA is a tax instrument to stimulate investments in energy efficiency measures for businesses. When a company invests to enhance its energy efficiency level, it can get a part of the investment back via an allowance on the taxes that have to be paid over the total profits of the company. In general the benefit of EIA for companies is about 10.5% of the investment (Kamp, 2013-2014) and the investment should be between €2500 and €119 million (Ministry of Finance, 2014). The total budget for this subsidy in 2015 is €106 million (RVO, 2015b).

4.2.2. MJA3 covenant

MJA3 (Long-term agreement 3) continues the third period of long-term agreements between national government, provinces, companies, branch organizations and municipalities. The first two periods have led to an average annual efficiency improvement of 2% in 15 years. Because of its success, a third set of agreements was formulated for the period 2013-2020 (RVO, 2008). The responsibility for successful execution of the covenant lies at the RVO (RVO, 2015d).
Companies that sign the agreement, which is voluntarily, commit themselves to write an *Energy Efficiency Plan (EEP)*, to implement the measures as described in its EEP and to introduce systematic energy management. The EEP is a three-year plan that contains certain, conditional and uncertain measures to improve the company’s energy efficiency. The EEP also describes what results are expected, which have to match a 2% annual efficiency improvement. The company must improve its energy efficiency via chain efficiency as well, which entails that efficiency is improved in the process of raw material up to disposal. Additionally, it has to report on a yearly basis about its progress related to its EEP and energy management system *(RVO, 2008)*.

When companies do not comply with the rules set out in the agreement, they will receive an official warning. This warning enables the company to improve its situation in order to comply with the demands. However, if the company stays deficient, it will be eliminated from participation and will lose the benefits attached to participating *(RVO, 2008)*. Companies can also lose their privileges without being excluded from participation *(CONFIDENTIAL)*.

Branch organizations formulate a *multiannual energy efficiency plan (MJP)* that contains the anticipated efficiency gains of all companies covered in the MJP. These companies generally are from the same industrial sector. The MJP must be updated every three years and send to RVO for approval *(RVO, 2008)*. The participating ministries, like EZ, should provide financial support among other policy instruments to facilitate and stimulate the members of MJA3 *(RVO, 2008)*.

### 4.2.3. MEE covenant

In 1999 the Dutch government and companies with energy consumption larger than 0.5 PJ per year signed a so called *Benchmarking covenant*, which obliged companies to be at the world top regarding their energy efficiency results no later than 2012. Many companies that participated in the *Benchmarking covenant* became submissive to a different target when ETS was introduced in 2005, being emission instead of efficiency targets *(TU Delft, 2013-2014)*. In 2009 the Benchmarking covenant was replaced by the MEE (meerjarenafspraak Energie Efficiëntie) covenant, which included all ETS companies that were earlier member of the *Benchmarking covenant*. Non-ETS companies were encouraged to become a member of the already existing MJA3. Moreover, MEE included the new concept of chain efficiency, which was not part of the *Benchmarking covenant* *(RVO, 2009)*.

The structured approach of the MEE to increase energy efficiency, which improves the competitive position of these companies, is the incentive for parties to become a member. All parties that sign the MEE, which is voluntarily, agree to improve energy efficiency levels significantly in the period of 2009-2020. Energy efficiency and emissions reduction are often related, but in case efficiency decisions clash with emission reduction decisions, the latter is being prioritized *(RVO, 2009)*.

The MEE covenant is very similar to MJA3. Companies are obligated to formulate an EEP and to take actions accordingly. Also MJP’s are drafted and overall progress is being monitored and reported each year to RVO. And ministries are expected to provide their support by fulfilling their facilitating and stimulating role *(RVO, 2009)*.
An extra benefit members of the MEE covenant have is that most members are eligible for ETS compensation in the period of 2014-2020. These members can ask for ETS compensation as a result of increasing electricity prices due to ETS (Rijksoverheid, 2013). The compensation must safeguard the international competitiveness of Dutch companies, because ETS only applies to European companies and hence, increases their production costs. Put differently, there is a risk of business ‘leaking’ away to non-European countries due to the carbon tax, because production is cheaper there. The Dutch government, as a result, makes €78 million available to compensate these companies, which are on the so called Carbon Leakage List (NEA, 2015a). The Carbon Leakage list plays also a role at the provision of emission permits. When carbon leakage is considered significant, emission permits are distributed free of charge to these companies (NEA, 2015b).

4.2.4. Energy tax
Dutch electricity and gas consumers and suppliers pay energy tax over their consumption and supply level, respectively. Users that use energy originating from sustainable sources or a Combined Heat and Power (CHP) installation do not pay energy tax over that specific amount of energy (Belastingdienst, 2015a).

Companies that use more than 10 GWh a year and are a member of MEE or MJA3 are eligible for a tax reimbursement (Belastingdienst, 2015b). Stimulating high energy consuming companies to become a member of the covenants should help them to become more energy efficient.

4.2.5. Wet Milieubeheer (Environmental Management Act)
The Wet Milieubeheer is a law that aims to protect the environment. This law applies to anyone that potentially could harm the environment by its actions (EZ, 2015), like the industry. The Ministry of Infrastructure and Environment (I&M) strives for a safe and endurable society (Rijksoverheid, 2015d) and the Wet Milieubeheer is one of its measures to fulfil this vision. Companies are, for example, obliged to take all energy efficiency measures that have a payback time of less than 5 years (EZ, 2014; SER, 2013). At least, for companies with a yearly electricity consumption exceeding 50.000 kWh or 25.000 m³ gas that is. Moreover, companies that are a member of MJA3 are without exception submissive to the Wet Milieubeheer, while ETS companies are excluded from this obligation (EZ, 2014) as to prevent accumulation of similar policies ([CONFIDENTIAL]). Providing the licenses to operate and to enforce the law, both related to Wet Milieubeheer, are the responsibility of the local authorities. These are often the municipalities (InfoMil, 2015).

4.2.6. Energieakkoord (Energy Agreement)
The Energieakkoord voor Duurzame Groei is a voluntary collaboration with over forty organizations, like financial institutions, environmental organizations and employer and employee organizations. The goal of the Energieakkoord is to increase energy efficiency, to increase the share of renewable energy sources and to create thousands of new jobs. The participants of the Energieakkoord agreed to increase energy efficiency each year by 1.5%. In 2016 and 2018 the results will be evaluated. In case the results are not satisfactory, voluntary or non-voluntary measures will be taken. The agreements set out in the Energieakkoord only apply to energy users, not suppliers (SER, 2013).
A lot of emphasis is placed on energy saving measures in the real estate sector. However, also industries are included in the agreements. The measures described, applicable to the industry, are the following:

- stricter enforcement of the *Wet Milieubeheer*;
- introduction of the *Energy Performance Inspection* (EPK) for MJA3 and non-MEE companies;
- introduction of MEE company specific *(one-on-one)* agreements;
- introduction of action lists;
- introduction of an *expertise centre*;
- stricter enforcement of the EEPs (SER, 2013).

The *Energy Performance Inspection* (EPK) is similar to the annual inspection of a car (APK). It is designed to help companies and authorities to increase and evaluate energy efficiency, respectively. Implementation of the EPK is currently done on a pilot basis and in a few sectors only (RVO, 2015a). Refining and (petro)chemical industries are currently not included. When the EPK pilot is positively evaluated, actual implementation of the EPK will start in 2016 (SER, 2013).

The *(one-on-one)* agreements concern MEE companies that are willing to improve energy efficiency even further than prescribed by the MEE covenant. This is, however, a commitment that will lead to penalties, i.e. loss of certain benefits like the tax reimbursement, when no real effort is put into reaching the additional targets (Rijksoverheid, n.d.-a). The first *(one-on-one)* agreements are put into practice since the beginning of 2015 ([CONFIDENTIAL]).

The introduction of *action lists* applies to companies that are not part of MJA3 ([CONFIDENTIAL]), because MJA3 uses similar action lists already. These lists contain an overview of sector specific and general actions that companies can take to improve their energy efficiency level (Rijksoverheid, n.d.-b; RVO, 2015c). Moreover, the lists should enable the authorities to enforce the law more easily ([CONFIDENTIAL]).

The *expertise centre* is a platform where companies and authorities can share knowledge about energy efficiency. Moreover, it is a centre that advises the aforementioned parties about energy efficiency and the enforcement of the *Wet Milieubeheer*. In order to stimulate knowledge sharing, knowledge institutes are also involved (SER, 2013). *Plant One* is an example of such an expertise centre in Rotterdam, which focuses on sharing energy efficient equipment and technologies (Plant One, 2015).

**4.2.7. Wet Implementatie EU-richtlijn energie-efficiëntie (Energy Efficiency Directive (implementation) Act)**

Article seven of the EED provides Member States the opportunity to implement additional policies instead of an enforced regulatory system. The Netherlands has chosen to go for the additional policies (ECN, 2013), which includes all previously mentioned aspects. The Energieakkoord, which has to lead to 100PJ energy savings, is the continuation and completing policy regarding the implementation of article 7 (Kamp, 2013-2014).
However, there are more articles in the EED that need consideration. The *Wet Implementatie EU-richtlijn energie-efficiëntie* makes sure that these aspects are implemented in national law ([CONFIDENTIAL]). An example is article 8, regarding energy audits. The EEPs made by MJA3’s and MEE’s members are considered to be energy audits. Other companies, i.e. those that are not a member of the covenants, are by the *Wet Implementatie EU-richtlijn energie-efficiëntie* also obliged to undergo an energy audit before 5 December 2015 ([Kamp, 2013-2014]).

4.2.8. Additional policy
*Topsectoren* is an example of an extra policy focused on the sectors in which the Netherlands can gain significant competitive advantages. It is an initiative of the government that brings together universities, R&D organizations, companies and the government to collaborate on knowledge and innovation ([Rijksoverheid, 2015b]). All parties invest time and money in this initiative, which was about €2.8 million in 2012 and 2013 ([Rijksoverheid, 2015a]). One of the nine sectors specified is about energy.

4.3. Responsibilities
This section briefly explains the chain of command in the Netherlands regarding energy efficiency. The *Ministry of Economic Affairs* (EZ) is the policy maker regarding energy efficiency, while the *Ministry of Infrastructure and Environment* (I&M) is more concerned with emissions control. They get their orders from the European Union and they are the employers of the RVO. The RVO is responsible for the implementation of the policies and covenants. The authorities, which are the provinces and municipalities, have to make sure that the law is being obeyed. In order to do so, they have delegated several tasks to their execution departments, which are known as the *competent authorities*. These *competent authorities*, being the *Omgevingsdiensten* and *Milieudiensten*, provide companies with a license to operate and inspect the companies’ actions. They provide their employers, i.e. the authorities, with feedback about their experiences with the implementation of the law.

Refineries are in the Netherlands officially exempted from the EED’s energy savings obligation, because a refinery is perceived to be not an energy consumer, but an energy transformer. However, EZ motivates these companies to save energy by stimulating membership of the covenants. If they are not a member, they are not eligible for the energy tax reimbursement and ETS compensation ([CONFIDENTIAL]).

4.4. Main incentives for industry
From the previous sections can be concluded that the energy efficiency legislation has three main incentives to the industry. One is the EIA, which is an economic incentive (tax benefit is about 10.5% of the investment ([Kamp, 2013-2014])). Another is the energy tax reimbursement, an economic incentive, to get the industry to participate in the covenants. These covenants employ relieve of law enforcement as incentive on the industry to motivate it to proactively participate in the covenants. These main incentives should help the industry to become more energy efficient and to overcome the obstacles they face.
4.5. Application of information regarding the legislation

The Dutch energy efficiency policy system contains several instruments, which are mainly focused on article 7 of the EED. These instruments are collected and replenished in the Energieakkoord. The other EED articles that require implementation in the Dutch law as well are being reflected in the Wet Implementatie EU-richtlijn energie-efficiëntie. The NEEAP bundles all the policy instruments, targeted energy savings and planned actions, which will be send to the EU every 3 year. Progress reports have to be delivered annually. These are the last two steps required to satisfy all the demands of the EED. Figure 5 is a visual representation of the policy measures discussed in this chapter.

The legislation instruments and main incentives described in this chapter will be compared with the decisions that are made by the industry. The information in Chapter 5, which is about the results of the interviews, and Chapter 6, which is about the interpretation of these empirical results, are combined with the results from this chapter as to identify the areas of overlap and the gaps between the legislation’s implications and the decision making process of the industry.

Figure 5: Visual representation of the legislation regarding energy efficiency
Empirical results

This chapter shows the results of the empirical data. Section 5.1 contains the results regarding the goals of the interviewed companies. The following section, Section 5.2, contains an overview of the obstacles perceived by the industry in both a combined manner and as a graph in which the obstacles of the operating companies and non-operating companies are distinguished. Section 5.3 shows the motivation levels and Section 5.4 identifies the relationships of the industry chain. Some general remarks with regard to the results are included in Section 5.5 and this chapter concludes with a summary of the chapter’s content in Section 5.6.

5.1. Goals of the industry

In each interview the interviewee was asked what the goals of its company are. To check the consistency in their answers, their answers regarding the goals were compared with the information provided by answering the remaining questions. The outcome of this process is shown in Table 2.

<table>
<thead>
<tr>
<th>Goal</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfying market demand</td>
<td>9%</td>
</tr>
<tr>
<td>Bringing value to society</td>
<td>4%</td>
</tr>
<tr>
<td>Availability of techniques</td>
<td>35%</td>
</tr>
<tr>
<td>Stimulating communication in industry chain</td>
<td>13%</td>
</tr>
<tr>
<td>Honouring the regulation</td>
<td>4%</td>
</tr>
<tr>
<td>Enforcing the regulation</td>
<td>9%</td>
</tr>
<tr>
<td>Diffuse information among the industry</td>
<td>4%</td>
</tr>
<tr>
<td>Create profits</td>
<td>52%</td>
</tr>
<tr>
<td>Increase energy efficiency</td>
<td>70%</td>
</tr>
<tr>
<td>Focus on other priorities</td>
<td>13%</td>
</tr>
<tr>
<td>Establish and maintain sustainability culture</td>
<td>48%</td>
</tr>
<tr>
<td>Implementing energy efficiency measures</td>
<td>9%</td>
</tr>
<tr>
<td>EED awareness</td>
<td>65%</td>
</tr>
</tbody>
</table>

The table shows that the top three cited goals are to establish and maintain a sustainability culture (48%) to create profits (52%) and to increase energy efficiency (70%). The EED awareness has only been included to reflect the percentage of the interviewees that are aware of the existence of the EED. This awareness is not a goal of any of the companies and is therefore presented in purple. Appendix I contains a detailed overview of which goal is identified by what company.
5.2. Obstacles as perceived by the industry

Many obstacles were identified during the interviews. This section first shows the results regarding the obstacles in case no distinction is made between the operating companies and the non-operating companies. Secondly the results are shown in case such a distinction is made.

5.2.1. Total overview obstacles

The identified obstacles in the interviewees are presented in Table 3. The table shows that the obstacle of *profits* is the largest, with a score of 96%. This obstacle is closely followed by several obstacles that are identified by 91% of the interviewees, which are the initially *higher costs*, the perceived *higher risk of implementation*, the focus on *other priorities* and the *decision making power* of higher management in the operating companies. Note that the obstacle of *motivation* to increase energy efficiency has been identified by 61% of the interviewees as *not existing*.

Table 3: Overview of the identified obstacles in percentages

<table>
<thead>
<tr>
<th>Obstacle</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distortion in the energy price</td>
<td>43%</td>
</tr>
<tr>
<td>Decreased market demand</td>
<td>48%</td>
</tr>
<tr>
<td>Threat of business emigration</td>
<td>22%</td>
</tr>
<tr>
<td>Dependency on other companies</td>
<td>17%</td>
</tr>
<tr>
<td>Lack of societal motivation for energy efficiency</td>
<td>35%</td>
</tr>
<tr>
<td>Applicability of the techniques</td>
<td>13%</td>
</tr>
<tr>
<td>Availability of the techniques</td>
<td>9%</td>
</tr>
<tr>
<td>Insufficient communication in the industry chain</td>
<td>57%</td>
</tr>
<tr>
<td>Difficulty of measuring energy efficiency</td>
<td>26%</td>
</tr>
<tr>
<td>Lack of proper regulation</td>
<td>78%</td>
</tr>
<tr>
<td>Lack of enforcing the laws</td>
<td>61%</td>
</tr>
<tr>
<td>Presence of a moral hazard</td>
<td>13%</td>
</tr>
<tr>
<td>Presence of asymmetric information</td>
<td>57%</td>
</tr>
<tr>
<td>Insufficient diffusion of information regarding the law</td>
<td>35%</td>
</tr>
<tr>
<td>Existence of split incentives</td>
<td>43%</td>
</tr>
<tr>
<td>Focus on profits</td>
<td>96%</td>
</tr>
<tr>
<td>Higher initial costs of the investment</td>
<td>91%</td>
</tr>
<tr>
<td>Higher perceived risk of implementation</td>
<td>91%</td>
</tr>
<tr>
<td>Having the perception of being already efficient</td>
<td>17%</td>
</tr>
<tr>
<td>Existence of inertia in the companies</td>
<td>4%</td>
</tr>
<tr>
<td>Motivation to increase energy efficiency</td>
<td>-61%</td>
</tr>
<tr>
<td>Having other priorities</td>
<td>91%</td>
</tr>
<tr>
<td>The decision making power of higher management</td>
<td>91%</td>
</tr>
<tr>
<td>The culture of the industry</td>
<td>70%</td>
</tr>
<tr>
<td>Complex decision chain in operating company</td>
<td>13%</td>
</tr>
<tr>
<td>Lack of enough available time</td>
<td>22%</td>
</tr>
<tr>
<td>Difficulty of identifying opportunities</td>
<td>70%</td>
</tr>
<tr>
<td>Difficulty of implementing energy efficiency measures</td>
<td>48%</td>
</tr>
<tr>
<td>Ignorance of the industry</td>
<td>4%</td>
</tr>
</tbody>
</table>
5.2.2. Obstacles distinguished
The identified obstacles are visualized by means of a bar chart in Figure 6 in which the obstacles by non-operating companies and operating companies are distinguished. This approach shows which perceptions of the front-end of the industry chain are similar to the perceptions of the group the EED is targeting, which are the operating companies.

One observation is that non-operating companies argue that the diffusion of legislation information could be improved, while the operating companies do not experience any problems regarding this point. Another aspect is the obstacle of the energy efficiency culture within companies. The operating companies claim to have an energy efficiency culture, while the non-operating companies state the opposite. There will always be exceptions, the latter group argues, but the lion’s share is simply having other priorities. And, as can be seen in Figure 6, having other priorities is scoring considerably with scores of 90% of the non-operating companies and 100% of the operating companies that have been interviewed.

The perceptions between the non-operating companies and operating companies differ on more points. The uncertain energy price, the decreasing market demand, the dependency on others, the availability of techniques, the communication in the industry chain, the perception of being already energy efficient, and the complex decision chain within
operating companies are obstacles that score considerably higher with the operating companies than with the non-operating companies. When it concerns the obstacles of the lack of enforcing the regulation, the lack of appropriate measuring tools, the level of asymmetric information and the influence of split incentives, the opposite holds.

Similar scores of both groups concern the lack of societal value for energy efficiency, the focus on the best return on investment (the energy efficiency investments have generally longer payback times), the frequently higher initial costs of the energy efficient investments, the perception of higher risk coinciding with energy efficiency investments, having other priorities, the ultimate decision making power of higher management, and the difficulties with identifying improvement opportunities.

5.3. Motivation levels

In each interview it is measured how much motivation regarding energy efficiency the participant has and how the participant perceived the motivation of the members in its network and that of the operating companies. The different levels of motivation are combined in five groups, which are also explained in Appendix H. The groups are the following: lowest, low, medium, high, and highest. The results are shown in Figure 7.

In order to be in the highest level, a company should have an energy efficiency culture and investments/actions that show its commitment. If still many improvements can be done the company is assigned to the group of high motivation. Medium implies that there is some awareness, but that is all. The low level entails that there are no examples that signal motivation for energy efficiency, even though one may say there is. And the lowest grade is for those who cannot be bothered.

One aspect that stands out is that only the interviewees themselves score highest for energy efficiency motivation, but generally consider the other members of the industry chain as less to barely motivated. The operating companies score about the same in each of the four lowest categories.

![Figure 7: The different motivation levels of the participants.](image)

The figure shows the participants’ perception of its motivation level and that of the remaining industry separately, just as the motivation level of the operating companies. The x-axis shows the motivation level, the y-axis the number of times that level has been identified in the interviews.
The perceived level of motivation for energy efficiency differs much among the industry. While many vendors\(^1\) are convinced that transfer agents only care about energy efficiency in case it is demanded by operating companies, other types of organizations\(^2\) disagree completely. And each vendor individually sees itself as basically the only vendor that is really working on energy efficiency. More examples can be given, but the point is that these companies have apparently differed experiences and these experiences influence their perception about the industry as a whole.

### 5.4. Industrial relationships

This section first shows the results with regard to the frequency of the relationships in the industry chain. Next it describes the relationships in more detail by means of the PAT. The results are based upon the network overviews and elucidation of the overviews that each interviewee has made. An example of such an overview is shown in Figure 17 of Appendix C.

#### 5.4.1. Frequency of the relationships

The frequency of each relationship that is mentioned in the interviews is illustrated by the chart of Figure 8. The figure clearly shows that the group of the regulators and the operating companies are mentioned the most, which means that these groups appear most frequently in the industry chain network. Moreover, the interviewees stressed several times that the regulators and/or operating companies affected their decisions the most.

![Figure 8](chart.png)

**Figure 8:** Chart that clarifies which relationships are mentioned in each interview. Two relationships are peaking, which is the group of the regulators and the group of operating companies. The vertical axis contains the frequency of the specific relationship and the colour legend shows which groups are responsible for the frequency. The horizontal axis clarifies which group belongs to the peaks.

---

\(^1\) Argued by [CONFIDENTIAL].

\(^2\) Argued by [CONFIDENTIAL].
5.4.2. Regulators

Among the regulators are the EU, the Dutch government and other relevant authorities. Only a brief overview of the hierarchy follows, because Section 4.3 already touched upon the responsibilities of the regulators.

<table>
<thead>
<tr>
<th>Regulators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal</td>
</tr>
<tr>
<td>EU</td>
</tr>
<tr>
<td>Dutch government</td>
</tr>
<tr>
<td>Provinces &amp; municipalities</td>
</tr>
<tr>
<td>Dutch Government</td>
</tr>
<tr>
<td>Supervisor</td>
</tr>
<tr>
<td>Dutch government</td>
</tr>
<tr>
<td>Competent authority</td>
</tr>
<tr>
<td>RVO</td>
</tr>
<tr>
<td>Agent</td>
</tr>
<tr>
<td>Industry</td>
</tr>
<tr>
<td>Provinces &amp; municipalities</td>
</tr>
<tr>
<td>Industry</td>
</tr>
<tr>
<td>Industry</td>
</tr>
</tbody>
</table>

Figure 9: The principal-agent relationships in the group of the regulators. Four different types of relationships exist.

The EU is the principal and the Dutch government is the agent, since the EED is owned by the EU and obliges its Member States, by means of the EED, to increase energy efficiency. The EED assumes a rather straightforward hierarchical model in which the Member States make policies that the industry will obey. In case a lack of effort is being detected, the Member States should take action. And the Member States have to report about their achievements on a regular basis to the EU. Hence, the EED assumes a simple principal-agent model between the EU and its Member States, but is actually working with the revised version of the principal-supervisor-agent model, as introduced in Chapter 2.5. This relationship is represented in the first principal-agent relationship of Figure 9.

The Dutch government consists of its own principal-agent relationship, as shown in Figure 9. The Dutch government, for the EED case being the Ministry of Economic Affairs (EZ), the Ministry of Infrastructure and Environment (I&M) and the Ministry of Foreign Affairs (BuZA), has as its direct agents the Provinces and Municipalities. They are delegated with the task to execute the policies that should direct the behaviour of the industry.

The provinces and municipalities create a principal-supervisor-agent relationship of their own in order to comply with the wishes of their principal. The former hire supervisors, which are the competent authorities, to make sure that the agents, which are the industrial companies, do not shirk. Also this relationship is made visual in the third principal-agent relationship of Figure 9.

But there is another actor, in this research referred to as an executing authority, known under the name of Rijksdienst voor Ondernemend Nederland (RVO). This body is part of the government and, among other activities, makes sure that the participants of the MEE and MJa-3 covenants do what they ought to do. They cannot enforce the law, but can help companies to honour the law and warns them when they deviate. Hence, the RVO fits the role of a supervisor best, because it helps companies to obey the law and reports directly to the government.
5.4.3. Universities
Applying the PAT to the group of universities coincides with complications. From the interviews can be concluded that the universities have a relationship with several shackles of the industry chain, which are not always that hierarchical.

Relationships
The universities have a principal-agent relationship with the regulators, because they depend on the funds of the government. But the universities do much research that must be applied by the operating companies in society as soon as it is developed. Cooperation with the operating companies therefore exists; the operating companies even sponsor certain research activities. To bring the right technologies on the market, the universities have relationships with the equipment manufacturers and the technology providers as well. And in some occasions R&D organizations and consultants contribute too.

Despite the many relationships and collaboration modes that exist in the universities’ network, still some form of hierarchy is present, as shown in Figure 10. According to the interviewees the operating companies are the most influential on which type of research is done. The universities are nevertheless the ones that actively approach the operating companies and other actors. This would imply that although the operating company is the principal, it does not actively push down its goal on the agents. On the contrary, the goal is said to be decided upon by means of networking and sharing of information and experience, often in special knowledge platforms.

![Figure 10: The principal-agent relationship of the universities.](image-url)
The operating companies have the ultimate decision making power and are therefore the principal. The goals, however, are determined by cooperation of the whole network of agents in which the operating companies are involved too.
5.4.4. R&D organizations

The R&D organizations have a wider network than the universities, because they have a more active relationship with branch organizations and the regulators. They are often hired by the branch organizations for specific research, because they stand closer to the industry than the universities. The latter group focuses on fundamental research, while the R&D organizations incorporate more practical elements.

Relationships

R&D organizations try to bring the technology providers, equipment manufacturers and operating companies closer together by means of projects in which the several parties work together. Universities can participate in these projects as well, just as transfer agents and branch organizations. Another important aspect of R&D organizations is that they try to link the funds of the government and the EU to industrial projects, which are done in consortia.

The R&D organizations are often the ones who compose the consortia. One can expect that they are therefore the principal, but that is not the case. From the interviews can be concluded that the R&D organizations are influenced by the goals of the regulators and the private organizations. Hence, this relationship means that the PAT had to be modified to allow for having multiple principals in a relationship with only one agent, as Figure 11 shows.

5.4.5. Vendors

The group of the vendors consists of companies that produce and/or trade equipment and they have often direct relationships with operating companies. They are influenced by the regulators only as to work conform the law, meaning that the manufacturing and distribution of their products and the products’ properties are consistent to the rules set by the regulators. The regulators are, however, not their principal.

Relationships

The vendors are influenced the most by the operating companies, because they want to sell their products to these companies. The transfer agents could play an important role as well, but only when hired by the operating companies. Hence, in the relationship with the transfer agent it is still the operating company that decides whether energy efficiency techniques are demanded. The latter is therefore identified as the principal. The transfer agent can be seen as the supervisor, because it makes sure that the vendor delivers to the operating company. These two relationships and the relationships that will be elucidated in the following paragraphs are visualized in Figure 12.
The vendors are actively involved in many other relationships as well. Bilateral relationships with R&D organizations are present to work as a team on innovations that the operating companies require. The operating companies are often less inclined to share their process information with the vendors, but will share it with the R&D organizations. Hence, the intermediating role of the R&D organizations makes them the supervisor in the principal-agent relationship.

Figure 12: The principal-agent relationships of the vendors group. All these relationships can exist at the same time, due to the number of operating companies, their projects and the accompanying relationships.

The vendor is also a principal in its relationship with manufacturers and service providers, in case it is outsourcing its production. Collaboration with universities occurs as well, but that is mostly with the strategy of finding talented people and has not much to do with energy efficiency.

5.4.6. Transfer agents

Transfer agents are companies that do engineering work for operating companies or can even deliver the whole project from design to construction. The PAT fits the relationships concerning transfer agents almost perfectly.

Relationships
Transfer agents are hired by operating companies to engineer their processes or to deliver the design including construction. In case only the engineering is done, the relationship between the transfer agent and the operating companies is a straightforward principal-agent relationship. The transfer agent tries to satisfy the demands of the operating companies. If, however, the transfer agent is also responsible for construction, it hires vendors and service providers to deliver and install all required equipment and products. Hence, the transfer agent is a supervisor in the latter relationship, as is shown in Figure 13.

Figure 13: The principal-agent relationships of the transfer agents.
5.4.7. Operating companies
The group of the operating companies consists of the companies that the EED is targeting to be more energy efficient. These companies have factories or production plants in which energy is consumed when producing the products they sell.

Relationships
The operating companies are the centre point of the network with universities, R&D organizations, service providers, vendors, transfer agents, technology providers, consultants and branch organizations. Even collaborations with other operating companies exist. The operating companies have the decision making power and are, therefore, the principal in a relationship with many agents. As said, the transfer agents can be seen as supervisors, just as the R&D organizations. Furthermore, also direct principal-agent relationships with R&D organizations exist in case R&D work is outsourced.

The operating companies make sure that their shareholders are kept satisfied, which means that making profits is important. Hence, the shareholders are the principal of the operating companies. Moreover, the regulators are another very important principal in its network, because the latter can either give or take away the License to operate. This license is required to execute its business and is environmental in nature. This means that the operating companies are in a principal-agent relationship with multiple principals that could have conflicting goals, which would be a modification to the original PAT. Each principal-agent relationship in which the group of the operating companies is positioned is visualized in Figure 14.

![Figure 14: The principal-agent relationships of the operating companies.](image)

The operating companies are in many relationships the principal. However, they are the agent in the relationship with the regulators and shareholder principals, which causes a conflict of goals and a difficulty for the operating company to honour these goals.

5.4.8. Consultants
The difference between the consultants and transfer agents is that the consultants deliver advice on paper only, while transfer agents are doing engineering work and could also do construction work.
Chapter 5: Empirical results

Relationships
The relationships of the consultants differ much per consultant. All are nevertheless doing work for private organizations, like operating companies, vendors and branch organizations. And they do work for regulators, both on European level and on national level. These private organizations and the regulators are therefore identified as the principal in the principal-agent relationship in which the consultants are the agent.

The different principals of the consultant are likely to have conflicting goals. This causes no problem because consultants can either do one project at the time or have different teams for each project. Hence, the group of consultants fits the PAT quite well. Despite the several principals that are present, it does not bring up the issue of which goal to choose. Due to this reason the relationships in Figure 15 are drawn independently. And, as can be seen in the figure, the relationships are hierarchical.

5.4.9. Branch organizations
The task of the branch organizations is to represent the interests of its members, which are, in this research, the operating companies. They organize meetings and network events on top of their lobbying activities and other required activities.

Relationships
The branch organizations are the agent in the principal-agent relationship with the operating companies. That what is desired by the operating companies is what the branch organizations try to realize. But it is also the intermediary in the communication channel between its members and the regulators, because it tries to help its members to obey the law. It therefore has a sort of supervising role as well, although it does not exactly fit the requirements of supervising (Tirole, 1988), because the branch organizations are not hired by the regulators to report about the achievements and behaviour of the operating companies. Hence, the PAT does not fit this relationship well, despite its modification of the supervisor.

Additionally, close communication and collaboration exists between the national branch organizations and their European sister organizations. Furthermore, in its network also transfer agents, vendors, technology providers, R&D organizations, universities and consultants are present. In some occasions these
parties approach the branch organizations and in some occasions it is the other way around. Nevertheless, the branch organizations could be seen as the principal in this relationship, because they will decide whether or not collaboration will start. Moreover, they decide what the content of the relationship is, although influenced by what is important to its members. The two different principal-agent relationships that the branch organizations are in are visualised in Figure 16.

5.5. General remarks

Some general remarks with regard to the results can be made. The first is that two industry groups are only limited represented in the interviews, while other industry groups are relatively over represented. The group of the universities and transfer agent have both only one participant, while the group of the vendors and the consultants have five participants each. This influences the generalizability of the results regarding the information given in Section 5.4.

Additionally, the results regarding the motivation levels were not easily obtained. The interviewee normally was very generic about motivation levels. In other words, the industry was seen as a whole and not as consisting of separate organizations. Supplementary questions were required to at least make a distinction between operating companies, the interviewees themselves and the remainder of the industry. Also, the network overview that each participant made required several supplementary questions to really understand what the overview represented.

5.6. Chapter summary

This chapter gave an overview of the results that directly derive from the empirical data. The results regarding the goals of the interviewed companies were shown and the obstacles perceived by the industry as a whole were visualized, just as the differences between the non-operating companies’ and operating companies’ perceptions. The motivation levels with regard to energy efficiency have been identified and the relationships in the industry chain were analyzed by means of the PAT. The results will be interpreted in the following chapter in which the PAT has again an important role for the evaluation of the results.
Chapter 6: Interpretation of the results

This chapter interprets the results that are described in the previous chapter. It starts with section 6.1, 6.2 and 6.3 in which the PAT is connected to the results regarding the goals and obstacles of the industry. The insights obtained from this process are summarized in Section 6.4. Next these insights are used to identify the goals and incentives of the different industry groups in Section 6.5. These interpretations are bundled in Section 6.7 that describes the industrial decision making process, followed by Section 6.8 that explains the additional obstacles to energy efficiency deriving from that process. This chapter concludes with a summary in Section 6.9.

6.1. Goal conflict

As mentioned in Chapter 2.4, one of the two core assumptions of the PAT is that the principal and the agent have a goal conflict (Laffont & Martimort, 2002; Miller, 2005a; Mitnick, 1992; Shapiro, 2005; Waterman & Meier, 1998). The first subsection, subsection 6.1.1, discusses the goals of the EU and the industry. Next the concepts of risk-aversion and opportunistic behaviour are described in subsection 6.1.2 and 6.1.3, respectively. A final remark in subsection 6.1.4 about the core assumption concludes this section.

6.1.1. European Union versus the industry

The 20% energy efficiency goal of the EU, the principal, is predicted not to be obtained by the industry, the agent. This problem is referred to as the EED case, for the means of the analysis. But is the EED case experiencing a goal conflict indeed? As mentioned in Chapter 4, the 20% target was part of the European strategy to create new jobs and sustainable growth, in order to boost economic growth and to limit climate change (Europa Nu, 2015b). In other words, creating new jobs and sustainable growth are the principal’s incentives for its goal to increase energy efficiency by 20%. One could argue that sustainable growth is of economic origin, because damage to the environment imposes an economic cost on society (negative externalities) (Popp, Newell, & Jaffe, 2012) and the EU is trying to reduce these costs when increasing energy efficiency. However, for the means of this research this aspect is framed as social, because both incentives concern society. This means that the EU has social incentives, because they concern both the wealth of society. The EU’s energy efficiency goal is of social-economic origin, because it has both a cost-saving (less imports) and environmental (less emissions and use of fossil fuels per produced product) property.
The industry has goals of its own it pursues, as can be seen in Appendix I Table 15, which can be grouped into social and economic goals as well. The social goals relate to caring for the environment and society while executing the business. The economic goals include making a profit and all actions related to making a profit, like technological development. Goals that have been frequently cited in the interviews are, from most to least, valuing energy efficiency (70%), making profits (52%), and having sustainability as the company’s culture (48%) in which energy efficiency plays a role. The difference between valuing energy efficiency and having a sustainability culture is that the former is about thinking of ways to improve energy efficiency (there is motivation). The latter entails that energy efficiency is part of a whole sustainability culture, which entails much more than just energy efficiency improvements, like using recycled paper, reducing the Carbon footprint, etc.

**Table 4: Goals of the EU and the industry**

<table>
<thead>
<tr>
<th>European Union</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing energy efficiency by 20%</td>
<td>Increasing energy efficiency</td>
</tr>
<tr>
<td>Making profits</td>
<td>Making sustainability a company’s culture</td>
</tr>
</tbody>
</table>

The above paragraphs would indicate that the EED case does not suffer from a goal conflict to such a large extend, because the principal and the agent have similar social and economic motives for their actions. Furthermore, the social goal of the agent to make sustainability, e.g. energy efficiency, a company’s culture, corresponds with the principal’s desire to increase energy efficiency. The goals of both parties are shown in Table 4.

It must be noted, however, that all interviewees have admitted that having energy efficiency motivation and having a sustainability culture is part of making a profit. The chance that a company would invest in energy efficiency measures just because of the environmental property was considered by all interviewees to be very unlikely if the investment would not be economically feasible.

This would mean that goal conflict between the EU and the industry as a result of an incentive mismatch, i.e. social versus economic incentives, could be present after all. Especially if one considers that 91% of the interviewees claimed that energy efficiency is not a priority of the operating companies in investment decisions. The intensity of the goal conflict, however, is less than assumed by the PAT. When a company deviates from its legal obligations regarding energy efficiency, the consequences are marginal. Licenses to operate are in reality almost never withdrawn and legal steps are not taken quickly by the competent authorities. In other words, the enforcement of the law is minimal, partly due to the difficulty of measuring energy efficiency in quantitative terms. Put differently, the negative incentives that are scarcely present weaken the intensity of the goal conflict, because the direct conflict is being avoided.

---

3 Social goals are diffusion of information, enforcing the law, communication, valuing energy efficiency, a culture of sustainability and bringing value to society.
4 Economic goals are satisfying market demand, increasing availability of techniques, making profits, other priorities and implementing measures.
5 See Appendix I Table 14 at ‘Other priorities’.
6 Mentioned by [CONFIDENTIAL].
7 The difficulty of quantitative energy efficiency measurements is mentioned by 26% of the participants.
6.1.2. Risk-aversion

A consequence of the goal conflict in the PAT is that the agent is considered to be more risk-averse than the principal (Miller, 2005a). 91% of the results show that the refining and (petro)chemical industry is risk-averse and that it is an obstacle to energy efficiency indeed\(^8\). These interviewees argue that increasing energy efficiency frequently coincides with implementing new or different technologies into the industrial process. These processes are continuous and only stopped for large maintenance every 5 or 6 years. The risk of a production disruption is avoided by implementing techniques that are commercially proven in their own industry\(^9\). Only in rare occasions the risk of applying an unknown technique will be taken. This can be the result of a pressing problem or after years of developing trust between the operating company and the required actors in the industry chain\(^10\), like equipment manufacturers and technology providers.

The principal of the EED case, however, is very active in stimulating ‘risky’ innovation in order to increase energy efficiency. Examples are its support for ISPT, which is about developing sustainable process technologies (ISPT, 2015), and the Dutch Topsectoren policy (Rijksoverheid, 2015b) as mentioned in Chapter 4.2.8. Furthermore, via the Dutch covenants and the Wet Milieubeheer the agent is obliged to do all investments with a payback time of up to 5 years in order to increase energy efficiency by at least 1.5% each year. The risk of the investment is in these measures not considered, although one could argue that the payback time can incorporate possible economic damage\(^11\). Nevertheless, implementing new technologies or doing drastic changes to the existing plant are frequently brought forward as the solution to increase energy efficiency to the targeted level (Vleeming & Hinderink, 2011), which means that the government is indeed less risk-averse than the industry. To be even more exact, the government experiences no risk at all since it does not have to do any investment itself.

But what are the implications of risk-averse agents in the PAT? Miller (2005b) argues that agents rely on standard operating procedures to avoid risk. The fact that the industry is implementing conventional techniques rather than innovative techniques proves this statement, although it can be an effect of the time constraint as well (Tirole, 1988). Companies do not have unlimited time and may fall back on known strategies and procedures because time to explore or implement new possibilities is not available. Indeed, this is by 48% of the interviewees identified as an obstacle\(^12\) and hence, cannot be attributed to risk-aversion. However, every interviewee who identified this obstacle mentioned the risk-aversion obstacle as well. Moreover, they considered the risk-aversion to be of more influence, meaning that a total of 91% of the cases\(^13\) supports the claim of Miller (2005b).

6.1.3. Opportunistic behaviour

The preference for conventional techniques implies that the ambiguity effect, suggested in Chapter 1.2.2, is actually an obstacle to energy efficiency. Directly linked to the ambiguity effect is, for the EED case at least, a sort of opportunism. In the classical PAT opportunism means that the seller benefits at the cost of the buyer due to asymmetric information (Himmelweit et al, 2011), as explained in Chapter 2.5. In the EED case no evidence for this
event was found. In other words, companies do not deliberately wait with adopting new technologies until the price drops. On the contrary, it is even suggested\textsuperscript{14} that the implemented technologies would probably only increase in price when time passes. Technology providers and equipment manufacturers are occasionally offering (part of) their technologies free of charge\textsuperscript{15} to first time users in order to get the technology proven, which will lead to increasing demand, subsequently. Hence, a wait-and-see attitude of one company, to have its competitors adopt the technique until mass production would lower the price, is unlikely to result in monetary benefits.

Nevertheless, a different form of opportunistic behaviour exists that does apply to the EED case, which concerns the agent’s risk-aversion. 35\% of the interviewees\textsuperscript{16} argue that companies wait with their investment until their competitors have tried out the new technology, as to experience whether the technology is reliable. Although the EED case of opportunistic behaviour appears to differ from the classical PAT, because it relates to risk benefits instead of cost benefits, it is actually the same. The risk that is being avoided is the risk of a process’ disruption, which is the same as avoiding a direct cost. In other words, the agent is trying to opportunistically benefit by maintaining the status quo, while others bear the costs of a potential process disruption due to a failing technique.

However, the opportunism of the EED case is still not comparable with the opportunism of the PAT. The latter is about the agent that opportunistically benefits on the costs of the principal, not on those of other agents (Laffont & Martimort, 2002; Waterman & Meier, 1998). Of course, if the industry decides to delay the investment in energy efficiency, the government is bearing the cost of not achieving its goal. This cost could be expressed in monetary terms if, for example, that means that the government has to import energy for a longer period of time or has to pay a fine to the EU. But the aspect of paying a fine to the EU implies that there is another principal present in the EED case; a situation which is not part of the core assumptions of the PAT. The alternative in which multiple agents exists (one company is waiting for another company to implement the technology), is just as troubling, because it entails the presence of several agents that move independently instead of as one entity (Mitnick, 1992; Waterman & Meier, 1998). The actions of one company are, after all, influencing the actions of another, but that does not necessarily result in having identical actions as well. This would mean that the core assumption of having one principal and only one set of identical agents is invalid for the EED case.

In spite of the above observation that the EED case opportunism does not fit the PAT, there is another form of opportunism present in the EED case\textsuperscript{17}, which fits the core assumption of the PAT indeed. According to nearly 50\% of the interviewees the industry is trying to influence the EU and Dutch government to get funds for research areas of their interest, to bend the legislation in their advantage, or to influence the policy making process directly from the beginning. In other words, the agents are showing opportunism that is likely to result in the principal not achieving its goal.

\begin{footnotesize}
\begin{enumerate}
\item By [CONFIDENTIAL].
\item Mentioned by 3, which are [CONFIDENTIAL].
\item Argued by [CONFIDENTIAL].
\item Identified in the interviews of [CONFIDENTIAL].
\end{enumerate}
\end{footnotesize}
6.1.4. Remark on the core assumption

It is most likely that the agents in an organization, like the industry, have more than one principal they are serving (Shapiro, 2005; Tirole, 1988). As became clear in Chapter 6.5.3, 6.5.6 and 6.5.7, the R&D organizations, the operating companies and the consultants have wishes of multiple principals they are trying to satisfy. And the problem with multiple principals is that these principals can have conflicting goals of their own, which they want the agent to achieve simultaneously. Hence, the core assumption of the PAT that the relationship concerns goal conflict between just one principal and one agent, or several agents treated like one (Mitnick, 1992; Waterman & Meier, 1998), is invalid for the EED case. As Waterman and Meier (1998) argue, the PAT is applicable to organizations, but only if the organization is not treated as a subordinate dyad.

6.2. Information asymmetry

The second core assumption of the PAT is that the principal suffers from information asymmetry (Laffont & Martimort, 2002; Miller, 2005a; Shapiro, 2005; Waterman & Meier, 1998). The concept of asymmetric information is explained in the first two subsections, followed by information regarding the moral hazard, after which a final remark about the core assumption concludes.

6.2.1. Asymmetric information in the industry

Miller (2005a) argues that the amount of money left on the table is a result of the level of risk-aversion of the agent and the degree of information asymmetry that is present in the principal-agent relationship. The more risk-averse the agent and the higher the degree of information asymmetry, the more opportunities are left untouched. That the refining and (petro)chemical industries are risk-averse has been confirmed in Section 6.1.2. But to what degree does information asymmetry exist in the industry chain?

The obstacle to energy efficiency caused by information asymmetry is identified in 57% of the interviews18. Operating companies know considerably more than the authorities about their abilities, because they know their own processes best, which improvement possibilities are still left and how much effort they actually put in while trying to improve their efficiency levels. Additionally, the claim by 78% of the interviewees that the regulation is insufficient19 might imply an even higher degree of information asymmetry. After all, if the principal would have complete information it should be capable of making a proper incentive contract, being the legislation. Also, 35% of the interviewees20 (all non-operating companies) argue that the diffusion of governmental information to the industry is insufficient. The interviewed operating companies, on the other hand, are saying the opposite. Hence, even among the agents themselves information asymmetry exists. The only issue with the last statement, however, is that it undoes the PAT assumption of having only one static unit of agents in the principal-agent relationship.

Furthermore, according to Waterman and Meier (1998) the information asymmetry is especially common in policies related to technical matters. In other words, it is not striking that a high level of information asymmetry exists in the EED case, which is about a technical concept intertwined with a policy.

---

18 See Appendix I Table 14 at ‘Asymmetric information’.
19 See red values in Table 14 at ‘Regulation’.
20 See Appendix I Table 14 at ‘Diffusion’.
6.2.2. Split incentives

As mentioned, the agents of the EED case are very risk-averse and there appears to be quite a high level of information asymmetry. As argued by Miller (2005a), it would mean that there is a large amount of money left on the table. The question that remains is how this money, i.e. the potential for energy efficiency, can be utilized.

One possibility is to reduce the existence of split incentives. For the EED case this translates into the energy efficiency achievements individual companies have, but which are not observed in the industry as a whole. 43% of the interviewees confirmed that more public exposure would help to increase energy efficiency, because companies would get visible credits for their achievements. But maybe more importantly, they say, energy efficiency would become part of the organization’s culture.

On the other hand, it is argued by 61% of the interviewees that energy is such a significant cost to the overall production process that companies have high motivation to increase their energy efficiency levels already. Put differently, increasing energy efficiency would result in an improved competitive position which is beneficial for profits. This is in line with the PAT, because that theory assumes that agents want to maximize value. Nevertheless, the largest part of these 61% confirmed that although motivation is present, split incentives cause a serious obstacle to energy efficiency and should be reduced. Moreover, these interviewees signal a problem of collective action (Olson, 1965) as described in Chapter 1.2.3, because companies are apparently more eager to increase their efficiency levels if they observe that their competitors are doing the same. Companies avoid risk by waiting for another in their own industry segment to implement the technique first, creating a catch-22. Hence, money is left on the table indeed.

The prisoner’s dilemma does not play a role in the collective action problem. As mentioned by all interviewees, energy efficiency investments make the company better off regardless of the action of its competitors, due to its money saving property. If the competitors do not choose to invest in energy efficiency, they will have a worsened competitive position. If they both invest, their situation would basically be similar to the original situation. Hence, their dominant strategy would be to invest in energy efficiency. However, the EED’s struggle to reach its target shows that the industry is not making enough use of this strategy.

6.2.3. Moral hazard

The presence of a moral hazard has been identified in 13% of the interviews. In case the law requires interpretation the operating companies are said to interpret the law in their benefit in order to pursue their personal goals. Hence, in that case the shirking of the agents imposes a cost on the principal, which is that it may not achieve its 20% energy efficiency target. Some possible monetary consequences of shirking agents have already been mentioned in Section 6.1.3.

As explained in Chapter 2.4, one option to reduce the moral hazard is by rewarding the good efforts or achievements of the agent (Miller, 2005b). The EED case, the Dutch government that is, already makes use of such an approach. Well-performing companies are more freely

---

21 See Appendix I Table 14 at ‘Split incentives’.
22 See Appendix I Table 14 at ‘Values’.
23 This is confirmed by all interviewees but [CONFIDENTIAL].
24 5 out of the 14 interviewees that identified ‘Values’ did not identify ‘Split incentives’ too.
25 See Appendix I Table 14 at ‘Moral hazard’.
in their improvement choices than companies that are falling behind26. This could be an explanation for the relatively low amount of participants that identified the moral hazard threat.

6.2.4. Invalid assumption
There is, however, a problem surfacing in the above subsections. That companies are acting in such a way as to increase their profits is in line with the PAT, while assuming that the agents act as one unit. However, nearly all of the interviewees claimed that while some companies are very actively increasing their energy efficiency levels, the most have other priorities27, like safety and product improvement. This would mean that the agents do not act as one and have to be seen independently or at least as separate groups, which is a contradiction to the PAT core assumption. Furthermore, when more principals and agents are present the assumption of complete information asymmetry is invalid, because the sharing of information becomes more common when goals are becoming aligned (Waterman & Meier, 1998).

And there is another aspect that requires the assumption of the relationship between the principal and the agent to be relaxed. The PAT relies on aligning the interests of the principal and the agent as to avoid loss of the principal’s control. But another option to solve the moral hazard is by monitoring the actions of the agent by means of introducing a supervisor in the original PAT (Brandt & Svendsen, 2013; Miller, 2005b). Chapter 5.4 showed that such relationships exist quite often in the industry. In conclusion, the problems that arise when analysing the EED case by means of the PAT emphasize that the core assumptions of the PAT are disputable.

6.3. Core assumptions of PAT disputed
The original PAT is about the relationship between a buyer and a seller (Laffont & Martimort, 2002; Waterman & Meier, 1998). But as mentioned, the model has experienced quite some changes in order to cope with the dynamics of the social, political and organizational science (Miller, 2005a, 2005b; Shapiro, 2005; Tirole, 1988; Waterman & Meier, 1998). But even in the buyer and the seller relationship of the original PAT an issue about the core assumption of goal conflict may arise. Goal conflict between the agent and the principal does not have to exist at all times. And in case it does not and goal consensus exists, this indicates that cooperation between the agent and the principal could emerge (Waterman & Meier, 1998). This is an aspect that is far removed from the classical PAT, just as introducing multiple agents and principals. These elements are nevertheless required to apply the PAT to the EED case.

6.3.1. Multiple principals and agents
One of the issues Mitnick (1992) wrote about was that PAT did not allow the influence of multiple principals and agents. In his eyes this limitation made PAT not yet adequate to be applied as an organizational theory. As the results in Chapter 5.4 show, agents can simultaneously be a principal to others in a different relationship (Shapiro, 2005). Tirole (1988) identifies this aspect as ‘side contracting’ and argues that the core assumptions of the model need to be relaxed in order to make the PAT applicable to organizations.

---

26 This statement is confirmed by 4 participants [CONFIDENTIAL].
27 See Appendix I Table 14 at ‘Other priorities’.
Additionally, the EED case supports the claim of having multiple agents as well. When focussing on the industry chain this consists of authorities, universities, R&D organizations, vendors, transfer agents, technology providers, operating companies, consultants and branch organizations, which are all agent in a specific relationship. And each of these agents is actually a large group of yet again agents. The consultants’ agent group, for example, consist of all kinds of different consultancy companies that focus on different areas, like finance, solar energy, sustainability, etc. And these agents have their own goals and make decisions of their own, which are not necessarily identical. Hence, the EED case confirms that the assumption of having one identical group of agents has to be relaxed.

However, the introduction of multiple principals and agents bring also some difficulties into the equation. As mentioned, the operating companies are risk averse, while the equipment manufacturers, R&D organizations, universities, and technology providers are often the opposite. As a result, conflicting goals among the agents of the industry will exist as well, which will be identified in Section 6.5. Furthermore, the chance on information asymmetry is also higher when the number of different agents with conflicting goals is high (Shapiro, 2005). Section 6.2.1 has clarified that a high level of information asymmetry is indeed present in the EED case. Additionally, a difficulty of having more principals is that the agents must choose between the different goals these principals have. This aspect has already been briefly touched upon in Section 6.1.4. The problem with the PAT is that the model assumes that the principal controls the agent in some way. However, when principals put conflicting goals on the agent the model does not explain which goals should be pursued and which ignored (Waterman & Meier, 1998).

6.3.2. Cooperation between principal and agent
Another aspect that Mitnick (1992) wrote about is that the PAT did not take inter-organizational behaviour into account. This was seen as a problem, because organizations’ goals are determined by both endogenous (from within) influences as exogenous (from outside) influences.

The EED case relates itself to this objection, because many obstacles to energy efficiency are due to exogenous influences indeed. Exogenous obstacles to energy efficiency that are being identified in the interviews are summarized in Table 5. Hence, in order to further apply the PAT to the EED case the model has to be extended in order to take account of the influences from outside the principal-agent relationship. This will help to understand why a conflict of goals exists.

<table>
<thead>
<tr>
<th>Exogenous obstacle</th>
<th>Identified by ...% of the interviewees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertain and currently low energy prices</td>
<td>43%</td>
</tr>
<tr>
<td>Decreasing market demand</td>
<td>48%</td>
</tr>
<tr>
<td>Attractive investment climate elsewhere</td>
<td>22%</td>
</tr>
<tr>
<td>Dependency on other organizations</td>
<td>17%</td>
</tr>
<tr>
<td>Society does not value energy efficiency</td>
<td>35%</td>
</tr>
<tr>
<td>Technologies are not applicable to the processes</td>
<td>78%</td>
</tr>
<tr>
<td>No proper tools exists to measure energy efficiency</td>
<td>26%</td>
</tr>
<tr>
<td>Difficulties with the communication between organizations</td>
<td>57%</td>
</tr>
<tr>
<td>Lack of proper diffusion of the required information</td>
<td>35%</td>
</tr>
</tbody>
</table>
However, the model requires more adjustments in order to analyse the EED case further. These adjustments are still in line with what is proposed by other researchers that applied the model to the political and organizational environment. An important missing element in the PAT is the aspect of cooperation and cooperation is quite common in organizations, sociology and politics (Shapiro, 2005; Tirole, 1988; Waterman & Meier, 1998). The PAT considers the relationship between the principal and the agent as static, while in reality the relationship develops over time. This aspect allows the parties to learn about each other’s motives and actions (Shapiro, 2005) and it can also evolve in a relationship in which the goals of the two parties grow closer together. Furthermore, when no goal conflict exits cooperation is very likely to occur (Shapiro, 2005; Waterman & Meier, 1998). And that has consequences for the legislation, because political control, i.e. the incentive contract, would be less relevant in a cooperative relationship. On the contrary, providing the agent sufficient freedom to pursue the common goal is what becomes more important, efficient and effective according to Waterman and Meier (1998). Also the industry is characterized by cooperation, as will become clear in Section 6.5 and in the following chapter.

6.3.3. Bureaucracy and power
A just question one might ask at this point is whether the EED case can indeed be compared to an organization, for the adjustments to the PAT may still not justify its use to analyse the EED case any further. There are many definitions of what an organization is, but an important element is the “repeated and frequent relationship between its members” (Tirole, 1988, 464). Since the industry is depending on Licenses to Operate and other legislation aspects, it is regularly visited by the authorities to make sure it obeys the law. Moreover, the industry alone consists of many businesses, as also became clear from the relationships described in the previous chapter, which are offering each other services or products on a regular basis. And the branch organizations have an important communicating role in the network of policy makers and the industry. Hence, the EED case is considered to be comparable to an organization.

One of the problems of the PAT addressed by Tirole (1988) is that the organizational elements of power and bureaucracy are not presented well in the model, despite its relation to the concept of shirking. The EED case emphasizes the need for improvement on these aspects as well. One of the largest obstacles to energy efficiency is the power of decision making. Analysed on a general level, no matter how much effort non-operating companies put into the quest, the operating companies have the ultimate power whether or not to go for energy efficiency. But, when analysed one level deeper, it is the higher management in these operating companies that make the ultimate decision, which is often stationed in a non-European office and influenced by several other parties, like stakeholders and shareholders. Furthermore, the bureaucracy within the company is another point that is identified as an obstacle by 66% of the operating companies. Hence, power and bureaucracy are important elements in order to distinguish between shirking as a result of a conscious choice or as an outcome of something more complicated.

What about the role of the principal; is there a way for the principal to influence the decision of the agent whilst power and bureaucracy exist? As mentioned before, a supervisor has been included in the original principal-agent relationship in order to reduce shirking. In the EED case the supervisor (Dutch government) is already present, who should monitor the

---

28 See Appendix I Table 14 at ‘Power’.
29 See Appendix I Table 14 at ‘Complex decision chain’.
actions of the agents. But monitoring energy efficiency has been identified as an obstacle by 26% of the interviewees\textsuperscript{30}, because it is very hard to measure energy efficiency in itself or the actual effort the operating companies put in. Another important objection to monitoring is that it leads to a new problem, which is that the agent could try to influence the supervisor (Miller, 2005b). Hence, bureaucracy and power could really be a problem for the EED case, because supervising causes problems of its own.

An extreme supervisor problem applies to agents trying to bribe their supervisor (Brandt & Svendsen, 2013) with a colluding agent and supervisor as a consequence (Tirole, 1988). These aspects of bribing and colluding are, however, far removed from the core assumptions of PAT and they are also not supported by the data of this research.

6.4. Interim recap

A lot of information about the PAT and its applicability to the EED case has been provided. This section provides a brief recap in the form of Table 6. The table touches upon the core assumptions of PAT and how they relate to the EED case. Additionally, the adjustments that are required to analyse the results further are also briefly mentioned.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Most important points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal conflict</td>
<td>One core assumption of the PAT.</td>
</tr>
<tr>
<td>EU versus industry</td>
<td>Social-economic versus economic goals; a less intense goal conflict than assumed by the PAT.</td>
</tr>
</tbody>
</table>
| Risk-aversion | - Industry is more risk-averse than the EU.  
- Standard procedures are preferred (ambiguity effect). |
| Opportunistic behaviour | - Industry shows opportunistic behaviour regarding risk and is lobbying the regulators.  
- Risk opportunism is among agents; between the agent and the principal PAT opportunism exists (lobbying). |
| Remark on the core assumption | Multiple principals with possible conflicting goals exist (in comparison to only one principal) |
| Information asymmetry | The second core assumption of the PAT |
| Information asymmetry in the industry | A high level of asymmetric information exists between the principal and the agent and even among agents. |
| Split incentives | Split incentives is an obstacle to energy efficiency and it signals a collective action problem |
| Moral hazard | The Dutch government currently tries to avoid the moral hazard by rewarding good effort and achievements regarding energy efficiency. |
| Invalid core assumption | - Agents act as individuals, not as one unit.  
- Complete information asymmetry does not exist in organizations |
| Core assumptions disputed | Some of the core assumptions have to be relaxed in order to apply the PAT to organizations. |
| Multiple principals and agents | - The EED case has both multiple principals and multiple agents that can have different goals.  
- The EED case has agents that are at the same time principals in a different relationship. |

\textsuperscript{30} See Appendix I Table 14 at 'Measuring'.
Cooperation

- Endogenous influences must be included
- Relationships evolve over time, resulting in conflicting goals that grow closer together
- Cooperation occurs when goals are similar
- Cooperation makes legislation redundant

Hierarchy in the EED case

- The EED case can be compared with an organization
- Power and bureaucracy should be incorporated in the PAT
- Principal-supervisor-agent relationship

6.5. Goals and incentives in the industry chain

The goals and incentives in the industry chain are described by applying the PAT in its additional form; that is, when its core assumptions of a static relationship between only one principal and one agent are being relaxed. That such an approach is required became clear in Chapter 5.4 and the previous sections of this chapter.

6.5.1. Regulators

Conflict of goals

The group of actors that are part of the regulators group are all part of a hierarchical structure, which is a core principle of the PAT. But this group clearly shows that in reality the relationship does not apply to only one principal and one agent, because there are several supervisors present as well. Moreover, agents are at the same time the principal in another relationship. Nevertheless, each relationship is clearly hierarchical. The important question is, does this mean that there is a conflict of goals and hence a possible misalignment of incentives?

Goal conflict is to some degree present between the EU and the Dutch government. The Dutch government is not eager to introduce new policies and prefers to honour the demands of the EED by only slightly modifying existing policies. This could be a result of the difficulty to measure energy efficiency, which makes it hard to design a detailed incentive contract. After all, the incentive contract only works if the actions of the agent can be controlled by means of the contract and hence, can be checked. The incentive contract loses its controlling power when it cannot specify tacit measures of control, which is a consequence of the energy efficiency measurement difficulty. Sticking to existing policies is in that case probably a safer and cheaper choice than to introduce a possibly unclear and ineffective new policy.

Furthermore, if companies participate in the covenants, they do not have to do the additional energy audits and ENEMS as prescribed by the EED. Hence, a mild form of collusion between the agent and supervisor appears to be present after all. However, the current developments are that existing regulations became more strict, meaning that the collusion will decrease. Any other form of goal conflict than the new policy making deviating behaviour of the Dutch government could not be identified.

Incentives

The group of the regulators is especially driven by societal matters. Its potential for economic growth and decreasing the harm done to the environment are the incentives to make energy efficiency policies on a European and national level, which should result in its

31 Argued by 3, [CONFIDENTIAL].
subordinates sharing these energy efficiency interests. Because of the power the government possesses, i.e. if one violates the law its business will be shut down, the subordinates have not much choice than to honour the policies or to move their business somewhere else.

6.5.2. Universities
Caution with regard to the statements concerning the university group is required, because it is based upon the result of only one interview and has therefore a high chance of being not generalizable.

Conflict of goals
Despite the hierarchical relationship that exists between one principal (the operating company) and several agents (remaining industry chain, including the universities), goal conflict is reduced by consultation prior to technology development. This almost confirms with what is theoretically argued by Shapiro (2005), Tirole (1988) and Waterman and Meier (1998), which is that in case goal conflict does not exist cooperation will occur. However, in this research it appears that it is the other way around. The willingness to cooperate leads to the alignment of goals between the principal and the agents.

It is also possible that having a similar goal is the reason why the different parties (including the universities) want to collaborate in the first place. The desire to remain competitive and/or stay in business is a goal that would apply to each party. That is also the reason why shirking of the agents is not expected, because shirking makes one untrustworthy and consequently the collaboration will be stopped, leaving the shirking agent with nothing. Nevertheless, everyone will try to get the deal in its favour within the boundaries of how far one could go (Scholz, 1991).

Incentives
Universities are driven most by the wishes of the industry, i.e. the operating companies, at least regarding energy efficiency aspects that is. The opportunity to develop new techniques that can be applied in society is the incentive for the universities to collaborate in these energy efficiency projects.

6.5.3. R&D organizations
Conflict of goals
It is quite likely that the goals of the private organizations and regulators differ and even conflict, which are the principals of the R&D organizations. Private organizations think most about the return on investment, low costs and minimum risk in order to use the research for their own benefit. The regulators are often guided by environmental and societal programs, which do not get much support of the private parties. A frequently mentioned example is that of carbon storage. The government is considering this technological solution as a means to reduce CO₂ emissions. The industry, however, is not unanimous about carbon storage being a good measure to reduce emissions, because it will lead to an increase of the energy consumption and a lot of extra costs32.

---

32 Six interviewees argued that the industry would be motivated to reduce its emissions, but only due to the existing law that restrict emissions. Without the law, they say, barely any motivation to reduce emissions would exist.
The problem with the PAT, as described by Waterman and Meier (1998), is that it does not tell which goal the agent must choose when its principals have conflicting goals. It basically leaves the agent no other choice than to choose the goal most beneficial for himself and to shirk with regard to the other goal. However, the PAT does not take into account the possibility of communication between the principals and agents as to grow to a mutual understanding. In other words, R&D organizations put different parties in one room as to come to an agreement about which path must be followed. Each party gives and takes a bit until an agreement has been reached. It could apply the same strategy of formulating its consortia to its principals in order to satisfy both its principals. After all, the agent in this R&D relationship can always try to get more funds from the party that corresponds to its own goal, making the second principal superfluous. If the latter party than tries to use coercion to get his goal satisfied, it will have less to no effect and, consequently, his goal is not obtained. Sticking to its goal will leave the principal worse off than when some sort of agreement would be reached with the other principal. This networking element is therefore likely to occur. Even the adjusted PAT does not take the networking element into account, but it is an important aspect of the R&D relationship. The quote below identifies the four elements of a network.

“A network can be defined as (1) a number of actors with (2) different goals and interests and (3) different resources, (4) who depend on each other for the realization of their goals” (de Bruijn & ten Heuvelhof, 2008, p. 1).

The elements of a network differ from the characteristics of a hierarchy, which is where the PAT relies on. In a hierarchy there is uniformity in the organization, there is a top-bottom power structure, the actors are willing to be steered by their superiors, and the structure is regarded as stable (de Bruijn & ten Heuvelhof, 2008).

In their book about decision making in networks de Bruijn and ten Heuvelhof (2008) explain how difficult it is to get what you want, even when you are the boss, i.e. the principal. As soon as one is in a network he must cope with different parties with different interests and strategic behaviour. After all, the actor can always decide that he will exit the network, even when he is not the boss. And the boss needs the actors to get what he wants. Mutual dependency is the driver of the network but makes it also a complicated process regarding having one’s own goal satisfied. Careful communication is key to get as close to what one prefers. And, as mentioned, the aspect of communication to get the goals closer together is a phenomenon that the adjusted PAT does not cope with. Hence, the group of the R&D organizations probably fits analysis by means of a network approach better than that of the PAT. After all, the consortia that are being composed exist of even more agents with their own interests and strategic behaviour, which emphasises the network elements in the relationship.

Incentives
R&D organizations are driven by opportunities to connect innovation to practical applications. Regarding energy efficiency projects the incentives to do such projects are the beneficial impact on the environment and the competitive value it can bring the industry.
6.5.4. Vendors

Conflict of goals
Goal conflict is present in the principal-agent relationship of the vendors, because of the preference the operating companies have for conventional techniques and the strategy of the vendors to be innovative in order to remain competitive. The agents are unlikely to show opportunistic behaviour, because trust and reputation is of the highest value if the agent wishes to sell its products to the industry.

The goal conflict in the vendor relationships with the transfer agents and the R&D organizations is similar to the direct relationship with the operating companies. But the vendors are eager to sell their products and the transfer agents and R&D organizations can often choose between many similar agents. It is therefore expected that the vendors will transform their goal within the boundaries of their capabilities in order to meet the goal of the principal. If they will not, they have to walk out on the relationship and focus on another company or industry segment that meets their goal.

That an agent walks out on a relationship is an element that the adjusted PAT does not incorporates and the network approach indeed does. Hence, even though the PAT seems to be applicable to the group of the vendors due to the hierarchical structure of the relationships, it misses the important element of possible relationship termination. Moreover, the PAT also fails to take account of the many agents a principal can choose from in order to reach its goal. This means that goal conflict is avoided before the relationship is even started. Nevertheless, the agent will try to get the most out of the deal in monetary terms, while the principal wants to pay only the minimum. However, the contract is drafted with mutual agreement, aligning the goals from that moment on.

And another important aspect is that the PAT does not think of the value of long-term relationships that build trust between the agent and the principal. Of course, the chance of shirking could increase. But if the agent falls prey to this temptation it knows it will hurt its reputation, which is of utmost value to stay in business. And reputation is yet another element that is not present in the PAT or the adjusted PAT. Only if one would consider a good reputation to be an agent’s goal the PAT is applicable.

Incentives
The vendors have their competitiveness as goal. Hence, they have profits and costs as incentive for their actions, which reflect in a desire to be innovative. Nevertheless, all interviewed vendors have environmental incentives as well, due to a personal believe or due to pressure from other industries in which they sell their products.

6.5.5. Transfer agents

Caution with regard to the statements concerning the transfer agent group is required, because it is based upon the result of only one interview and has therefore a high chance of being not generalizable.

Conflict of goals
Collusion between the supervisor (transfer agent) and the agent (vendor) is considered to be non-existed. The reputation of all parties involved is very important if one wants to maintain its business. Moreover, contracts are tight and only small opportunities for opportunistic behaviour will exist, which could be about guarantees regarding the quality of
Chapter 6: Interpretation of the results

processes and products. But as mentioned, building trust is very important in the industry and delivering less what one has promised is a direct harm to one’s reputation and therefore unlikely to occur.

In the direct relationship between the operating company (principal) and the transfer agent (agent) the goal conflict is about paying the least amount of money for the project against making the most profit possible, respectively. But also in this relationship the principal can choose between several agents. The agent that meets the criteria of the principal will be chosen and goal conflict is reduced once the contract is signed. A successful collaboration leads to the transfer agent gaining the trust of the principal. This trust can materialize in future cooperation even though the agent would not offer the lowest price.

This touches upon another shortcoming of the PAT, because it does not think of one principal with multiple goals that it wants to satisfy simultaneously. For the principal the goal is, in the transfer agent relationship, to get its project done for the lowest price, but it is also important that the project has low risk, meets the quality requirements, is delivered on time and is executed safely. The principal will have to weigh its goals in order to come to an overall conclusion which demands it will put on its agent. Moreover, the capabilities of the agents also influence which goals are met and which to a lesser degree. The PAT, however, does not take these aspects into account.

The matter of conflicting goals between the transfer agents and the vendors is already been described in the subsection about vendors.

Incentives

The goal of the transfer agents is to be competitive in order to get projects from operating companies and to earn a profit for its shareholders. Its goals are therefore determined by economic incentives like profits and costs.

6.5.6. Operating companies

Conflict of goals

The regulators impose environmental obligations on the companies and put also other constraints on the operating companies’ actions. Several interviewees have stressed that environmental restrictions are causing a large cost to operating companies and as a consequence suppress profits and other investment opportunities. The goal of the regulators to have an environmental friendly business is therefore conflicting with the goal of the shareholders to make a high profit. Due to the issue of trust and wide offer of suitable agents it is unlikely that shirking is a problem in the remaining principal-agent relationships regarding the operating companies group.

Incentives

Operating companies want to make a profit while honouring the law, because there will be no business otherwise. They have economic incentives. Shirking with regard to this relationship is almost impossible to avoid, because both principals must be kept happy and at the same time cannot be satisfied entirely.
6.5.7. Consultants

Conflict of goals
The consultants explained that their goals are simply matched with those of the client (regulators and private organizations). Its ultimate own goal is to make money by providing the client with advice. To attract future work it has to deliver what the client is asking for, which would mean that shirking is not a large threat. However, all consultants confirmed that they know much more than the regulators or the private companies, which is after all the reason why they are hired, which means that a high level of information asymmetry exists. Hence, the chance of shirking in the principal-agent relationship is quite large as long as the boundaries of trust are not crossed, because consultants need their reputation to stay intact as well if they want to attract business in the future.

Incentives
Consultants have economic incentives, because they want to stay in business by providing its clients of advice. In other words, market demand is leading in what actions they do. Some consultants have environmental incentives as well and, as a result, incorporate energy efficiency in all of their projects.

6.5.8. Branch organizations

Conflict of goals
A conflict of goals is most unlikely to exist between the operating companies (principal) and the branch organizations (agent), because the branch organizations are representing the interests of the operating companies. In other words, the goals of the principal are the goals of the branch organizations.

In the relationship of the branch organizations and the remainder of the industry chain goal conflict is more likely to occur. The remainder of the industry chain wants to make use of the network of the branch organizations to get in contact with the operating companies. Their underlying goal is to attract business via the branch organization’s network. The branch organizations, on the other hand, want to distribute knowledge and experiences among its members. The agents in the remainder of the industry chain are a good tool to satisfy that goal, but the agents are likely to show opportunistic behaviour. The latter wants, after all, to attract new business and will use its information carefully. Hence, the PAT fits the first described type of relationship not well, due to a lack of goal conflict. But that is solved when the adjusted model of goal consensus is applied. The second type of relationship, on the other hand, does fit the characteristics of the original PAT.

Incentives
Branch organizations share the incentives of its members. Put differently, the wishes of its members are in fact the incentives of the branch organizations. This means that economic incentives like profits are very important, but also aspects like safety. Knowledge sharing opportunities are also a driver of its actions.

6.6. Analysis of the PAT summarized
It became clear that while some groups fit the hierarchical assumption of the PAT quite well, others are experiencing difficulties and fit a network relationship and its characteristics much better. The group that can be related best to the PAT is the group of the regulators.
The groups that still have some similarities with the PAT, similarities to the adjusted model that is, are the following groups:
- Universities (several independent agents);
- R&D organizations (multiple principals with conflicting goals);
- Operating companies (principal-supervisor-agent relationships and multiple principals with conflicting goals);
- Consultants (an agent can have several principals);
- Branch organizations (goal consensus between principal and agent).

The groups that seemed to fit the PAT at first glance but after closer examination appears not to do so, are the R&D organizations (multiple principals with conflicting goals), the vendors (principal-supervisor-agent relationships), and the transfer agents (principal-supervisor-agent relationships). Despite its correspondence to the adjusted PAT model, which is the information given between brackets, the PAT cannot solve the following issues that are important for the decision making process of the industry:
- Desire to build long-term relationships reduces opportunism;
- Reputation and trust building reduces opportunism;
- The agent can walk out of the relationship;
- Networking and collaboration instead of a principal-agent relationship;
- Strategic behaviour other than monetary opportunism;
- A principal can choose out of several agents as to align goals;
- One principal can have multiple goals that have to be met at the same time.

The complexity of the industry chain's network is emphasized by the following aspects:
- The existence of several principal-agent, principal-supervisor-agent and network relationships alongside each other;
- Principals that are simultaneously agents and the other way around;
- Principals with conflicting goals between which the agent must choose;
- Hierarchies that are often crumbled into collaboration modes.

This latter aspect of collaboration, which coincides with different responsibilities and bilateral relationships, is making it impossible to frame the decision making process in only one principal-agent model. But that is exactly what the EED is trying to do.

### 6.7. Industrial decision making process summarized

The EED mainly treats the industry as if it only consists of operating companies that have just the regulators to obey and that can easily determine the actions of the rest of the industry chain. However, in reality the industry itself is much more complex than such a plain hierarchic organ. Cooperation of all industry groups is very important in which long-term relationships are formed and trust is being developed. Furthermore, communication plays a very important role in these relationships, which also leads to avoidance of goal conflict between the different members. Moreover, it means that mutual dependencies exist and that participants of a network are free in their choices. This makes enforcing one's goal an ineffective strategy and the hierarchy becomes redundant as a result. In other words, the EED approaches the industry as being a hierarchic organ, while it is actually a large network in which some players, i.e. the regulators and operating companies, are perceived to be more dominant than others.
According to 96% of the participants operating companies are mostly driven by the best return on investment, i.e. economic incentives. Also the largest part of the industry chain is influenced by economic incentives. This could indicate that monetary incentives, which the Dutch government is providing to operating companies by tax reimbursements and subsidies, is actually the correct way to get the industry more energy efficient. Furthermore, 91% argue that these companies are also risk-averse due to the importance of their continuous processes, which means that they prefer proven techniques. Moreover, the risk aversion leads to a collective action problem, because nearly all interviewees stated that operating companies prefer another in the same industry segment to test the technology first, creating a catch 22.

Also, most operating companies are global operating companies in which the higher management has the decision making power and is located in non-European offices. According to nearly all participants they have other priorities than energy efficiency, despite their motivation to increase energy efficiency. The motivation derives from its money-saving property, as explained by 61% of the interviewees. Also, these global operating companies have their shareholders and the regulators to satisfy, but both have conflicting goals that often cannot be obtained simultaneously. Lastly, factors as market demand, energy prices, available techniques, competitiveness, investment costs, and legislation are all important factors that influence the decisions that are being made as well. It also means that multiple goals have to be met in only one project. These influences can lead to additional obstacles, which cannot be identified by applying the PAT.

6.8. Additional obstacles to energy efficiency

This section interprets the possible consequences of the different perceptions about the existing obstacles, the structures of the relationships of the industry chain and the differing motivation levels.

6.8.1. Different perceptions

50% of the non-operating companies and 100% of the operating companies argue that the communication in the industry chain should be enhanced. The several obstacles that derive from the different perceptions in the industry chain confirm their claim.

It is argued by several interviewees that the operating companies are pointing their finger to the vendors and technology providers because the availability of adequate technologies is insufficient, but the latter claim that the operating companies are not sharing the required information about what they need. Others argue that a new technology only stands a chance when it is presented to the highest possible management level, while some say that the people that are directly experiencing the problem should be approached. Of course, several strategies can exist next to each other, but they all say that it is very tough to get the technologies adopted and the different perceptions will not help to overcome this obstacle. Moreover, pointing fingers generates a wait-and-see approach that is likely to slow down the energy efficiency improvement process, as briefly mentioned before in Section 6.2.2. In other words, the different perceptions form an obstacle to increase energy efficiency.

Argued by [CONFIDENTIAL].

Mentioned by 4, [CONFIDENTIAL].

Argued by [CONFIDENTIAL].
6.8.2. Complex hierarchical structure
The complex hierarchical structure of the industry increases the level of information asymmetry and the uncertainty regarding the legislation. As became clear before, in some situations a network exists instead of a hierarchy. Moreover, the sideways existence of one actor having both principal and agent roles in different relationships leads to strategic behaviour, because it means that information becomes a valuable resource and future encounters are also likely to occur. Mutual dependency and also the chance of a future encounter mean that each agent chooses its actions carefully, which complicates the decision making process (de Bruijn & ten Heuvelhof, 2008) and hence, is an obstacle to energy efficiency.

Also the hierarchical system of the regulators leads to complications. The policy makers know much less than the competent authorities regarding the abilities and actions of the industry. And the competent authorities know even less than the companies themselves36. Also information regarding legislation has to be diffused to the industry, but this process is insufficient37. Moreover, the abundance of governmental information and changing policies makes it difficult for the companies to keep pace and to know what is applicable to whom38. Hence, even a clear principal-agent relationship cannot resolve the uncertainty and difficulties that arise regarding the incentive contract, because it is connected to a dynamic network of companies.

And the dynamic network of companies causes yet an obstacle of its own. The collective action problem that originates from the risk-aversion of the industry is a problem of a very large group. According to Olson (1965) large group’s problems can only be overcome if there is some sort of coordination that leads the members of the group to its collective goal. But the larger the group, the higher are the costs of coordination. When this latter point is combined with the result that the industry consists of dynamic relationships, it is clear that coordinating the industry to its collective goal of energy efficiency is associated with challenges.

6.8.3. Additional principal-agent problems
Although the government is relying on mainly economic incentives to stimulate the industry to increase energy efficiency, it also applies non-monetary incentives as a rewarding system (Miller, 2005b) or, as Tirole (1988) calls it, it applies supervision and an act of co-operation. If companies perform well, they get less strict supervision, i.e. independency, of the competent authorities in return. Put differently, the companies become self-regulating. Self-regulation, however, introduces principal-agent problems of its own due to its monitoring element. The agent(s) that do the monitoring are, after all, working for the manager(s) (principals) that ordered the monitoring. Hence, the rewarding system designed to ease the process is actually introducing another principal-agent relationship (Shapiro, 2005) that could be an obstacle to increase energy efficiency.

6.8.4. Differing motivation levels
A possible explanation of why the perception in motivation differs so much among the participants is the high level of information asymmetry, as identified earlier. In case the industry chain members believe that limited to no motivation for energy efficiency is

---

36 See Appendix I Table 14 at 'Asymmetric information'.
37 See Appendix I Table 14 at 'Diffusion'.
38 See Appendix I Table 14 at 'Regulation'.

present in the industry, this could reduce their efforts in trying to enhance energy efficiency altogether. Indeed, nearly a third of the interviewed companies\(^{39}\) say that they do not have a motivation level that is worth mentioning regarding increasing their own energy efficiency levels. They argue that it would not make a significant difference to the total industry consumption level or that they do not own the building in which they are positioned. The operating companies, they argue, are where the real gains are situated and on which the focus must be.

The interviewees agree that motivation to increase industrial energy efficiency always originates from its operational costs saving property. However, this motivation alone does not bring about the required efficiency increases. As described in the previous sections, the ambiguity effect, the focus on the return of investment, previous achievements, trust and the competitiveness are all matters that influence which projects a company will execute. Also the influence of other companies should not be forgotten, which is typical for networks (de Bruijn & ten Heuvelhof, 2008).

The operating companies in the Netherlands that are global operating companies have the world as investment area. Countries that have cheaper energy, labour and less stringent legislation are often favoured over the expensive and strict Europe. It is therefore argued by almost all of the participants that the intrinsic motivation for energy efficiency in companies should be increased. In other words, companies should be motivated to increase energy efficiency for just the value energy efficiency has. Some of the interviewees have identified this value as its benefit to the environment\(^{40}\). But the largest part of the interviewees does not specify this value exactly. They stress, nevertheless, that the decision making model of operating companies should change as to consider investments that bring benefits on a longer-term\(^{41}\). Others mention that the risk aversion and independent character of the industry should be brought about\(^{42}\). Furthermore, the lack of appreciation for energy efficiency in society is also mentioned by 35% of the participants as an important aspect that needs changing. Hence, these persons argue that current lack of sufficient motivation in both the industry and society causes an obstacle to increase energy efficiency, because it brings the focus to other priorities.

6.8.5. Other priorities
With regard to one aspect all interviewees agreed, which is that energy efficiency is not a priority in investment decisions. Safety and product improvement, on the other hand, are a priority, because the former is part of the industry culture and treasured by society and the latter is a way to increase profits. Note that safety does not directly make money, but is a priority nevertheless. This implies that an industry culture is very powerful and could lead to investments that are not directly related to costs or profits. Even though energy efficiency has the potential to increase profits, it has currently low priority and is frequently not part of the companies’ culture. The latter two aspects are an obstacle to energy efficiency. Put differently, motivation alone is not enough, which refers to behaviour due to external incentives, it must become part of the intrinsic motivation, i.e. doing the activity for the activity itself, which is what the incentives must accomplish (Grant, 2012). Moreover, Porter

---

39 This is identified in the interviews of [CONFIDENTIAL].
40 Mentioned by [CONFIDENTIAL].
41 Mentioned by [CONFIDENTIAL].
42 Mentioned by [CONFIDENTIAL].
and van der Linde (1995, p. 115) argue that “environmental strategies must become a general management issue if the sorts of process and product redesigns needed for true innovation are to even be considered, much less be proposed and implemented.”

6.9. Chapter summary

This chapter started with an overall evaluation of the applicability of the PAT to the EED case. The original PAT assumes a static relationship between one principal and one agent. In order to apply the PAT to the EED case, several adjustments were required. These are the following:

- Allow more principals, who can have conflicting goals;
- Allow more agents that behave independently and can have conflicting goals;
- Allow for a supervisor;
- Allow for exogenous influences;
- Allow for cooperation (goal consensus).

The PAT analysis revealed that the EED case experiences difficulties of risk aversion, goal conflict, opportunism regarding risk and the law, the ambiguity effect and a moral hazard that create obstacles to energy efficiency. The PAT proved itself as being a good tool to analyse the several relationships of the industry. However, some relationships of the industry chain concern a network. The PAT cannot cope with a network and that makes it unfit for further analysis, which is nevertheless outside the scope of this study.

The EED approaches the industry as if it is a straightforward hierarchic principal-agent relationship. The operating companies and regulators are identified as the most influential in the industry chain and regarding the decisions that are being made. However, the results show that the whole industry chain actually concerns a complicated relationship of both an organization and a network in which cooperation is common and hierarchies weaken. The industry's incentives are overall economic, but its decisions are influenced by more than just economics. This characteristic could lead to additional obstacles with regard to energy efficiency.
Legislation’s implications

According to Scholz (1991) the government is trying to get its subordinates to act in its benefit by means of positive incentives and enforcement. The positive incentives are aspects like tax reimbursement and less monitoring. Enforcement is done by means of the tax and the law, which the subordinates must pay and obey, respectively.

This chapter compares the decision making process of the industry, as described in Chapter 6.7 and 6.8, with the legislation regarding energy efficiency, which is explained in Chapter 4. Firstly the similarities are identified in Section 7.1; secondly the gaps in Section 7.2 and thirdly the implications of cooperation are explained in Section 7.3. Next the largest obstacles to energy efficiency are being described in Section 7.4 and Section 7.5 explains the complications with the incentives of the EU and the industry. Section 7.6 concludes with a summary.

7.1. Industries’ decisions and the overlaps with the legislation

The description of the similarities of the industries’ decisions and the legislation is divided in a section that compares the decisions with the European EED legislative instruments and a section that does the same for the Dutch policies.

7.1.1. European legislative instruments

The EED relies on five important instruments to increase energy efficiency in the industry. These are the following:

- Energy audits;
- Energy efficiency management systems (ENEMS);
- National energy efficiency action plans (NEEAP);
- Emissions trading scheme (ETS);
- Best available techniques (BAT).

*Energy audits*

Energy audits could help a company to identify energy efficiency improvement possibilities. One of the obstacles to energy efficiency is the difficulty of identifying the energy efficiency opportunities, which is confirmed by 70% of the interviewees. Often do they consider energy audits to be a good tool to reveal the efficiency possibilities that are still left and it could be made mandatory.

*ENEMS*

The energy management system is a structured approach that must lead to the commitment of the whole company, i.e. top to bottom, to increase energy efficiency. According to the obstacle that energy efficiency is not a culture within operating companies, which is confirmed by 70% of the participants, an ENEMS is required. Moreover, some interviewees argue that ENEMS, although often in a lean form, is already applied by companies.
**NEEAP**
The NEEAP forces Member States to formulate a plan, monitor the progress and take corrective action when required. The government is therefore expected to solve the obstacle of measuring energy efficiency in order to monitor its progress and to be able to report about it. The current lack of adequate measuring tools has been identified by 26% of the interviewees. Hence, the NEEAP could help to overcome this obstacle.

**ETS**
The ETS applies directly to the large energy consuming companies, which are the operating companies. By letting companies pay for their emissions they are stimulated to emit less, for example by becoming more energy efficient. The EU is hereby effectively making use of the economic incentives of companies, because all interviewed operating companies are incorporating the ETS in their investment decisions. Moreover, Porter and van der Linde (1995, p. 111) argue that "Where possible, regulations should include the use of market incentives, including pollution taxes, deposit-refund schemes and tradable permits". Hence, that ETS is making use of the market incentives is justified.

**BAT**
The documents regarding BAT are an appropriate instrument to help companies with identifying efficiency improvement opportunities. However, BAT is considered a helpful instrument for less innovative companies only, because these documents are lagging behind with regard to which techniques currently are available. Despite the threat the concept of BAT imposes on innovation, i.e. companies could drop efforts to innovate (Porter & van der Linde, 1995), the EU is making very clear that its documents are only a guideline and far from comprehensive. Moreover, it stresses that other and new techniques can be added to the list (EC, 2013a). The EU documents of BAT are therefore not considered to be a threat to innovation.

### 7.1.2. Dutch national policies
The Dutch energy efficiency policy contains the following instruments:
- Energy investment allowance (EIA);
- MJA3 and MEE covenants;
- Energy tax;
- Wet Milieubeheer;
- Energieakkoord;
- Wet implementatie EU-richtlijn energie efficiëntie.

**EIA and energy tax**
The EIA is an economic incentive to get companies more energy efficient. It can help to overcome the obstacle of costs, which is identified by 91% of the interviewees, because it lowers the investment costs of energy efficient techniques. The energy tax reimbursement is part of the covenants and can be seen as an economic incentive to have companies participating in the covenants, with the underlying goal to get them more energy efficient. Since companies seem to focus most on economics, this instrument has the potential to reach its goal.
Covenants
The covenants are signed by the correct group(s) to increase energy efficiency, because they are the most influential of the industry chain and/or consume the actual energy, i.e. the regulators and operating companies. Out of the 22 principal-agent relationships that have been described earlier, operating companies are of all company groups most frequent the principal with a score of 11 times. This means that they have a considerable influence on the energy efficiency levels when demanding attention for the topic from its agents. Moreover, the RVO, which is the supervisor regarding the covenants, has the power to make the monitoring leaner (a ‘carrot’) for well-performing companies. According to Miller (2005b) this approach, in which the principal gives the supervisor the power to use the carrot, will lead to a higher efforts of the agent.

The covenants introduce a very strategic approach to increase energy efficiency that the participants have to apply. This should help to overcome the obstacles of identifying opportunities and to stimulate the company to make energy efficiency a priority. Furthermore, the covenants offer the economic incentives of tax deduction in case a company successfully participates. Hence, the covenants are making use of the economic motives companies have.

Laws
The Wet Milieubeheer and Wet implementatie EU-richtlijn energie efficiëntie are strict laws when enforced properly. The laws should enhance energy efficiency, because it forces companies to do certain energy efficiency investments. According to Porter and van der Linde (1995) strict environmental regulation can strengthen the competitiveness of companies because they have to innovate in order to obey the law. It also avoids opportunism and collective action problems (Olson, 1965) because companies cannot apply a wait-and-see approach, which is what companies currently tend to use as a method to mitigate risk. This implies that these laws are beneficial for increasing energy efficiency, because it overcomes several obstacles, like increasing the applicability of technologies and reducing opportunism, and it should lead to increased profits for the industry. Moreover, 61% of the interviewees argued that enforcing the law will lead to more energy efficiency.

Energieakkoord
The Energieakkoord is a voluntary policy, which is a result of cooperation between forty groups that were involved in the composition of the policy (SER, 2013). The fact that the policy is a fruit of cooperation between industrial actors means that these actors will be more inclined to put effort in honouring the rules set out in the policy. This leads to a more effective policy than in case the policy was composed by only policy makers (Porter & van der Linde, 1995; Scholz, 1991).

Additionally, the Energieakkoord is the realization of the opt-out possibility provided in the EED regarding article 7. The EED prefers an obligation scheme that Member States must introduce as to increase energy efficiency, but it provides Member States the opportunity to obtain the same goal by implementing alternative policies (EU, 2012). Hence, also the EED allows approaches other than plain coercion. This will reduce the obstacle of a moral hazard, which is mentioned by 13% of the participants, because resistance to comply with a policy is less when the industry participates in policy making, as mentioned earlier.


7.1.3. General observation

The PAT approach of the EED corresponds to the reality of the industry when analysed on a general level. Having this general point of view is not bad per se, because the regulators and operating companies are the most influential parties of the industry chain, as was shown in Figure 8 of Chapter 5.4. This means that the other players are mainly influences on the decision making process and that the centre of gravity regarding decision making lies with the regulators and operating companies, just as the EED assumes.

Furthermore, according to Porter and van der Linde (1995) laws regarding the environment, which the EED is, should meet three criteria. One is that the legislation allows the environmental goals to be met in flexible ways. The EED satisfies this criterion, because it sets a clear target of 20% increased energy efficiency before 2020 and leaves Member States the choice of how to obtain that goal. The second criterion Porter and van der Linde (1995) mention is that innovation must be encouraged as a way to obtain the aforementioned goal. The EU and the Dutch government have several innovation groups that they support, like SPIRE (EC, 2014b), Horizon2020 (EC, 2015b), ISPT (ISPT, 2015) and Topsectoren (Rijksoverheid, 2015b), that should lead to energy efficient technologies that can be applied in the industry. Hence, also the second criterion is met. The last criterion is that the system linked to reaching the goal, which is targeted by means of the law, is being coordinated and administrated (Porter & van der Linde, 1995). The NEEAP and yearly reports that the Member States have to deliver and the similar reports the participants of the covenants have to make are a fulfilment of this third criterion.

Summarizing, the EU and the Dutch government have several policy instruments that should work in theory. The legislation should remove or at least weaken some of the most important obstacles. Moreover, the EED satisfies the conditions to have a successful environmental policy. Nevertheless, the policy instruments are already employed for some time and the energy efficiency gap still exists. That indicates that gaps with the decision making process and the legislation are likely to exist as well, which can undo the positive legislative implications.

7.2. Industries’ decisions and the gaps in the legislation

This subsection has a slightly different approach than the previous section. First the EED and the difficulties with the legislation in general are described. Next the most important policy instruments, which are also mentioned in Chapter 4, are discussed with regard to the industries’ decisions. Lastly the general difficulties with the industries’ decisions and the legislation’s implications are explained.

7.2.1. EED awareness and legislation uncertainty

Of all the interviewees 65% have heard of the EED and 52% also know more or less what the EED's content is. However, of the interviewees with regard to the operating companies only a third is knowledgeable about the EED. Furthermore, while the operating companies say not to have a problem, the non-operating companies mention the inadequate diffusion of legislative information. The mediocre EED awareness proves that this process can be improved indeed. Other objections to the regulation are that too much information exists and that policies change too often. If the regulation would remain stable for several years in a row, this would be beneficial for energy efficiency investments. This opinion is supported by Porter and van der Linde (1995) who argue that investments are always encouraged
when certainty is provided, independent of the area in which the investment is done. Hence, the current situation, in which policies change frequently and legislative knowledge is insufficient, leads to uncertainty. And the perceived uncertainty is an incentive to decide for aspects other than energy efficiency.

### 7.2.2. Specific legislation instruments

**Energy audits and ENEMS**

The positive points of energy audits and ENEMS are already mentioned. But these two instruments have a downside as well. 57% of the interviewees argued that the industry, and especially the operating companies, knows more than the authority or the external consultant that has to do the energy audit. This either leads to a less valuable energy audit or a significant amount of time and effort must be put in to explain the consultant how the processes work. Either way, both consequences lead to the operating companies preferring to do their own energy audits. However, this increases the chance of a moral hazard, because the efforts of the company cannot be properly monitored, as long as the measuring obstacle exists.

The ENEMS is seen by the largest part of the interviewees as a positive tool to get the culture of a company more about energy efficiency. To make it mandatory, as suggested by the EED, would lead to high administrative costs and a higher chance of creating a moral hazard. ENEMS is a rather intense system and consumes a lot of the companies’ resources. If the company does not agree with the implementation of such a system, it will most likely try to avoid or even fight against the system (Porter & van der Linde, 1995). Hence, both instruments have a positive side and a negative side. These instruments should have the most effect in case companies use them voluntarily, because the moral hazard is than reduced the most.

**ETS**

The ETS is making use of the economic incentives that operating companies have for their actions, which leads to a theoretically effective system. However, the system is in reality not that effective, which is also a result of contradicting policies. The EU is stimulating energy efficiency and renewable energy, which results in conventional power generators experiencing decreasing electricity demand. When in 2008 the crisis started this resulted in an even lower demand for electricity. The combination of the crisis and the EU sustainability policy resulted in an abundance of CO₂ allowances, because considerable less CO₂ was being emitted by the industry than anticipated. The system could not handle this shortfall of demand and the price dropped from €30 to €6 per tonne of CO₂ emissions in the period of 2008 to 2014. The present low price means that ETS has currently limited to no effect on stimulating investments in sustainability (IEA, 2014b). Hence, ETS does not stimulate energy efficiency investments, which is also confirmed by all the interviewees that know what ETS is.

The EU is aware of this shortcoming and is thinking of adequate measures to make ETS effective again ([CONFIDENTIAL]). But the uncertainty about the future developments is not beneficial for energy efficiency investments, as explained before.
**EIA and energy tax**

All interviewed operating companies say that the subsidies for energy efficiency investments are by themselves not initiating energy efficiency projects. A subsidy can influence the outcome of a project, but whether such a project exists depends on other aspects. Furthermore, the reimbursement of the energy tax and the ETS compensation are said not to compensate for the higher costs companies have, which is already suppressing the available investment money. Hence, despite that these instruments make use of the economic incentive companies have, they are of negligible effect regarding increasing energy efficiency.

**Laws**

Strict laws should help to overcome several of the obstacles to energy efficiency. But stricter laws mean that the laws must be enforced as well, which is currently lacking. 61% of the interviewees argue that current enforcement is insufficient; leaving the operating companies too much interpretation room that leads to deviation of the law's targets. But there is also a downside to stricter legislation, especially when enforced.

Business emigration to countries with a better business climate becomes a serious threat, as identified in 22% of the interviews. Most of the operating companies that are positioned in the Netherlands are global operating companies, which means that these companies can invest anywhere in the world. Europe has currently not a beneficial investment climate, because its energy prices are relatively high just as its labour price. Furthermore, the demand for products that are produced in Europe is falling (IEA, 2014b). In case the legislation becomes stricter and is being enforced, this reduces the investment opportunities of the global operating companies, which prefer other countries to invest in as a result.

The European refinery industry, for example, is currently experiencing several shut-downs due to falling demand. Fifteen refineries have been closed in the period of 2007 to 2013 and further capacity reductions are expected (IEA, 2014b). Hence, a trade-off must be made between the level of stringency to push energy efficiency and the risk of business emigration as a consequence of the push.

### 7.2.3. General observation

The biggest gap with the legislation’s implications and the decision making process of the industry is that the legislation tries to motivate companies to become more energy efficient, but fails to remove the biggest barriers. The legislation for instance does not take away the risk companies perceive of implementing a new technology⁴³. Although companies must bear some part of the risk (Miller, 2005b), they are now bearing all the risk of technology adoption, which stifles the energy efficiency levels. Also, the legislation is currently ineffective in making energy efficiency a priority⁴⁴ and it seems to use incentives in the wrong way. Incentives are a tool to get a company behaving in a way it would otherwise not do, but it should lead to a permanent change of behaviour as well. In other words, the company transfers from doing an activity because of the incentive to doing an activity just for the value itself (Grant, 2012). Hence, a culture change must be initiated by the incentive and the contemporary legislation is failing to do so⁴⁵.

---

⁴³ Perceived to be a barrier by 91% of the participants.
⁴⁴ Supported by 91% of the interviewees.
⁴⁵ See Appendix I Table 14 at ‘Culture’.
Another shortcoming of the current legislation is that it does not cope with the industry’s focus on the best return on investment, which is related to its global competitiveness. This matter is mentioned by 96% of the interviewees as an obstacle to energy efficiency. The process industry is risk-averse and cares about its competitiveness. Its relative performance therefore influences the decisions. The refining industry, for instance, has the Solomon benchmark that is comparing energy efficiency levels of refineries globally. Interviewees are positive about this system\textsuperscript{46}, because it motivates companies to become more efficient when they fall behind on their competitors. The EU and Dutch government are monitoring the performance of the industry and they are comparing industry sectors based on this data. However, it does not publicly compare relative performance of the operating companies within a sector. This is a gap in the legislation, because tournaments can help risk-averse agents to put more effort into the cause and to take relatively riskier actions to become more profitable (Miller, 2005b). Moreover, the legislation is also failing to take account of the networking element of the industry, which will be explained next.

7.3. Emphasis on cooperation

Both the BAT documents and the Energieakkoord are a result of cooperation between the regulators and the industry (EC, 2013a; SER, 2013). To such a degree the legislation is considering cooperation. The Energieakkoord mentions cooperation regarding exchanging heat flows, because the waste heat of one company can be the input for another. Also some other aspects of cooperation are mentioned (SER, 2013), but not regarding the industry chain. However, in the previous chapter it became clear that the decision making process of the industry is about cooperation within the industry chain as well, which is not considered in the legislation.

7.3.1. Control loss

The basic element of the PAT is the loss of control that the principal has to cope with (Mitnick, 1992). Measures that are being proposed to regain control is via introducing a supervisor and/or a rewarding system (Brandt & Svendsen, 2013; Miller, 2005b). These measures of control entail that the relatively straightforward PAT approach of hierarchical relationships is being applied. The legislation has the same approach of using hierarchical control mechanisms to regain the principal’s control. After all, the principal of the EED case is experiencing control loss, because its prognosis is that the 20% target is not reached (EEA, 2013).

However, the problem with the EED is that its solutions of a supervisor and rewards do not work properly in a network, as is proven by the present situation in which both methods are ineffectively being applied. These solutions are ineffective because the participants in a network are exercising strategies, which are for a large part unknown to the other participants (de Bruijn & ten Heuvelhof, 2008). Moreover, it makes the participants less sensitive for influences with regard to rewards and the supervisor, because more matters are at stake than those observed. The standard regulation model, however, does not incorporate the strategic behaviour of those that are submissive to the law (Scholz, 1991). Hence, the EED is failing to account for strategic behaviour that makes it less effective and causes a gap between the legislation’s implications and the decision making process of the industry.

\textsuperscript{46} Solomon came up in the interviews with [CONFIDENTIAL], which were all positive about the benchmark and its effect on energy efficiency.
7.3.2. Problems with cooperation and legislation

The problems with cooperation in the industry can be subdivided in two parts. The first concerns the cooperation of the regulators and the industry in formulating policies. It reduces the problems encountered by the industry to comply with the law (Porter & van der Linde, 1995; Scholz, 1991) on the one hand, but it makes the industry more powerful on the other hand (Scholz, 1991). The industry applies its own strategy to formulate the legislation in its favour, which makes it difficult for the regulators to reach their goal. This is a typical problem that emerges in networks (de Bruijn & ten Heuvelhof, 2008). It also means that the regulators are in a prisoners' dilemma, because they have to make a trade-off between how much influence they want to give the industry in return for their cooperation (Scholz, 1991). The more influence it allows the more effective the policy is, but also the more likely it is that the policy deviates from its original purpose.

The other part relates to the cooperation in the industry chain. Put differently, it is the cooperation of a company with other companies and regulators that are not part of the network. A cooperation network takes the past behaviours of the network's members into account (de Bruijn & ten Heuvelhof, 2008; Scholz, 1991). As mentioned several times, this means that opportunism will be reduced, because trust has to be built. However, it often takes years for a relationship to successfully develop (Scholz, 1991). In other words, even if the legislation would focus on the implications of cooperation in the industry chain it would take years to see effect and currently less than five years are available before the EED target must be reached.

7.4. Large obstacles to energy efficiency

Scholz (1991) argues that problems of control are just a source to policy ineffectiveness as technical and political problems are and should, therefore, be recognized. The results show that employing economic incentives should work to get companies more energy efficient, because they are influenced most by economics. However, it became also clear that companies have more goals they want to obtain at the same time, which the legislation is not touching upon. Moreover, as identified in Section 7.2.3, the legislation does not take away the largest obstacles that the industry is facing. These obstacles were already shown and elucidated in Figure 6 and Section 5.2, respectively. The largest obstacles clearly show that the issues are not just about economics. The largest obstacles are the following:

- Decreasing market demand; [economic]
- Lack of proper communication in the industry chain; [social]
- Lack of adequate regulation; [political]
- Focus on the best return on investment; [economic]
- The higher initial costs of the investment; [economic]
- The perceived higher risk; [social]
- Having other priorities; [social]
- The decision making power of higher management; [social]
- The culture of operating companies. [social]

The social obstacles reflect obstacles caused by a certain type of behaviour and habits. For example, the operating companies perceive a certain technique as too risky, while other industries have successfully implemented the technique for years.
The obstacles of decreasing market demand, the focus on the best return on investment, the higher initial costs of the energy efficiency investment and the decision making power of higher management are aspects that the legislation cannot do that much about. Of course, subsidies and tax reductions can bring down the initial higher costs, but the remaining obstacles will still exist. As argued by almost all interviewees, the higher management of companies are hesitant to invest in Europe due to its unattractive business climate, i.e. high labour and energy costs and decreasing demand. Put differently, the required investments in Europe are still done but not just for the sake of energy efficiency. Such investments would lead to a longer payback time than investment opportunities in other parts of the world, which also have a better future market prognoses. Hence, subsidies and tax reliefs are unlikely to compensate for all these financial issues.

However, efficiency improvements in the Netherlands are still economically possible whilst considering the overall applicability of the techniques (Vleeming & Hinderink, 2011). The issue revolves around how to persuade the higher international management to become less risk averse and to invest in those energy efficiency opportunities. They have the decision making power, which means that their obstacles require consideration.

The identified social obstacles emphasise that economic incentives are not enough to move the companies in the right direction, due to the non-economic goals that have to be obtained simultaneously. As became clear from the PAT analysis, if an agent can choose among several goals, it will choose the goals that are most beneficial to him. Currently the legislation is not resulting in an alignment of goals between the industry and EU.

### 7.5. Legislation and incentives

This study started by assuming that an incentive mismatch exists between the EED and the industry that causes obstacles to energy efficiency. Indeed, the previous section made clear that "economic incentives are, to be sure, not the only incentives; people are also motivated by . . . other social and psychological objectives" (Olson, 1965, p. 60). And when problems with obtaining the common goal emerge, i.e. the 20% energy efficiency target, this can be the result of a lack of group oriented action, i.e. the industry, or due to a lack of individual motivation (Olson, 1965), i.e. the individual company.

The EED case fits both. Chapter 5.3 made clear that motivation levels differ much throughout the industry chain and leave often room for improvement. Furthermore, Chapter 6.8.5 made clear that operating companies often miss the required culture to make energy efficiency a high priority and Section 6.2.2 emphasized the problem of collective action. Coming back to the observation that operating companies and the regulators have the most influence on the decisions regarding energy efficiency, this could be a starting point to close the gap and to get the industry as a whole more energy efficient.

This section first briefly described the incentives of the EU and the industry. Next it will elucidate the possibility of crowding out and it concludes with a subsection about ethics.
7.5.1. Incentives of the European Union
The EU has seven reasons to increase energy efficiency (EU, 2012), which are the following:
1. To reduce irreplaceable fossil fuel consumption;
2. To decrease imports, secure energy supply;
3. To reduce Greenhouse gas emissions;
4. To boost economic growth;
5. To create high quality jobs;
6. To improve industrial competitiveness;
7. To accelerate the spread of technological solutions.

These reasons are both social and economic in nature. Reasons 1, 3, 5 and 7 are considered social motivation reasons. The first and the third relate to the environmental condition of the earth, the fifth to the employment level of society and the seventh reason is about innovation and knowledge sharing. Reasons 2, 4 and 6, on the other hand, are of economic origin. The second reason is about the dependency of Europe on energy imports, meaning that economic independence is strived for by increasing energy efficiency. The fourth reason goes without saying and the sixth relates to industrial competitiveness, which is about the profits the industry can make.

7.5.2. Incentives of the industry
As identified in the previous section, the industry has both social and economic incentives, which is the same with the EU. However, the incentives differ when looked at in more detail. The social incentives of the industry do not relate to environmental issues. And the economic incentives of the EU do not directly correspond to those of the industry, because they are about Europe as a whole. Nevertheless, the incentive of industrial competitiveness was mentioned by all interviewees as a mutual incentive. One incentive could in theory be enough to get the industry more energy efficient. However, despite the previously mentioned non-economic obstacles that play a role, crowding out can also be of an influence that reduces the positive effect of the incentive.

7.5.3. Crowding out
As argued by more than 50% of the non-operating companies and 100% of the operating companies, intrinsic motivation to increase energy efficiency is present 47. It is therefore interesting that it is not part of the companies’ culture. As mentioned, the current legislation makes use of mainly economic incentives. These incentives, however, could backfire when intrinsic motivation is already present, because intrinsic motivation distorts the straightforward behavioural responses of the company on the economic incentive. As argued by B. Frey (2012), environmental policies should be drafted carefully in order to avoid getting the opposite effect of what the environmental policy is trying to accomplish. In other words, when a policy is drafted to increase motivation for a certain aspect, this could reduce the intrinsic motivation of the individual, which means that the policy has even less effect than before it existed; it has the effect of crowding out.

B. Frey (2012) mentions two conditions that either lead to crowding in (a positive effect of the policy) or crowding out (a negative effect of the policy). In case the policy leads to an environment of support, it will have a positive effect. In case the policy is perceived to be controlling, it will have a negative effect. Moreover, the policy could even lead to “a shift from other-regarding or group-regarding to more selfish preferences and behaviour” (B.

47 See Appendix I Table 14 at ‘Values’.
Obstacles to Energy Efficiency

Frey, 2012, p. 79). Hence, the effect of crowding out and becoming more selfish could be present in the EED case. Intrinsic motivation for energy efficiency is present at the companies and the policy is likely to be perceived as controlling. After all, a competent authority visits companies on a regular basis in order to check the company’s achievements. Even the covenants require yearly reports as a means to stimulate real effort, which is a form of control as well. The consequence is that intrinsic motivation decreases and efforts for energy efficiency diminish. Moreover, the companies are in a network but the interviewees complain that the communication in the industry chain is inadequate. This could be seen as a form of selfishness, because companies in general are not eager to share information with another.

Additionally, the ETS could be perceived by companies as a way to pay off the harm it is doing to the environment, which would lead to decreased efforts to reduce emissions. Empirical evidence showed that as soon as a day care centre introduced fines for parents that were too late, the number of late arrivals increased substantially. These parents did not feel guilty anymore, because the fine was seen as a compensation for their inappropriate behaviour (B. Frey, 2012). The ETS is currently ineffective for several reasons, but the crowding out effect could also play a role just as it did at that day care.

It can be concluded that the intrinsic motivation of companies could have an important influence on the effectiveness of the EED. It does not necessarily mean that monetary incentives have no effect at all, but they could backfire (B. S. Frey & Oberholzer-Gee, 1997; Grant, 2012). Considering that currently monetary incentives are being employed and that the EED fails to fulfil its purpose, crowding out could be present.

7.5.4. Remarks regarding incentives
Incentives are designed to influence in a direct fashion, but the social environment does not respond in such a predictive way (Grant, 2012). And more issues with incentives arise when studied in more detail. Most see incentives as providing one with a free choice. In case a company decides to do an investment in energy efficiency, it will get some money in return via the EIA. The company is not forced to invest in the technique and hence, has a free choice. However, incentives are also a form of power (Grant, 2012). Companies that want to get a compensation for their economic loss due to ETS have to become a member of the covenant. But if the company decides not to do so, it could worsen its competitiveness to such a degree that it will go bankrupt. Hence, this form of incentive does not relate to a real choice and is actually a form of power. Is it in such a case still ethical to use incentives? After all, the government is taking away the free choice of the company and is forcing it to invest in the obligations that coincide with covenant participation, while it is already experiencing financial challenges due to decreasing demand and tough competition.

Moreover, incentives often do not address the underlying problem, leading to a limited influence on the long-term (Grant, 2012). And that is exactly the problem of the EED and related policies. From the interviews it can be concluded that the operating companies do not have environmental issues as a high priority in their investment decisions. Furthermore, operating companies appear to choose less regulated countries over the EU to invest in, meaning that the Dutch companies struggle to get money to improve their energy efficiency levels. Hence, the economic incentives that the legislation is currently employing are not addressing these underlying problems and have, as a consequence, only limited to no effect.
7.6. Chapter summary

This chapter identified which areas of overlap and which gaps exist between the legislation's implications and the industry’s decisions. Furthermore, it concluded that the legislation is not providing any support to overcome the largest obstacles. Also the incentives of the EU and the industry were compared, in which became clear that they differ. Furthermore, the legislation could have the opposite effect on energy efficiency motivation than intended. A summary of the gaps is provided in Table 7, which is the basis for the proposals to enhance the EED that are introduced in the next chapter.

<table>
<thead>
<tr>
<th>Gap</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertainty</td>
<td>Changing policies, uncertain development ETS, lack of proper diffusion of information regarding the legislation.</td>
</tr>
<tr>
<td>Moral hazard</td>
<td>Information asymmetry that leads to potentially ineffective energy audits and a moral hazard, which enables possibilities for opportunism.</td>
</tr>
<tr>
<td>Consuming too many resources</td>
<td>Energy audits and ENEMS require many resources of the companies which they do not want or cannot bear.</td>
</tr>
<tr>
<td>Barely any effect of economic incentives</td>
<td>The EIA, ETS and energy tax reimbursement have barely any effect on initiating energy efficiency projects.</td>
</tr>
<tr>
<td>Enforcing the law</td>
<td>The law is not well enough enforced, leading to ineffective policies.</td>
</tr>
<tr>
<td>Business emigration</td>
<td>Europe is an unattractive investment climate for global operating companies. Business emigration causes a dilemma of how stringent the law should be enforced.</td>
</tr>
<tr>
<td>No support provided for overcoming largest obstacles</td>
<td>The obstacles of for instance risk and focus on best return on investment are not addressed by the legislation. See section 7.4 for all obstacles.</td>
</tr>
<tr>
<td>Incentive mismatch</td>
<td>The industry is far a large part driven by social matters whilst the legislation mainly puts economic incentives on the industry. No culture change of doing the activity for itself is initiated.</td>
</tr>
</tbody>
</table>
This chapter aims to do several valuable proposals for enhancing the EED, which is the objective of this research. The gaps identified in Section 7.2 and the complementary conclusions regarding the obstacles the industry faces, which are described in Section 7.4, are the basis for the six general recommendations. Many of the recommendations require future research as to describe how to exactly implement or execute the recommended actions. The areas of future research will be described in Chapter 10.

At the start of this study it was assumed that the EED would suffer from an incentive mismatch with the industry, because the regulators have social incentives and the industry economic ones. As become clear in Section 7.5, an incentive mismatch exists, but of a slightly different nature as originally assumed. The industry is actually also driven by social matters, but these are often not of an environmental origin. However, these social matters are considered to be very important opportunities to enhance the EED. The proposals regarding these opportunities are described in Sections 8.1 up to and including Section 8.6. This chapter concludes with a summary of the chapter’s content in Section 8.7.

8.1. Do not focus on motivation

Not all the obstacles to energy efficiency can be easily overcome. Nevertheless, many of the gaps that are identified can be narrowed or even closed. The legislation should not focus on getting the process industry motivated to increase its energy efficiency levels, because motivation is already there due to the operating companies' high energy consumption level and coinciding costs. Such legislation's focus is most likely to backfire by reducing the motivation. Instead, the EED should focus on several other points, which are described in the next sections.

8.2. Reducing the risk

One of these points is to focus on one of the largest obstacles, which is risk (identified by 91% of the interviewees). Companies have money to invest; it is apparently just not favouring Europe to invest in due to the unbeneficial investment conditions. However, changing the investment conditions in Europe is very difficult, e.g. market demand, energy prices, labour costs, etc. Therefore the EU should aim to reduce the perceived risk coinciding with economic feasible investments in techniques that are currently not yet applied at the refining and (petro)chemical industry.

A possible solution could be to set up some sort of insurance funds, although the costs of process disruption are significant and it is unlikely that such amounts can be insured, as argued by nearly all interviewees. Another solution is to have more funds available for the real-scale test application of new technologies. As mentioned by several interviewees, the
government is supporting innovation and small-scale testing. The step from small-scale testing to large-scale testing, however, is said by the interviewees to be insufficient. If more facilities for real-scale test application would be available, this would help companies to reduce the risk of actual implementation due to the smaller step.

Additionally, the interviewed vendors claim that economic feasible and proven techniques are available, but these concern techniques applied in different industry segments that are nevertheless to a large extend comparable. This refers to the previously mentioned catch-22 problem of collective action (Olson, 1965), because vendors struggle to get the first company in the refining and (petro)chemical industry persuaded to adopt such a technique. After all, due to the risk mitigation and the importance of their processes, companies rush to be the second when it comes to adopting unknown techniques. When the communication in the industry chain (perceived as an obstacle by 57%) and between industry sectors is enhanced, the uncertainty due to information asymmetry in the industry chain would be decreased as a result. Furthermore, the legislation’s gap of the moral hazard is reduced at the same time, because the regulators become more knowledgeable of what the industries’ drivers and obstacles are. Furthermore, maintaining stable policies, which is entirely in the hands of the regulators, should reduce the uncertainty perceived by the industry and hence, limit risk.

8.3. Improving the communication

As became clear in the Chapter 5, a lot of differences exist in the perception regarding what the actual obstacles to energy efficiency are and how motivated one industry group is compared to the other. These differences indicate an opportunity to improve the communication in the industry chain, as mentioned in the previous section as well.

The transfer agents, for example, have an important role in designing the process of the operating companies and stress that energy efficiency is important in their designs. All interviewed vendors agreed that the transfer agents are very valuable indeed, but because the vendors regard them as uninterested with regard to energy efficiency, they try to limit the cooperation with such companies. One can image that valuable opportunities to cooperate and to share knowledge are missed as a consequence of the misperception.

The industry chain should improve the communication, which is regarded as an obstacle by 50% of the non-operating companies and 100% of the operating companies. The EU is already trying to bring universities, regulators and other companies of the industry chain together via specific research programs as mentioned in Chapter 7.1. Additionally, it could organize knowledge platforms via specific events. These events not only bring all parties of the industry chain together and improve the communication; it also gives energy efficiency more awareness. Moreover, by making policies in cooperation with the industry, the whole industry chain that is, communication will be stimulated as well. Furthermore, it will also lead to more effective policies, because industries often do not fight against a law they have helped to make (Porter & van der Linde, 1995).
8.4. Creating an energy efficiency culture

Another important obstacle that needs to be targeted by the EED is the energy efficiency culture in companies throughout the whole industry chain. 70% of the interviewees identified the absence of an energy efficiency culture as an obstacle and all interviewees agreed that having an energy efficiency culture is a requirement to increase energy efficiency in the industry.

Creating a culture is coinciding with establishing intrinsic motivation for a specific activity, i.e. doing the activity for the activity itself. Intrinsic motivation is a powerful tool to overcome many of the existing obstacles. Similar to safety, when energy efficiency becomes a culture of companies it is most likely to become a priority in each project, regardless of the continent in which the investment is done. After all, energy efficiency often leads to direct operational costs savings as well. When energy efficiency becomes of significant importance, obstacles as costs, profits and risk will be easier overcome just as they are overcome in a crisis situation. Moreover, having an efficiency culture will align the goals of the government and the industry, because both want to increase energy efficiency only for the sake of energy efficiency itself. In other words, those incentives should be employed that bring about a company's culture. These are probably social in nature and should focus on the cooperation of the industry chain, because the current economic incentives that focused solely on the operating companies are clearly not sufficient to reach this goal. Future research, however, must clarify how such a culture can be initiated and guided.

A possibility to create such an industry wide culture would be to have the EU introducing a new type of environmental label. The power of environmental labels have been stressed by Porter and van der Linde (1995) and also by the globally recognized LEED certificate (USGBC, 2015), which is an environmental certificate for green buildings that is a success even in the US where energy is relatively cheap. The new EU label should focus on the energy efficiency of a product or service while considering the overall performances of the whole industry chain. This means that the industry chain besides the operating companies should also focus on how to increase their energy performance, making it a culture throughout the industry. One could even go as far as introducing national tournaments like the Solomon benchmark is doing globally for refineries, as explained in Section 7.2.

8.5. Accepting that the industry is not hierarchic

Additionally, the EED should accept that the industry is not a plain hierarchical organ in which the regulators tell the operating companies what to do. Creating an understanding of how the industry really works and what matters are important to its organizations should lead to better policies. Policies are required to create an equal level playing field for the companies, but they should not cause extra barriers to activities companies already want to do. By developing a better understanding of the drivers of the industry also the gaps of creating uncertainty, the incentive mismatch, business emigration and the moral hazard will be narrowed.

Accepting that the industry is not hierarchic is not enough; the government should take action to influence all the members of the network. A good starting point is society, because society can influence the thoughts and actions of the whole industry chain. The value of society regarding energy efficiency is recognized by 35% of the interviewees and they stressed that society is currently not really thinking of the environment regarding energy
supply. Another difficulty is that energy efficiency is not visible like wind turbines or solar panels are. The EU should focus on educating society about the value of energy efficiency and it should simultaneously give public exposure to well-performing companies. This should help to create a culture of energy efficiency, as mentioned in the previous subsection. Gaps in the legislation as business emigration, lack of enforcing the law and the almost ineffective economic incentives will become smaller when intrinsic motivation rises.

### 8.6. Enforcing the law

As argued by 61% of the interviewees, the laws regarding energy efficiency are currently not sufficiently enforced to bring about the actions of the targeted group. This can, according to 26% of the participants, be attributed most to the lack of proper measurement tools for energy efficiency. Hence, the EU should focus on developing adequate tools that can measure energy efficiency, because that will make its laws credible due to the consequences that arise when deviating behaviour is measured. Put differently, also the negative incentives become active when law enforcement is done, reducing the moral hazard.

But companies should get something in return for these stricter laws. The covenants are currently offering companies that have good achievements more freedom in how to improve their efficiency levels. According to B. Frey (2012) and Grant (2012) this method will be perceived as supportive legislation and does, therefore, not interfere with the intrinsic motivation. In other words, developing adequate tools to measure energy efficiency will make enforcing the law easier. The collection action problem will be reduced as well, because the law becomes coordinating by introducing some sort of coercion (Olson, 1965). But to prevent the businesses from emigration due to this coercion the companies should get something in return. This can for instance be more freedom to reach the targets, as suggested by many interviewees, or the promise of a stable policy for a certain number of years. The latter option also shrinks the gap of the uncertainty created by the legislation.

### 8.7. Chapter summary

Six recommendations were proposed to enhance the EED. How these proposals relate to the gaps that are summarized in Chapter 7.6 is described in Table 8. The proposals have been described in a general manner and require further research to transform them in clear actions.

<table>
<thead>
<tr>
<th>Gap</th>
<th>Proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertainty</td>
<td>Maintain stable policies and reduce the overall risk perception of the industry [8.2]</td>
</tr>
<tr>
<td>Moral hazard</td>
<td>Develop adequate tools to measure energy efficiency that makes it easier to enforce the law [8.6] and develop a better understanding of the drivers and obstacles of the industry [8.5].</td>
</tr>
<tr>
<td>Consuming too many resources</td>
<td>Develop a better understanding of the drivers and obstacles of the industry [8.5].</td>
</tr>
<tr>
<td>Barely any effect of economic incentives</td>
<td>Focus on the social incentives companies have to become more efficient, like increasing societal awareness [8.5], create an industrial culture of efficiency [8.4] and enhance the communication in the industry chain [8.3].</td>
</tr>
<tr>
<td>Enforcing the law</td>
<td>Enforce the law and give companies something in return [8.6].</td>
</tr>
<tr>
<td>Business emigration</td>
<td>See proposal ‘Barely any effect of economic incentives’.</td>
</tr>
<tr>
<td>No support provided for overcoming largest obstacles</td>
<td>These obstacles will for a large part disappear when energy efficiency becomes a culture of the industry [8.4].</td>
</tr>
<tr>
<td>Incentive mismatch</td>
<td>See proposal ‘Barely any effect of economic incentives’.</td>
</tr>
</tbody>
</table>
9.

Evaluation of the suitability of PAT & overall evaluation

This chapter evaluates the suitability of the PAT to this research. The outcome of this evaluation is the contribution this research does to science. Next, by means of reflecting on the theoretical framework, the overall evaluation identifies what aspects of this research could have been done differently.

Section 9.1 describes the conclusions that are drawn from the PAT’s analysis after which Section 9.2 elucidates the scientific contribution of this research. Next Section 9.3 reflects on the starting point of this study, its limitations and the validity and reliability. Section 9.4 describes this research’ contribution to practice and Section 9.5 explains what lessons have been learned. A summary of the chapter’s content is provided in Section 9.6.

9.1. Conclusion of analysis with the PAT

The PAT is helpful to analyse each shackle of the industry chain separately. The different hierarchies that exist prove the complexity of the industry as a whole. Furthermore, it explains that the top-down structure the EED is assuming is not that straightforward. However, the EED case also emphasizes that the classical PAT is not applicable to organizations without some drastic adjustments. Goals do not necessarily conflict, pure information asymmetry does not have to exist, principals can simultaneously be agents in another relationship and the other way around, supervisors exist, cooperation can emerge, and multiple principals and agents that behave as individuals can exist in the same relationship. These aspects were suggested by several scholars as required adjustments to the PAT (Miller, 2005a, 2005b; Shapiro, 2005; Tirole, 1988; Waterman & Meier, 1998). These adjustments were also required to analyse the relationships and responsibilities in the industry chain as to understand which obstacles to energy efficiency are present. It simultaneously identified additional shortcomings of the PAT, which will be explained first. The possible conclusions from these shortcomings are described next.

9.1.1. Additional shortcomings of the PAT

The EED case brought more shortcomings of the PAT to the surface, due to its inability to give an answer to several aspects. These shortcomings are the following:

1. Desire to build long-term relationships reduces opportunism;
2. Reputation and trust building reduces opportunism;
3. The agent can walk out of the relationship if goal conflict is too severe;
4. Networking and collaboration instead of a principal-agent relationship;
5. Strategic behaviour other than direct monetary opportunism;
6. A principal can choose out of a group of several agents as to align goals;
7. One principal can have multiple goals that have to be met at the same time.
Many of the above objections can be linked to the characteristic of cooperation. As emphasized by Tirole (1988) cooperation requires long-term relationships because only then trust can be build, which is essential to a successful cooperation. Hence, shortcomings number 1, 2 and 4 relate directly to cooperation. Shortcomings number 3 and 6 are also related, because the large network includes many agents (reason 6) and many principals to choose from (reason 3) as well. If an agent does not like the conditions of the principal-agent relationship, he can draw back and try to attract business at another principal or even at a principal in a different industry segment. Hence, reasons 3 and 6 are both about reducing goal conflict in the relationship before the actual relationship is accepted by both parties. Communication will be an important tool as to know what one party wants from the other and to have their goals grow closer together.

Shortcoming number 5 is about the consequences of cooperation. As argued by de Bruijn and ten Heuvelhof (2008), actors in a network have strategic behaviour. The underlying motives are hidden for the participants of the network and can be related, for example, to gaining information about one’s behaviour and actions, building trust, gaining credits that can be used in a future collaboration, and to have the other participants playing each other of the field. These strategies are not directly linked to monetary opportunism, which is the only type of opportunism the PAT considers. Moreover, the PAT assumes that only agents behave strategically, while in a network the principal, for as far there is one, is likely to have a strategy of its own as well. After all, plain coercion is unlikely to evolve in a successful collaboration (de Bruijn & ten Heuvelhof, 2008).

Shortcoming number 7 is not related to cooperation or the amount of agents and principals that are present. Nevertheless, a principal that has several goals that have to be met simultaneously is likely to be present in organizations, because companies rarely have a vision that exists out of only one goal. And even if it would, the regulation imposes extra constraints on a project that automatically leads to extra goals that have to be met to successfully execute the project. The operating companies in the EED case clearly show that several goals, like (environmental) safety, budget and planning, are all to be obtained in the same project.

9.1.2. Possible conclusions from the additional shortcomings
The identification of the seven additional shortcomings leads to three possible conclusions, which are the following:

1. The PAT should be extended in order to overcome the identified difficulties;
2. The PAT, whether classical or adjusted, should not be applied to organizations;
3. The EED case cannot be compared with an organization.

Possible conclusion 1
The first possible conclusion can be rejected immediately. If the model was to be extended in order to cope with the shortcomings, it would lose its principal-agent relationship characteristic altogether. The hierarchic element would be reduced considerably due to the aforementioned issues of mutual dependency that arise in a network environment. Controlling the agent is not the mean issue anymore, but how to cope with the strategic behaviours of all participants of the network to obtain one’s goal becomes the mean concern.
Furthermore, the goal conflict and information asymmetry diminishes when long-term relationships are being developed as a result of successful cooperation. When all core elements of the theory have to be adjusted as to be able to apply it to that which is being analysed, one should wonder if the correct model has been applied to begin with.

**Possible conclusion 2**

The second possible conclusion, which is that the (adjusted) PAT should not be applied to organizations, is harder to reject or accept. In principle organizations have a hierarchy, which can be analysed with the adjusted PAT as long as the scope is intra-company relationships. Furthermore, several scholars were able to theoretically prove the applicability of the adjusted PAT (Miller, 2005a, 2005b; Shapiro, 2005; Tirole, 1988; Waterman & Meier, 1998). However, organizations will have multiple goals as well (shortcoming nr 7) and will also perform better when an environment of trust and respect (shortcomings nr 1 and 2) is created (Tirole, 1988). Furthermore, individuals within a company are likely to behave strategically as well, in order to secure their position in the company, to work as little as possible, etc.

Due to the theoretical applicability of the adjusted PAT one could argue that the PAT is applicable to organizations. The practical EED case could be analysed for the largest part by applying the adjusted PAT. But organizations are expected to experience the same difficulties that the EED case is experiencing regarding the seven shortcomings, which would mean that the core assumptions of PAT must be changed even further to apply it to organizations. Hence, conclusion 2 cannot be rejected or accepted just yet. An exhaustive research in which the PAT is applied to analyse a large number of organizations, small and large and from different origins, is expected to solve this issue.

**Possible conclusion 3**

The third possible conclusion is probably the best to explain the seven additional shortcomings of the PAT. If the EED case cannot be identified as an organization, then it is logical that issues arise whilst analysing the EED case with an organizational model. Already at the start of the analysis it became clear that the core assumptions of the PAT have to be adjusted in order to apply it to the EED case, as explained in Section 6.1, 6.2 and 6.3.

Despite the straightforward principal-agent relationship the EED is assuming, i.e. the EU dictates the goal that industries must obtain regarding energy efficiency, it already introduces a supervisor by demanding its Member States to analyse the industries and report back about the accomplishments (EU, 2012). The introduction of a supervisor is one of the many adjustments that were required to analyse the EED case further. But it appeared that even the adjusted PAT cannot handle the issues that arise when the principal-agent relationships are getting the characteristics of a network.

The difference between an organization and a network circles around the aspects of a hierarchy, mutual dependency and free choice. Organizations have a hierarchy, which can be mechanistic or more organic (Robbins & Judge, 2012), but the top-down structure is present. The top-down structure also means that there is only limited to no mutual dependency, because the agents do not require services or products from the principal. Moreover, they have no real influence on the principal. Of course, the agent can try to communicate with its principal to get the conflicting goals more aligned, but if the principal refuses, the agent is basically forced to do its job. The other option the agent has is to resign.
In a network the agent and the principal rely on each other to come to a successful collaboration and the hierarchy is often not that clear. The principal requires the services or products of the agent, but cannot simply force the agent to do what is demanded. The agent has a free choice of leaving the network and to find business elsewhere, but it loses its opportunity to get something from the principal that the other agents can still get. This could concern strategic information, access to the principal's network or resources, to build trust, etc. Hence, the agent is for more reasons in the network than just fulfilling the principal’s wishes. Additionally, during the communication process both parties invest time, money and information in order to make the relationship work. If either one walks out, valuable resources have been spent for nothing.

The EED case is a combination of a network and an organization. As the analysis in Chapter 6.5 showed, some of the industry groups fit the adjusted PAT perfectly, meaning that these relationships correspond to an organization. Other groups, however, run into the problems that the presence of a network indicates. Hence, also the third conclusion cannot be accepted. The conclusion is instead that the EED case fits both the characteristics of a network and those of an organization. As shown in the previous sections, the theory is able to identify the influences of both types of relationships, but it is unable to predict the behaviour of the agents in a network. The latter is, however, outside the scope of this study.

### 9.2. Scientific contributions

The analysis of the applicability of the PAT in Chapter 6 and the conclusions that are drawn in Section 9.1 regarding this analysis are two contributions this research does to science. A comprehensive analysis of the core assumptions of the theory combined several adjustments to the theory that individual researchers have suggested. These assumptions were tested by linking the results of this research regarding a whole industry chain to these assumptions, which was not done before. This approach resulted in a broad overview regarding the developments in the PAT and its applicability to organizations. In the previous section it is concluded that the PAT is applicable to rather hierarchical organizations, but cannot cope with the elements of a network. Additionally, this research shows that future research is required in order to conclude whether the industry is actually similar to an organization. Furthermore, although many scholars argue that the PAT can be applied to organizations; questions are raised about the rightness of their claim. Hence, this research identified two possible gaps in the existing literature and provided, by combining the findings of several scholars, an enhanced overview of the modern PAT.

Additionally, the existing barrier taxonomy of Cagno et al. (2013) has been extended in order to categorize the data sufficiently. Future research that focuses on the industry chain as well could use this extended taxonomy, which will simultaneously test its features.

### 9.3. Overall evaluation of the research

The overall evaluation of the research reflects on the starting point of the research and the insights gained from conducting the research. The assumptions of this study are described first and the reflection on these assumptions follows directly after. Next the limitations of the research are identified and the validity and reliability of this study are addressed last.
9.3.1. The starting point of the research
This research assumed that an incentive mismatch exists between the EED and the industry, i.e. social versus economic, that results in the EED not reaching its 20% increased energy efficiency target. It was also expected that this incentive mismatch would have the characteristics of a principal-agent problem, which would make the PAT a suitable theory to analyse the problem. Additionally, aspects as short-term benefit focus, competitor’s actions, ambiguity effect, moral hazard, and split incentives were anticipated to play an important role in the decisions of the industry. Additionally, the prisoners’ dilemma was expected to be present.

9.3.2. Reflection on the starting point
This research identified that industrial decisions are influenced by a focus on the highest return on investment, that the ambiguity effect plays a role, that in some relationships the moral hazard exists and that competitor’s actions matter. The original expectation was correct regarding these points. The aspect of split incentives appears to play a role as well, but is compared to the other influences negligible. Also, the prisoners’ dilemma appeared not to play a role at all, which is contradicting to the starting point of this research. Furthermore, an important observation is that the industry is not solely driven by economics. On the contrary, social drivers are most frequently the cause of the largest obstacles to energy efficiency, which was not expected at all.

Also, the existing goal conflict between the industry and the EED is less severe than originally assumed due to the minimal enforcement. With regard to the incentive mismatch assumption can be concluded that an incentive mismatch with negative consequences for the EED exists, but it is of a different nature than originally assumed. Originally the mismatch would derive from social versus economic incentives, whilst in reality it is social versus social in which both ‘social’ terms have different meanings. One concerns the environment and society; the other concerns matters like safety, decision making power, communication and risk perception.

Another very important assumption concerns the applicability of the PAT. Due to the characteristics of the PAT it was expected that this theory would be suitable to analyse the industry chain and its decision making process. This assumption appeared to be partly true. On the one hand it was no problem to identify the industry’s relationships, as long as all the adjustments proposed by independent scholars were combined. On the other hand, the behaviour of the network relationships, which could be identified, cannot be predicted with the PAT due to several shortcomings. These shortcomings have been described in Section 9.1 and raised questions about its applicability to analyse organizations, which was originally not questioned at all.

In summary can be stated that many of the assumptions were proven to be wrong; the influences on the decision making process exempted. Nevertheless, the falls assumptions were frequently in the right direction. After all, an incentive mismatch does exist that causes many of the largest obstacles to the energy efficiency target of the EED and the PAT could be applied for the means of this research, despite the identification of several shortcomings.
9.3.3. Limitations of the research
The interviewees were all persons that were willing to cooperate, indicating a likely bias towards favouring energy efficiency. Also, the interviewees do not necessarily reflect the opinion of the company they work for and a representative sample was not available. However, according to Bewley (2002) this should not cause a problem, because worthy insights are nevertheless obtained. After all, this explorative research managed to get an understanding of the obstacles the industries face. Nevertheless, a representative sample would have led to better generalization of the results. Additionally, a more balanced overview of the different perceptions in the industry chain could have been provided if the group of the operating companies was larger, i.e. in balance with the rest of the industry chain. And the reliability could have been improved by having several researchers categorizing the data, which was unfortunately not a possibility for this research. Lastly, this study reduced its scope to the Netherlands, which means that especially observations with regard to the legislation can differ when other countries are studied.

9.3.4. Validity and reliability
This research is explorative in nature, but validity and reliability are nevertheless important aspects for the overall value of the conducted research. The validity can be subdivided in internal and external validity, which are covered first and second, respectively. The matter of reliability is covered last.

Internal validity
The internal validity of this research concerns the open interviews that were conducted and how accurate the data from these interviews are represented (Sekeran & Bougie, 2013). The method of open interviews is for instance also applied by Venmans (2014) in his economic research into the decision making process of the ceramic, cement and lime sectors regarding energy efficiency barriers.

The questions that were asked in the open interviews were composed with the help of industry specialists while keeping an eye on the aim of this study. This ensured that the questions were clear and relevant. Moreover, almost every interview was recorded, which made the processed interview near to identical to the actual interview. Furthermore, the interviewee had the opportunity to provide its comments on the processed interview, which ensured that the interviews were interpreted in a correct fashion.

The answers that were given were checked several times throughout the interview process on their correspondence with what was intended to be measured. Furthermore, the same questions were asked to each participant. The data of these interviews are represented by two tables in Appendix I that clearly show which obstacle is mentioned/identified by who. Additionally, in all graphs and tables the answers of the operating companies and the remaining industry groups are shown separately. This process together with the profound data collection method ensures that internal validity is guaranteed.

External validity
The external validity of this research concerns the results and to what extend these can be generalized to other industries (Sekeran & Bougie, 2013). At the ERTC Energy Efficiency conference in Brussels on the 16th of April 2015 similar observations to this research were shared among the conference's participants. An example is a presentation by Fuels Europe (2015), an European branch organization, in which was emphasized that the refining
industry is experiencing heavy competition due to increasing energy prices in Europe. Furthermore, it was stressed that the legislation is currently only increasing the number of obstacles instead of breaking them down. Also, it is said that making the implementation of new techniques mandatory is less effective than providing implementation support. Another example is the presentation by Yokogawa Europe Solutions BV (2015), which is a vendor, that emphasized the importance to the industry of matters as safety, reliability, clients, scheduling, maximizing margins and maintaining competitiveness. Moreover, presentations by Slovnaft (2015) and Repsol (2015), refining companies in Slovakia and Spain, respectively, showed their motivation to increase energy efficiency through examples of their accomplishments. In other words, these presentations confirmed that the findings of this research, originating from Dutch interviews, are supported by European parties.

The result of this research that the focus of policies should be on the intrinsic motivation of companies is supported by B. Frey (2012) who has the same conclusion after its analysis of the implications of crowding out and crowding in. Furthermore, extensive research in the barriers to energy efficiency by IEA (2014a) stresses the importance of aligning the European policies about energy efficiency with the needs and goals of the industry. Hence, the conclusion of this research is also shared by other independent researchers.

Research by Trianni, Cagno, Thollander, and Backlund (2013), which aimed to identify the barriers to energy efficiency in foundries, concluded that operating companies try to avoid the risk of adopting energy efficient technologies. According to them the process disruptions and technical risk are important barriers to energy efficiency, which corresponds to the observation of this research.

Furthermore, obstacles as delaying investments to capture knowledge from others, a lack of proper information diffusion regarding energy efficiency, the difficulty of identifying the opportunities for energy efficiency, relying on standard solutions, uncertainty, risk of process disruptions and ineffective energy audits are mentioned in recent American research by Newell et al. (2015). Additionally, Venmans (2014) concluded that energy efficiency investments are indeed seen as important by operating companies, but the focus of managers on payback times cause nevertheless challenges to have energy efficiency investments approved.

Summarizing, the results and conclusions of this research are supported by several scholars', companies' and researchers' findings that have a border-crossing scope or have studied the obstacles to energy efficiency in different industry segments. It is therefore very likely that the results of this study can be generalized to at least the rest of the Dutch refining and (petro)chemical industry and probably other processing industries as well.

**Reliability**

In qualitative research the research’ reliability concerns the categorization of the empirical data (Sekaran & Bougie, 2013). The category reliability has been safeguarded by applying an existing and tested taxonomy regarding energy efficiency obstacles. After analyzing several taxonomies for their applicability to this research the taxonomy of Cagno et al. (2013) was considered to fit the means of this research best. Cagno et al. (2013) did not investigate a whole industry chain, which resulted in some of their categories requiring adjustments that were attributable to the wide scope of this research.
Additionally, all interviews were conducted face-to-face by the same person to prevent differences in approach and personality causing biases in the gathered data. Another advantage was that questions could be clarified when required, making the answers more reliable (Sekaran & Bougie, 2013).

9.4. Contributions to practice

The overview of the EED and the Dutch legislation regarding energy efficiency is one of the contributions this research does to practice. The interviewees often did not or not entirely know what the Dutch policies are and what the content of the EED is. Also for this research it was a struggle to compile a clear overview of the legislation. Hence, the provided overview in Chapter 4 has practical value for the industry. Furthermore, it can also signal policy makers that the diffusion of governmental documents could be improved.

Additionally, the overviews about the obstacles as perceived by the operating companies and the remainder of the industry chain differ. This provides value to the industry because it shows that information asymmetry is present and that existing perceptions may not be correct. This can enhance the communication process and can lead to quicker mutual understanding. Moreover, it shows where targeted action can be taken in order to overcome the obstacles.

One of the conclusions of this research is that the present employed incentives to get the industry more efficient require reconsideration, because they do not seem to lead to a culture of prioritizing energy efficiency in the industry. Policy makers can use this conclusion, among other insights from this research, to make more effective policies.

Another contribution of this research to practice derives from the result that the perceived motivation for increasing energy efficiency among the industry differs and can in general be improved. But it simultaneously shows that companies, including operating companies, are not the only one in their quest to increase energy efficiency. This observation can motivate companies to search for companions and to try to improve energy efficiency in the industry together. Such an encounter, in consequence of this research, has already occurred. A meeting between two companies took place while this research was still ongoing in which they decided to join forces. Hence, the first contribution of this research to practice can already be observed.

9.5. Lessons learned from the research

This research clearly shows that the problem as formulated in the Introduction is an actual problem. And it became also clear that many of the reasoned assumptions were falls, stressing that reality can differ from theory. Furthermore, conducting all the interviews was really a good tool to gather the data, but with regard to the generalization of the results it would have been much better when groups of equal sizes were interviewed. Moreover, the group of the operating companies should have been larger to be in balance with the remaining industry chain.

But the most important lesson learned from this research is that the PAT, which seemed to fit perfectly to analyse this case, was not fully suitable for analysis of the problem. It would have been better to apply a combination of both the PAT and the process management
theory. The former identifies the type of relationship and decision, but the latter could give more debt into the explanation why industry groups are in such a relationship and why they make the decisions they do. Furthermore, it is an enrichment for science that after decades of development with regard to the PAT still issues can be raised when the theory is applied to a different setting, i.e. a whole industry chain. In other words, the development of the theory continues, emphasizing that future research regarding the theory is required.

9.6. Chapter summary

This chapter started with the evaluation of the suitability of the PAT in which it became clear that the PAT has seven shortcomings with regard to analysing an industry chain. These seven shortcomings led to three possible conclusions. The most important conclusions are that questions were raised about the applicability of the PAT to organizations and whether the industry chain could be identified as an organization. The scientific contribution of this research was elucidated as well, which concerns the applicability of the PAT to an industry chain. Also the overall evaluation of the research was described. This included a reflection on the initial assumptions, the validity and reliability of the research, its limitations, its practical relevance and the lessons that were learned from conducting this research.
Conclusions and recommendations

This research started with the observation that the EU composed the Energy Efficiency Directive (EED) to limit climate change (EU, 2012). The EED has set its goal to get the industry, among other sectors, 20% more energy efficient by 2020 (EC, 2014a) compared to projected efficiency levels (EC, 2015a). However, the industry is expected not to reach that target (EEA, 2013). For this reason this research studied the obstacles faced by the Dutch industry in becoming more efficient by analysing the whole industry chain, e.g. regulators, R&D organizations, vendors and operating companies. The aim of this research is to give recommendations about how these obstacles can be overcome by means of enhancing the EED. To achieve its objective this research was guided by seven research questions, which were introduced in Chapter 2.7, that will be answered in this chapter in the form of drawing conclusions. The research questions are italicized for clarity reasons and answered in Section 10.1. The recommendations concern the areas of future research, which are included in Section 10.2.

10.1. Conclusions

Study of the legislation
The identification of the most important EU and Dutch energy efficiency instruments was done by means of an exhaustive paper and internet research. The following most important policy instruments to enhance energy efficiency are included in the Energy Efficiency Directive:

- Energy audits [4.1.1]
- Energy efficiency management systems (ENEMS) [4.1.2]
- National energy efficiency action plans (NEEAP) [4.1.3]

Policies that the EED’s instruments should not interfere with, but that are nevertheless strongly related to energy efficiency are the following:

- Emissions trading scheme (ETS) [4.1.4]
- Best available techniques (BAT) [4.1.5]

With regard to the Dutch legislation the most important policy instruments to enhance energy efficiency are the following:

- Energy investment allowance (EIA) [4.2.1]
- MJA3 and MEE covenants [4.2.2; 4.2.3]
- Energy tax [4.2.4]
- Wet Milieubeheer [4.2.5]
- Energieakkoord [4.2.6]
- Wet implementatie EU-richtlijn energie efficiëntie [4.2.7]

The Dutch government delegates the execution of the law to the provinces and municipalities who delegate the enforcement to the competent authorities, which also
provide companies with a License to operate. See Chapter 4.3 for the description of the entire hierarchy. The main incentives that the legislation puts on the industry is the EIA, the energy tax reimbursement and the relieve of law enforcement [4.4]. The information regarding the legislation was required for its relevance to the industry’s decisions.

**Results from and interpretation of the empirical data**

A total of 23 interviews with companies from the industry chain (also called ‘the industry’) were conducted, i.e. authorities, universities, R&D organizations, vendors, transfer agents, operating companies, consultants and branch organizations. These empirical results identified the influences on the process of decision making among the selected organizations regarding energy efficiency, which is summarized in Chapter 6.7. The results and further interpretation identify the following influences in a nutshell:

- The regulators and operating companies are the most influential regarding which decisions are being taken; the other industry groups are influencers of the process [5.4];
- The industry is much more complex than the plain hierarchic organization the EED assumes [5.4; 6.6];
- Operating companies are risk averse due to the importance of their continuous processes and prefer therefore proven technologies (91%) [6.1.2].
- Risk aversion causes a collective action problem [6.2.2].
- Motivation to increase energy efficiency exists because of its money-saving property, (61%) [6.2.2].
- Operating companies have their shareholders’ and the regulators’ wishes to satisfy [6.5.6].
- Society’s motivation for energy efficiency influences decisions (35%) [6.8.4].
- Operating companies have other priorities than energy efficiency (91%) [6.8.5].
- Operating companies are driven by the best return on investment (97%)[7.2.3];
- Social factors play an important role in decisions of operating companies [7.4].

The information regarding the influences on the decision making process was required to make a comparison between the industries’ decisions and the legislation’s implications.

**Reflection on the legislation**

The areas of overlap between the legislation’s implications and the industries’ decisions are described in detail in Chapter 7.1. The conclusions regarding the areas of overlap are summarized in Table 9 in which the percentages of the interviewees that identified that area of overlap are given between square brackets.

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Area of overlap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy audits and covenants</td>
<td>The industry has difficulties with identifying opportunities to improve its efficiency level, because the low hanging fruits are gone (70%). The energy audits and covenants should help to overcome this obstacle.</td>
</tr>
<tr>
<td>ENEMS and covenants</td>
<td>The operating companies are currently not having a real energy efficiency culture (70%). The ENEMS and covenants stimulate the creation of such a culture.</td>
</tr>
<tr>
<td>NEEAP</td>
<td>The government is expected to make an effort to solve the difficulty of measuring energy efficiency (26%), because it has to monitor its own progress in order to report about its achievements in its NEEAP.</td>
</tr>
</tbody>
</table>
Chapter 10: Conclusions and recommendations

ETS

The legislation is making use of market incentives (Porter & van der Linde, 1995) by means of the ETS; all interviewed operating companies are incorporating ETS in their investment decisions.

Energy tax

Nearly all participants stated that the industry is influenced the most by profits and competitiveness, which are economic incentives. The government is trying to make use of these incentives by means of the energy tax.

EIA

Higher initial costs of energy efficiency techniques is an important obstacle (91%). The EIA is aiming to overcome this obstacle.

Energieakkoord and European BAT

The Dutch Energieakkoord and European BAT are both regulations that are composed via cooperation between the industry and the policy makers, which should lead to a more effective policy (Porter & van der Linde, 1995).

Satisfying the three criteria of environmental policies

Porter and van der Linde (1995) have prepared three criteria that environmental policies must satisfy in order to be effective, which the EED satisfies indeed.

Multiple gaps can be identified between the legislation’s implications and the industries’ decisions. These are described in detail in Chapter 7.2 and already summarized in Table 7 of Chapter 7.6.

With regard to the legislation’s implications and the industries’ decisions the biggest gap concerns the lack of addressing the largest obstacles that the industry faces. These are the following, in which next to each obstacle first the percentage of the non-operating companies is mentioned, second the percentage of operating companies, third the combined percentage and last the nature of the obstacle:

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Obstacle</th>
<th>N-OC</th>
<th>OC</th>
<th>Total</th>
<th>Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Decreasing market demand;</td>
<td>40%</td>
<td>100%</td>
<td>48%</td>
<td>economic</td>
</tr>
<tr>
<td>2.</td>
<td>Lack of proper communication in the industry chain;</td>
<td>50%</td>
<td>100%</td>
<td>56%</td>
<td>social</td>
</tr>
<tr>
<td>3.</td>
<td>Lack of adequate legislation;</td>
<td>85%</td>
<td>33%</td>
<td>78%</td>
<td>political</td>
</tr>
<tr>
<td>4.</td>
<td>Focus on best return on investment;</td>
<td>95%</td>
<td>100%</td>
<td>95%</td>
<td>economic</td>
</tr>
<tr>
<td>5.</td>
<td>The higher initial costs of the investment;</td>
<td>90%</td>
<td>100%</td>
<td>91%</td>
<td>economic</td>
</tr>
<tr>
<td>6.</td>
<td>The perceived higher risk;</td>
<td>90%</td>
<td>100%</td>
<td>91%</td>
<td>social</td>
</tr>
<tr>
<td>7.</td>
<td>Having other priorities;</td>
<td>90%</td>
<td>100%</td>
<td>91%</td>
<td>social</td>
</tr>
<tr>
<td>8.</td>
<td>The decision making power of higher management;</td>
<td>90%</td>
<td>100%</td>
<td>91%</td>
<td>social</td>
</tr>
<tr>
<td>9.</td>
<td>The existing culture of the industry.</td>
<td>80%</td>
<td>-100%</td>
<td>70%</td>
<td>social</td>
</tr>
</tbody>
</table>

The information regarding the above enumeration can be found in Chapter 5.2 with regard to the percentages and in Chapter 7.4 regarding the obstacles’ nature. An important conclusion is that the largest obstacles to energy efficiency are more often social (a behaviour or habit) than economic, which is contradicting the original assumption of this study. Furthermore, the regulators rely heavily on economic incentives to get the industry more energy efficient. It also shows that in the industry chain some of the obstacles are perceived differently by the operating companies and the non-operating companies. The operating companies, for instance, do not perceive the existing culture of the industry to be an obstacle at all (i.e. negative value), while 80% of the non-operating companies identify this as an important obstacle.

Recommendations for enhancing the EED

The recommendations made for enhancing the EED focuses mostly on the social obstacles and should help the EED to reach its 20% energy efficiency target. The main message is that a culture of energy efficiency should be created in the entire industry chain that will reduce the severity of most of the largest obstacles. The recommendations are described in detail in Chapter 8 and relate to the following:
- The perceived risk of applying energy efficient techniques should be reduced;
- The communication in the industry chain should be improved;
- Enforce the law more strictly, but give companies something in return.

**Scientific contribution**

*The principal-agent theory is suitable for analysing the influences on industrial decision making,* as long as the modifications to the model, which are already suggested by other scholars [6.1; 6.2; 6.3; 6.4], are applied. The PAT visualized the structure of the industry, i.e. both hierarchical and a network, and identified what obstacles can emerge due to this structure. This coincides with the aim of this study and therefore the PAT was suitable. However, the PAT is not suitable for analysis of the network actors’ behaviour due to its inability to cope with the characteristics of a network. These shortcomings in the theory have been identified and could largely be attributed to the element of cooperation. Additionally, these shortcomings raised questions about the rightness of the claim of several scholars that the PAT can be applied to organizations and the assumption of this study that an industry can be compared with an organization [9.1]. The application of the PAT in this research proved to be a valuable contribution to science [9.2].

**The incentive mismatch**

The EED relies heavily on economic incentives for the operating companies to get the industry more energy efficient. The industry, however, faces obstacles that are more often of a social nature than economic and these are not contributable to just the operating companies. In other words, the social incentives of the industry chain should also be the focus of the EED, which is the opposite of what it currently is. Hence, an incentive mismatch exists.

### 10.2. Recommendations for future research

Five areas of future research emerged while conducting the research. The first area relates to the promotion strategy of the government regarding innovative techniques and to the marketing strategy of the industry companies that try to sell their techniques and technologies to the operating companies. The operating companies can be attributed to the group of the pragmatics or, as Geoffrey A. Moore calls it, the early majority. Members of this group "are averse to disruptions in their operations and, as such, want proven applications, reliable service, and results" (Mohr, Sengupta, & Slater, 2010, p. 241). Moreover, this group is not eager to buy new techniques if they lack a reference from someone they trust, who is often in the same industry. The industry companies and the government, however, try to persuade the operating companies to invest in revolutionary techniques, which lack the required reference (Mohr et al., 2010). Future research should focus on how to effectively persuade the pragmatics to invest in innovation, because currently, according to the interviewed vendors, the operating companies are hardly persuaded.

The second area of future research concerns the water sector. The water sector is, just as the refining and (petro)chemical industry, an industry characterized by risk aversion due to the significant importance of their continuous processes. Recent developments in the water sector show that this obstacle can be overcome with a new type of cooperation. Equipment manufacturers in the water sector make financial agreements with the operating companies that reduce the implementation risk of a new technique for the operating companies (Schotsman, 2015). Future research can study this development in the water sector, whilst
especially paying attention to the communication process and cooperation strategies of the different industry players, which can be of value for other process industries in becoming more energy efficient.

A third area of future research is about the investment climate of Europe with regard to energy efficiency investments. This research shows that the relatively high energy prices, high labour costs and strict regulation are making Europe less attractive for global operating companies to invest in. Moreover, it makes business emigration a serious threat to effective policy making. If future research can identify how Europe can be made more interesting to invest in for specifically global operating companies in the process industry, this will be of great value.

The fourth area that is considered to be of interest for future research is the area of organizational culture change. One of the conclusions from this research is that a culture change should emerge within the industry chain to get the industry more energy efficient. This is, however, far from easy. Future research in how such a change can be initiated and guided is therefore advised.

The fifth area of future research concerns the PAT. It should be investigated whether the PAT can actually be applied to organizations, which is currently argued by many scholars. Organizations are expected to have similar network difficulties as the EED case has, which would make the PAT unsuitable for analysis. Future research should analyse organizations to identify whether network characteristics are present. Furthermore, future research should confirm whether it is just to analyse industries as if they are organizations.
Acknowledgements

On September 2014, on a sunny Saturday, a meeting between two people took place. It was immediately apparent they had a shared interest; taking care of the environment by increasing energy efficiency. This meeting was the start of my thesis that I refer to as my ‘dream project’ and it has never failed my expectations. The help of many persons was essential for this project, who I would like to show my gratitude.

I would like to thank my TU Delft thesis committee for their guidance. Dr. ir R.M. Stikkelman and his strategic advice and questions made sure that I did not deviate from my planning, Dr. S.T.H. Storm was indispensable with his advice concerning my theory and Prof. dr. C.P. van Beers ensured that I kept an eye on the generalization of my research. I am also thankful for the detailed advice Dr. ir. L. Stougie has given me. And from Fluor I would like to thank Dr. J.C. Göbel for all his valuable advice and for making time whenever I needed his help. Special thanks go out to Ms. M. Muralee for her enthusiasm and patience in helping with the daily thesis activities.

All these people have been of significant value for me in making this thesis and I hope that they enjoyed working with me as much as I have enjoyed working with them.

I need to thank many more, like everyone that made time available for an interview or otherwise provided information for this thesis. And I would like to thank my parents, for being there for me at every step. And I thank my sister in law for the beautiful cover page she has designed especially for my thesis. Of course special thanks go out to Mr. M. Verschuur for allowing me to do my thesis at Fluor and letting me attend the ERTC Energy Efficiency in Brussel, which was most valuable for my thesis. And I would like to thank the management of ERTC for giving me a free ticket.

Finally, I consider myself very lucky that I met Dr.-Ing C.-P. Hälsig from Fluor that sunny Saturday. I do not know whether it was coincidence, luck or fate, but I could not have hoped for a better subject of my thesis. His drive, enthusiasm and unlimited confidence in me motivated me to do my absolute best making this thesis. I hope that he is just as pleased with the result as I am.

This thesis is the result of a project to which these persons made a contribution. I am grateful for all these individuals. Without them this thesis would not have been the same.

L.S. de Kleijn
Delft, June 2015


References

[CONFIDENTIAL]


A. Legislation overview

Table 10: Overview of the analyzed legislation

<table>
<thead>
<tr>
<th>Document title</th>
<th>Source</th>
<th>Level of analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004/8/EC</td>
<td>Ec.europe.eu</td>
<td>profound</td>
</tr>
<tr>
<td>2006/32/EC</td>
<td>Ec.europe.eu</td>
<td>profound</td>
</tr>
<tr>
<td>2012/27/EU</td>
<td>Ec.europe.eu</td>
<td>profound</td>
</tr>
<tr>
<td>Activiteitenbesluit</td>
<td>wetten.overheid.nl</td>
<td>scanned</td>
</tr>
<tr>
<td>BREF Polymers</td>
<td><a href="http://eippcb.jrc.ec.europa.eu">http://eippcb.jrc.ec.europa.eu</a></td>
<td>scanned</td>
</tr>
<tr>
<td>BREF Refinery</td>
<td><a href="http://eippcb.jrc.ec.europa.eu">http://eippcb.jrc.ec.europa.eu</a></td>
<td>profound</td>
</tr>
<tr>
<td>Energieakkoord</td>
<td><a href="http://www.energieakkoordser.nl">http://www.energieakkoordser.nl</a></td>
<td>profound</td>
</tr>
<tr>
<td>Energy Efficiency Directive Artikel 7 Nederlandse invulling</td>
<td><a href="http://www.ecn.nl/publications">www.ecn.nl/publications</a></td>
<td>quick read</td>
</tr>
<tr>
<td>Factsheet ETS</td>
<td><a href="http://ec.europa.eu">http://ec.europa.eu</a></td>
<td>profound</td>
</tr>
<tr>
<td>MEE convenanttekst 2-10-2009</td>
<td><a href="http://www.rvo.nl">www.rvo.nl</a></td>
<td>quick read</td>
</tr>
<tr>
<td>Meerjarenafspraken Energie-Efficiëntie en Energieakkoord Resultaten 2013</td>
<td><a href="http://www.rvo.nl">www.rvo.nl</a></td>
<td>profound</td>
</tr>
<tr>
<td>MJA-3 convenanttekst 01-07-2008</td>
<td><a href="http://www.rvo.nl">www.rvo.nl</a></td>
<td>quick read</td>
</tr>
<tr>
<td>NEEAP (3th)</td>
<td>Ec.europe.eu</td>
<td>profound</td>
</tr>
<tr>
<td>Resultaten brochure convenanten</td>
<td><a href="http://www.rvo.nl">www.rvo.nl</a></td>
<td>profound</td>
</tr>
<tr>
<td>Trends and projections in Europe 2013</td>
<td><a href="http://www.eea.europa.eu">http://www.eea.europa.eu</a></td>
<td>quick read</td>
</tr>
<tr>
<td>Uitvoeringsagenda Energieakkoord 2014</td>
<td>e-mail EZ</td>
<td>scanned</td>
</tr>
<tr>
<td>Wet implementatie EU-richtlijn Energie Efficieentie</td>
<td>wetten.overheid.nl</td>
<td>scanned</td>
</tr>
<tr>
<td>Wet mileubeheer</td>
<td>wetten.overheid.nl</td>
<td>scanned</td>
</tr>
</tbody>
</table>

The documents related to the Dutch policy regarding industrial energy efficiency are shown in Table 10. The level of analysis differs. *Profound* means that the document has been read carefully. The level *quick read* is about documents that have been read carefully, while different parts of the same document have only been scanned trough. The level *scanned* is given to those documents that have been read on a first sentence basis of each chapter, section and occasionally paragraph. A more detailed description of the legislation analysis is provided below.

**Description of the process**

The directives 2004/8/EC and 2006/32/EC have been read, which can be seen as the precursors of the EED. Also the EED itself was analysed; directive 2012/27/EU. The EED, article 24, mentions that all Member States have to deliver a *National Energy Efficiency Action Plan (NEEAP)* before 30 April 2014 (EU, 2012). Hence, the Dutch *NEEAP* has been analysed as well.

The Dutch *NEEAP* refers on page 6 to the *Energieakkoord voor Duurzame Groei* (Energy Agreement) as satisfying the demands of article 7 of the EED (EZ, 2014). Subsequently it was decided to look for the *Energieakkoord* as well. The *Energieakkoord* explains that it is the result of collaboration between forty parties and that it can be seen as an additional
policy (SER, 2013). This implies that there is general legislation regarding the EED, being the Wet implementatie EU-richtlijn energie efficiëntie (Energy Efficiency Directive (implementation) Act). However, this legislation was vague and let to a dead-end. Reports by ECN and PBL about the implications of Dutch policy regarding EED article 7 (ECN, 2013) and the impact of the Energieakkoord (PBL & ECN, 2013), respectively, provided clearer information.

The Energieakkoord (SER, 2013) and the NEEAP (EZ, 2014) both refer to the covenants MJA-3 (Long-term Agreement 3) and MEE on page 51 and 30, respectively, as a way to stimulate the industry in becoming more energy efficient. Moreover, it is argued that these covenants are very effective. These statements resulted in a more detailed search into what these covenants are all about.

Additionally, the Wet Mileubeheer (Environmental Management Act) and the Activiteitenbesluit (Activities Decree) have been scanned through, because the most important implications of these documents for the industry were already explained clearly in the Energieakkoord and the NEEAP. The relevant documents about the Best Available Techniques (BREF) are included as well, since the EED refers to these documents in paragraph 42 and article 15 (EU, 2012).

Additional browsing via Google.com was performed and led to a report by the European Environment Agency (EEA) (EEA, 2013) among other documents.
B. Interview question list

Organization related questions

1. Could you briefly describe what it is that your company does, its goal and what your role is?

2. Could you draw an overview of how your company is connected to these other organizations? (provide list of organizations, see third page)
   a. Could you clarify your drawing?

3. Before I informed you about my thesis, had you been aware of the EED and related regulations?

4. The EU has 7 reasons to increase EE, namely (also provide on paper, see third page)
   - To reduce irreplaceable fossil fuel consumption
   - To decrease imports, secure energy supply
   - To reduce Greenhouse gas emissions
   - To boost economic growth
   - To create high quality jobs
   - To improve industrial competitiveness
   - Accelerate the spread of technological solutions.
   What do you think of these reasons, are they valid? How do they influence the industry?

5. Within your connections, is there any attention for/promoting of energy efficiency?

6. And is there attention for energy efficiency within your company?

7. Let's assume that your company proposes a new energy efficient technology to the client that costs more to implement than conventional techniques, but increases profits for the client on the long term...
   a. How would they react?
   b. And what if the EE continues to costs more even on the long run?
   c. And what if the EE technology is equal in implementation costs?
   d. Do your clients ask for energy efficiency?

8. In the process of financial investment decisions, what other criteria play a role besides plain money? For example: competitive position, payback time, proven technologies, raw materials etc. Ask for EE if it is not mentioned.

9. Do you think that implementing EE measures enhance your competitive position or that of your client?

10. To what degree are competitors’ actions influencing the actions of your client?
Regulation related questions

11. How do the following points regarding regulation affect your company's (client's) decisions?
   a. (uncertainty about) policy changes
   b. CO₂ permits
   c. Norms and standards
   d. Prevention of opportunistic behaviour
   e. Accountability of EE decisions

EU related questions

12. Do you think that energy audits positively influence the investments in energy efficiency measures...
   a. ...within your company? Please clarify your answer.
   b. If applicable: is it currently applied?
   c. And how about other companies? Please clarify your answer.

13. Is your company being informed by the EC and/or the Dutch government about energy efficiency and:
   a. Available energy efficiency mechanisms, financial and legal frameworks? How?
   b. Best available techniques (BATs)? How?
   c. Associated monitoring? How?
   d. Developments in BATs? How?
   e. Would improved information disseminating lead to increased EE investments? Why?

14. An Energy Efficiency Management System (ENEMS) is a formal management approach that operating companies can use to address design, construction, maintenance, operation and decommissioning issues in a systematic way. Examples: benchmarking, definition of an energy efficiency policy, setting targets, commitment of top management, etc.
   a. Are you familiar with the concept of ENEMS?
   b. Who should be responsible for implementing ENEMS (members within chain/company)?
   c. Does your company have ENEMS? If yes, please explain briefly how it works?
   d. If not, why not?
   e. If not, should it be implemented?

15. What are the biggest barriers to increase industrial Energy Efficiency according to you?

16. Is there anything else you would like to share with me?
Organizations:

- a. Regulators like the government(al agencies) and European Union
- b. Universities and R&D institutes
- c. Equipment manufacturers (vendors)
- d. Technology providers
- e. Transfer agents (engineering companies and the like)
- f. Operating companies
- g. Consultants
- h. Branch organizations

EU reasons for increasing energy efficiency:

1. To reduce irreplaceable fossil fuel consumption
2. To decrease imports, secure energy supply
3. To reduce Greenhouse gas emissions
4. To boost economic growth
5. To create high quality jobs
6. To improve industrial competitiveness
7. Accelerate the spread of technological solutions.
C. Elucidation of the questions

Organization related questions
It was decided to start the interview with a question that anyone in the company could answer. The reason behind this approach is that such a question often gets the conversation going, which makes it easier to continue to the following question. Hence, the first question asked the interviewee to explain briefly what its company is doing and what his or her role is. After three interviews an evaluation of the results took place. It was concluded that the goal of the company was not clearly reflected in the information collected. The first question was, consequently, completed with a little note about the company’s goal.

The second question was formulated in such a way, that the interviewee had to draw a general overview of its connections to other companies. This interview method helps some interviewees to become more open in their statements and opinions. A list of suggestions was provided, which is shown on the third page of Appendix B. It was explained to them that only the parties relevant for their business had to be drawn and that the list, when required, could be complemented. Also, the visual overview of the relationships helped the interviewees to answer the next questions easier. An example of such an overview is shown in Figure 17.

The next step was to guide the conservation towards energy efficiency. First was asked about their knowledge regarding the EED. This question also helped the interviewer to understand to what degree the interviewee was aware of the EED. The second step entailed a question about their opinion regarding the seven reasons the EU has to increase energy efficiency. This question was asked to determine if the objectives of the EU were similar to the objectives of companies to become more energy efficient. The fifth question made use of the drawing made while answering the second question. Each member in the company’s network was pointed to and asked for their involvement in the energy efficiency matter. It was also asked to what degree each connection influenced the energy efficiency decisions of the company under review. Hence, insight in both the decision making process and the companies’ goals was gained. The sixth question asked the interviewee to what degree his or her own company was actively improving its energy efficiency level. Once again it was about determining the incentives of the company under review and also its commitment and opinion about energy efficiency.
As mentioned, the questions three up and until five were guiding the conversation towards energy efficiency. Question six shifted the attention to the company of the interviewee itself, but still on a very general level, namely their energy efficiency actions. This was done on purpose, because the rest of the interview would dive deeper into relatively sensitive topics, like investments and regulations. Question seven was the first question that focussed on investment decisions. It contained elements that derived from the theory about preferring short-term over long-term benefits. The subsequent question was formulated to identify what other aspects than money plays a role in investment decisions. Hence, this question had to identify the incentives companies have to invest.

The next question, question eight, asked the interviewee if energy efficiency would enhance the competitive position of its company and that of its client. The reason to ask this question was to connect the incentive of competiveness, which is also about a high return on investment, to energy efficiency. After the first evaluation of the interviews’ results it was concluded that information about actions of one company influencing its competitors was not available. Hence, this question was inserted in the questions list, because it related to the prisoner’s dilemma explained in Chapter 2.5.

While constructing the question list, several conversations were held with industry experts in order to develop some general understanding of the energy efficiency gap. These conversations were initiated by Fluor and provided the basis for the formulation of regulation related questions. These were about changing policies, the ETS system and norms and standards. These three topics were mentioned as being barriers and opportunities and it was decided to test these statements via the interviews with other parties. The theory about opportunistic behaviour, mentioned by Porter and van der Linde (1995), and split incentives (Venmans, 2014) was also tested with regard to the EED.

**Regulation related questions**

The interview would now move away from the questions that determined the goals, incentives and decisions making influences and it would progress towards regulation related aspects. Questions about energy audits and energy management systems, which are according to the EED very effective tools to increase energy efficiency, were incorporated in this part of the interview. Also a question about information provision and Best Available Techniques was included, because these points were emphasized by the EED for their importance related to increasing energy efficiency. Also, as mentioned in the Chapter 2, Best Available Technique documents were expected to influence industrial decisions, which were tested in this part of the interview as well.

Already after the first interview question number fifteen and sixteen were inserted. It was decided that improvement was still possible by adding a question about what, according to the interviewee, the biggest barriers to energy efficiency are. And the last question was inserted to provide the interviewee the opportunity to share his or her ideas that came up during the interview or to share information he or she thought was important for the interviewer to know.
D. Interviewees

For this research 23 interviews took place. Every company and organization listed below is briefly explained, subsequently. This explanation originates from the information given by the interviewee.

Table 11: Overview of the interviewees

<table>
<thead>
<tr>
<th>Organization</th>
<th>Interviewee</th>
<th>Function</th>
<th>Sector group</th>
</tr>
</thead>
<tbody>
<tr>
<td>[CONFIDENTIAL]</td>
<td>[CONFIDENTIAL]</td>
<td>[CONFIDENTIAL]</td>
<td>[CONFIDENTIAL]</td>
</tr>
</tbody>
</table>

[CONFIDENTIAL]
E. Information about Fluor

The company
The work regarding the thesis was hosted by Fluor, which is a global company specialized in engineering, procurement, construction, maintenance, and project management. Moreover, it is one of the world's largest publicly traded companies in its field. Fluor is active in the Netherlands for over fifty years. The office in Hoofddorp is especially focused on the (international) Energy & Chemicals market, in order to satisfy worldwide demand for new oil and gas sources and in particular in the conversion of hydrocarbons into transportation fuels or petrochemical or chemical products. This is done by providing a whole range of services. Examples are front end studies, consultancy, design, and construction for new installations in the upstream, downstream, chemical and petrochemical industry. Additional examples are projects in the areas of bio fuels, Carbon Capture and LNG gas terminals.

Why energy efficiency is interesting to Fluor
The clients of Fluor are experiencing rising energy costs and increased legislation to continuously improve the energy efficiency of their operations. In addition, they have to apply new techniques, Best Available Techniques, in order to retain their license to operate. It is the task of Fluor's technical and industry specialists to guide Fluor's clients in how to achieve energy efficiency targets in a cost effective way. Hence, the specialists have to be up-to-date with new developments in legislative and technical aspects and share practical experience including information from vendors and technology providers.

The expertise of Fluor regarding energy efficiency
Fluor's experience is primarily the design and construction, with numerous steps in between, of hundreds and hundreds hydrocarbon processing plants including heat transfer and energy recovery, as well as "wasting" energy by air or water cooling. Fluor has people employed who are specialists in the application of design techniques, such as specialized simulation. Moreover, there are specialists in heat transfer, furnace technologies and material selection. These specialists save clients money by providing clever designs and reduce their CO2 emissions and their general emission footprint.

It can be said that all industry service providers are looking for ways to assist the hydrocarbon processing industry in finding solutions for their plants. These solutions must meet the desired sustainability targets and standards, driven by the new Energy Efficiency Directive. Fluor is in-between technical and technology solution providers and clients who need the services of an engineering company, so that they can apply the best techniques available cost effectively.
F. Accompanying letter

Very brief description of master Thesis Leonie de Kleijn:
The Energy Efficiency Directive and the obstacles faced by industries in making the transition

To complete the master program Management of Technology at the University of Technology Delft, a master thesis has to be conducted. TU Delft student Leonie is very interested in what obstacles the industries face regarding energy efficiency measures. Identifying these obstacles is therefore the goal of the thesis. Her research is fully supported by Prof.dr. C.P. van Beers, Dr.ir. R.M. Stikkelman, and Dr. S.T.H. Storm of the TU Delft. The company Fluor provided her with the valuable opportunity to guide her during this research, under supervision of Dr.-ing. C.P. Hälsig.

Currently there is a directive by the European Union (EU) that aims to decrease the negative externalities that cause climate change. This Energy Efficiency Directive (2012/27/EU) aims to increase the share of renewable energy by 20% and to reduce greenhouse gas emissions by 20% no later than 2020. In addition it aims to establish a 20% increase in energy efficiency. The first two goals seem to be on track, but the energy efficiency goal is experiencing some difficulties in the industrial sector. The industry has showed its willingness to become more energy efficient and has already obtained good results. Despite the good effort, the goal set by the Energy Efficiency Directive (EED) is predicted to be unachieved by several EU Member States. Former research by ECN and PBL shows that the Netherlands is also one of the Member States facing obstacles to achieve that goal.

The main research method of the master thesis is having conversations and interviews with all relevant parties in the Dutch industry chain to discover what obstacles these actors face. These conversations are of significant value for this master thesis, because theory and reality are often not the same. The actors in the industry chain are experts in their field and are therefore the best source of reliable information. Consequently, their experiences and insights are the best possible starting point to explain why increased energy efficiency is much more difficult to obtain in reality than that the EED predicts.

Impression of the questions
The interviews are expected to take about 1.5 hours. During this interview several open questions will be asked related to the following topics:
- Information provided to the company by the Dutch government and/or EU;
- Implications of (changing) legislation and regulation;
- Energy Efficiency Management Systems;
- Best available techniques;
- Energy audits;
- Energy efficiency measures inside and outside the company;
- The general process of decision making inside and outside the company.

Please be informed that no quantitative data will be asked. The questions are focused on general opinions and experiences. It is expected that someone with companywide knowledge is best able to answer the questions. Information obtained from the interview is sent back for confirmation purposes.
## G. Code taxonomy

Table 12: Applied code taxonomy based on the article by Cagno et al. (2013).
Solid underlined codes are added to the existing taxonomy, interrupted underlined codes are reformulated to better fit the gathered information.

<table>
<thead>
<tr>
<th>Origin</th>
<th>Area</th>
<th>Code / barrier</th>
<th>Elements/explanation of the code</th>
</tr>
</thead>
<tbody>
<tr>
<td>external</td>
<td>market</td>
<td>Energy price</td>
<td>distortion in the price</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Market demand</td>
<td>EU demand falls / market risk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Business emigration</td>
<td>moving away from EU</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dependency</td>
<td>joint venture, industrial cluster</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Societal value</td>
<td>what society thinks is important</td>
</tr>
<tr>
<td>technology</td>
<td></td>
<td>Applicability</td>
<td>in industrial processes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Availability</td>
<td>on the market</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Communication</td>
<td>industrial chain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measuring</td>
<td>quantitative results energy efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regulation</td>
<td>fiscal / regulatory/ agreements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enforcing</td>
<td>the legislation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moral hazard</td>
<td>industry interprets the law in its favour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asymmetric information</td>
<td>industry knows the most</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diffusion</td>
<td>legislation related information</td>
</tr>
<tr>
<td></td>
<td>economic</td>
<td>Split incentives</td>
<td>getting no credit for achievements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Profits</td>
<td>competitiveness</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>company image</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>growth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>return on investment / payback time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>high score in benchmarking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Costs</td>
<td>access to capital</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>available projects</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>investment (capex)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>operating costs (opex)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>administrative burden</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Risk</td>
<td>ambiguity effect</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>opportunistic behaviour</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>process reliability/ performance</td>
</tr>
<tr>
<td></td>
<td>behaviour</td>
<td>Perception of already efficient</td>
<td>lack of interest, good achievements already</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inertia</td>
<td>resistance to change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Values</td>
<td>motivation, not necessarily action</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other priorities</td>
<td>safety / product / environmental issues</td>
</tr>
<tr>
<td></td>
<td>organizational</td>
<td>Power</td>
<td>decision making</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Culture</td>
<td>norms, value, ideology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complex decision chain</td>
<td>within the company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Available time</td>
<td>time employees have available</td>
</tr>
<tr>
<td></td>
<td>competences</td>
<td>Identifying opportunities</td>
<td>efficiency in plant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Implementing measures</td>
<td>efficiency in plant</td>
</tr>
<tr>
<td></td>
<td>awareness</td>
<td>Ignorance</td>
<td>ignoring possible benefits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EED awareness</td>
<td>knowing existence of EED</td>
</tr>
</tbody>
</table>
Explanation of the code taxonomy

A company faces obstacles both outside the company and inside its own organization, which is labelled by Cagno et al. (2013) as the internal and external origins. Within these origins several areas are identified to which the obstacles to energy efficiency can be attributed. The areas (a) up to and including (c) are external obstacles. The remaining areas are the internal obstacles.

(a) Market
The Market area consists of six obstacles. The energy price is about the uncertainty regarding the future development of the oil, gas and electricity price, due to distortions. Market demand refers to the market risk the companies perceive due to falling demand for their products. Business emigration has been added to the taxonomy of Cagno et al. (2013), because this threat was mentioned by several interviewees. It concerns the threat of global operating companies moving their business to countries where energy and labour is cheap and taxes are low. Dependency is another obstacle that has been added to the original taxonomy, due to the fact that Dutch companies are often clustered and exchange energy and raw materials. The original obstacle 'value', which applied to the environment wherein companies were situated, has been rephrased to societal value, because the awareness of society for energy efficiency has been considered to be an obstacle by several interviewees.

(b) Technology
The area of Technology contains four obstacles. The applicability of a technology refers to the perception of companies that the available technologies are actually not applicable to their processes. Availability refers to lack of available techniques on the market that the industry requires to become more efficient. The obstacle communication has been added as a result of many interviewees complaining about the communication and collaboration in the industry chain regarding the possibilities of energy efficient solutions. The same holds for the obstacle measuring, because some have argued that energy efficiency can barely, if at all, be measured, which would cause an obstacle to efficiency improvement.

(c) Information
The Information area consists of five obstacles. The regulation obstacle refers to fiscal and regulatory policies and includes the covenants as well. The regulation could be perceived to be unclear, ineffective due to a lack of enforcement, too ambitious, or simply not providing enough incentive for operating companies to go for energy efficiency. While conducting the interviews, it appeared that there were two camps about whether or not the legislation should be enforced. The obstacle enforcing has, therefore, been included. The obstacle moral hazard was mentioned in the article, but not as an individual barrier. Due to the importance of that concept for the Principal-Agent model, this obstacle has been introduced as an independent obstacle. The same holds for asymmetric information. The lack of proper diffusion of information is mentioned in the original taxonomy, but in relation to the trustworthiness of the source. This obstacle never came up during the interviews. The diffusion of regulatory information, however, was mentioned all the more. Hence, the obstacle was being reformulated for the purpose of this research.

(d) Economic
Four obstacles have been identified in the area of Economic. Split incentive has been mentioned and explained by the Cagno et al. (2013), but in that case the obstacle applied to
the employees of the company. In this research, however, split incentives relates to the company within the industry chain. It is, as a consequence, seen as an internal obstacle, because the 'individual' (the company) gets no credit for his energy efficiency achievements in the ‘organization’ (the industry chain/ society). The obstacle profits implies that companies are focussed on making profits, which means maintaining image, competitiveness, growth and getting the highest return on investment. This is an obstacle to energy efficiency, because these investments have frequently a lower return on investment and have not much effect on the company’s image and growth (according to the interviewees). Moreover, increasing competitiveness on the short-term often does not coincide with more expensive efficiency investments.

The obstacle Costs refers to the lack of available capital, the global investment area global operating companies have that result in competing projects and higher investments costs. Also, the administrative burden of approving energy efficiency projects means higher costs to the company, which can be a barrier. And when the operating costs are barely affected, this will result in limited motivation to go for energy efficiency.

The Risk obstacle is also an economic one, because it relates to the risk of implementing a new technology, which could have negative consequences for the reliability of the process. If interviewees mentioned that companies prefer proven technologies over new ones, this has been identified as a risk and was linked to the ambiguity effect. And in case companies explained that companies prefer other companies to implement the technology first until it is proven, before they themselves would implement it, this has been identified as opportunistic behaviour. The latter has been related to the obstacle of Risk as well.

(e) Behaviour

Behaviour is an area in which four obstacles are relevant. One is the perception of already efficient. In case the company perceives itself as having obtained good efficiency results in the past this could limit its motivation to improve its efficiency levels further. Another obstacle is inertia. This obstacle reflects the unwillingness of an organization to change its way of doing business. Or, in case the organization must change, it will take a long time due to the existing customs and traditions that have to be changed. A third obstacle in the behaviour area is values. This obstacle is about the motivation the companies have to increase energy efficiency. If this is lacking, it is a barrier. The obstacle other priorities concerns all aspects that are prioritized over that of increasing energy efficiency. This can be product improvement, safety, pollution reduction, etc.

(f) Organizational

The area of the Organization is about the structure and the properties of a company and not about their behaviour, although these areas are related. The obstacle of power refers to the industry chain and the organization that has the power to make a decision. The company that promotes energy efficiency is not necessarily the one that makes the decision. Moreover, even in a global operating company the decision for an investment often lies at higher management, which is not present in the Dutch offices/plants. Hence, a lack of decision making power is an obstacle to energy efficiency. Culture reflects the strategy of a company, what it values in doing business and what intrinsic motivation it has. In case energy efficiency is not part of the culture, i.e. there is no intrinsic motivation, this is an obstacle. The obstacle culture differs from values is that the culture is reflected in energy efficiency policies within the company and actual achievements/investments. Values only reflect recognition that energy efficiency has potential and should therefore not be neglected as an investment possibility.
Also the *complex decision chain* within the company or industry chain can prove to be a barrier, just as the *available time* to look into the energy efficiency possibilities.

**(g) Competences**
The area Competences is about the capabilities of a firm to implement energy efficiency and to identify possible points of improvement. Think of the difficulty of analysing the process for further improvements and the constraints in the factory layout, the scheduling of large maintenance, available manpower on site, logistics, etc. These aspects are reflected in the obstacles of *identifying opportunities* and *implementing measures*.

**(h) Awareness**
The last area of the code taxonomy is about awareness. The obstacle of *ignorance* points to the decision makers in the industry chain that can choose for energy efficiency, know which benefits it could bring, but are nevertheless ignorant to apply it. The last obstacle mentioned in the area of awareness is that of *EED awareness*. It is actually not presented with the purpose to identify it as an obstacle to energy efficiency, but solely to give an indication about which part of the interviewees know about the existence of the EED.
H. Coded interview summaries

This appendix contains the brief summaries of the interviews, which is the result of the code weaving approach advised by Saldaña (2013). The codes are recognizable by their uppercase letters. The sequence of the summaries is outlined in Table 13.

The coded summaries are based upon the data of the confirmed interviews. Nevertheless, these summaries are the result of the code weaving process and cannot be seen as an exact reflection of the words that were spoken during the interview. Furthermore, the interviewees do not necessarily represent the opinion of the company he or she works for.

Each summary concludes with the motivation level of energy efficiency, as obtained by the information given in the interview. Five motivation levels exist, which are the following:

- **Highest**: the company has a culture of energy efficiency and a strong motivation that is reflected in its actions.
- **High**: the company has a motivation for energy efficiency, but its actions do not necessarily reflect it or much improvement possibilities regarding its actions still exist.
- **Medium**: the company is only motivated a little to increase energy efficiency. This level is so low, that it could easily be mistaken for no motivation at all.
- **Low**: the company might say that it is motivated, but energy efficiency has no priority, is not part of the culture and there are no actions present that reflect its motivation.
- **Lowest**: there is no motivation to increase energy efficiency at all, either because the company does not think it is important due to the low impact or because it does not care altogether.

<table>
<thead>
<tr>
<th>1</th>
<th>9</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>8</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

Table 13: Sequence of the companies’ coded interview summaries

[CONFIDENTIAL]
I. Code frequency

Table 14: Industries’ obstacles code frequency.

<table>
<thead>
<tr>
<th>Origin</th>
<th>Area</th>
<th>Code / obstacle</th>
<th>Identified by company (not an operating company)</th>
<th>Identified by operating company</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>external</td>
<td>market</td>
<td>Energy price</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Market demand</td>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Business emigration</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dependency</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Societal value</td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applicability</td>
<td></td>
<td></td>
<td>3/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Availability</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Communication</td>
<td></td>
<td></td>
<td>3/4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measuring</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regulation</td>
<td></td>
<td></td>
<td>2/2/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enforcing</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moral hazard</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asymmetric information</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diffusion</td>
<td></td>
<td></td>
<td>13/7</td>
</tr>
<tr>
<td>internal</td>
<td>economic</td>
<td>Split incentives</td>
<td>[Confidential]</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Profits</td>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Costs</td>
<td></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Risk</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perception of already efficient</td>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inertia</td>
<td></td>
<td></td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Values</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other priorities</td>
<td></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power</td>
<td></td>
<td></td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Culture</td>
<td>[Confidential]</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complex decision chain</td>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Available time</td>
<td></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identifying opportunities</td>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Implementing measures</td>
<td></td>
<td></td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ignorance</td>
<td></td>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>

In case perception differed among interviewees a colour scheme is applied:
- Green: Not perceived to be an obstacle
- Red: Perceived as an obstacle indeed
- Black: Neutral

All companies have a unique number. In case the coded obstacles or phenomena are identified by a company, its number is shown in the relevant row. The operating companies’ opinions are reflected in a separate column. In some occasions the interviewees had contradicting opinions about the obstacles. This is reflected via a colour scheme in the row of the obstacle concerned.
Table 15: Industries' goals code frequency.

<table>
<thead>
<tr>
<th>Origin</th>
<th>Area</th>
<th>Code / goal</th>
<th>Own company (not an operating company) [a measure of motivation]</th>
<th>Identified by operating company</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>external</td>
<td>market</td>
<td>Energy price</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Market demand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Business migration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dependency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>technology</td>
<td></td>
<td>Societal value</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applicability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Availability</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Communication</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measuring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>information</td>
<td></td>
<td>Regulation</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enforcing</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nerual hazard</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asymmetric information</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diffusion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>internal</td>
<td>economic</td>
<td>Split incentives</td>
<td>[Confidential]</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Profits</td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Costs</td>
<td></td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Risk</td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>behaviour</td>
<td></td>
<td>Perception of already efficient</td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inertia</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Values</td>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Risk</td>
<td></td>
<td>14</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other priorities</td>
<td>3</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>organizational</td>
<td></td>
<td>Power</td>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Culture</td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complex decision cha</td>
<td></td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Available time</td>
<td></td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>competences</td>
<td></td>
<td>Identifying opportunities</td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>awareness</td>
<td></td>
<td>Implementing measures</td>
<td>2</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ERD awareness</td>
<td></td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

In case perception differed among interviewees a colour scheme is applied:
- **Green**: Perceived as a goal
- **Red**: Not perceived to be a goal
- **Purple**: To measure ERD awareness among interviewees, not identified as a goal.