Change of owner, change of plans

A METHOD TO COMPARE DIFFERENT OWNERSHIP MODELS OF A SYSTEM, APPLIED TO A STEAM CASE

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Abstract

Large investments in renewable energy lead to new possibilities for industries. Such technologically and economically sound projects can be limited by non-optimal ownership settings. The Risk Ownership Assessment(ROA) is developed to integrate the ownership aspect with the technical system. ROA compares different ownership configurations with risks and provides a support tool for decisions on ownership.. The method can be further developed on usability to increase the chance of the future use by other parties.

Keywords: Ownership, Risk, Method, Institutions, System Thinking, Stedin

1 Introduction

The electricity sector is one of the major contributing sectors to global warming by emittance of greenhouse gasses. The electricity sector responds to this movement by investing more in renewable electricity(Eneco, 2015). The problem with renewable electricity is that it cannot be controlled due to dependency on weather for example. A higher percentage of produced wind energy will have effects on the electricity market. The increased share of renewables has led to bigger fluctuations in the electricity price. Sometimes the price will be very high for certain periods of time, sometimes the price will be very low.

The fluctuating electricity price will bring opportunities for the production and the consumer side of the electricity market. The low electricity price brings opportunities for consumers as they can use this cheap peak electricity for financial gain. The industrial users of cheap peak electricity provide an interesting approach for the use of cheap peak electricity. Larger installations can contribute to the use of cheap peak electricity.

Another option is to use technologies to capture the cheap peak electricity in the current system. The report “Converting excess wind power into power valuable products”(Stikkelman, 2014) discusses what the demands are for such technologies. The literature shows that the technologies are available to capture cheap peak electricity. From the report comes forward that a system which combines an electrical boiler with a gas boiler has a lot of potential.

A problem that does get exposed in the report is that comparable projects seem technical and economical feasible, but fail on other aspects. Several projects such as onshore CO_2

storage and offshore storage have encountered problems through institutional settings (Schrag, 2009; Van Roekel, 2012). Stedin is involved in these kind of projects and expects that ownership plays a big part in this.

Stedin and ownership

The research is conducted for the department of New Business Development(NBD) of Stedin. NBD focusses on new developments in the electricity market. The use of an electrical boiler combined with a gas boiler for the capture of peak electricity is considered in their domain. The goal of NDB is to own and operate the transport in such a system.

The question from NBD is whether their way of conducting business is the best one. The usual approach is that NBD owns and operates the pipelines/cables. There are other ways to design such a system with owners. The goal of the research is to provide insight on the advantages or disadvantages of other configurations. The method used for that is based on comparing different **ownership configurations** with each other.

Problem statement

The previous sections show that the energy landscape is changing. The New Business Development department of Stedin wishes to participate in this change, but does not know if their way of conducting business is the best one. This is why New Business Development wishes to have more insight in the different ways of designing a system with ownership configurations.

This thesis aims to use a scientific approach that contributes to answering the question as asked by NBD at Stedin. For this reason the question is used to define a more general problem statement:

“How can the ownership setting of the steam system affect the success chance/risks related/viability of the overall system?”

2 Research approach

The research focuses on creating a method that can compare different ownership settings with each other. In the literature, research has already been done on creating frameworks on similar problems. There is literature on comparing infrastructures (technical systems) and using risks to measure the performance of these systems.

The research consists of two combined processes. The first process is the problem solving of the case study. The second process is the development of a method. The process of the development happened simultaneously with the method. The method was developed, applied to the case study and then evaluated and changed if it required change. If the technique was changed, the new technique was applied to the case study.

To develop a new method. Literature was consulted on how to structure the method. Three different articles were analysed on how they executed their research on the problems. The first article explained how the CoDAN framework operates and works(Gómez, Sánchez-Silva, & Dueñas-Osorio, 2014). The second article focuses on the use of risk maps (Correa-Henao, Yusta, & Lacal-Arántegui, 2013). The last article is a chapter of the book “Handbook of seismic risk analysis on management of civil infrastructure systems” (Sánchez-Silva & Gómez, 2013) and focuses on the risk assessment on infrastructural projects.

With the risks of infrastructures, different scientific frameworks follow the same line with the use of three steps (Correa-Henao et al., 2013; Gómez et al., 2014; Sánchez-Silva & Gómez, 2013). These three steps can be described as system approach, risk assessment and the supporting of a decision. The steps are called differently in the different literature. In this research they will be called: Designing, assessing and interpreting. The literature also pays different levels of attention to the different steps, but the

different articles all follow the three steps. The table below shows how the different literature interprets the different steps and how different techniques are used.

The three phases can be generalized, each with their importance. The first phase focuses on the system breakdown. This can be done very simple by using an established model of an infrastructure or a system that can be logically broken down. The second phase will consist of a risk analysis in which the risks are identified as well as analysed. The third and last phase will compare the different configurations and conclude the results.

Research question

In the previous sections was shown that there is enough scientific basis for setting up a method to compare ownership configurations in a technical infrastructure setting. The aim of this research is to create a method that is applicable to the problem statement. This leads to the following research question:

How to compare ownership settings of a system, by creating a method?

3 Method design

The research question led to the creation of the Risk Ownership Assesment(ROA). ROA is a tool that compares different ownership configurations of the same technical system. The method is intended as a supporting tool for decision making.

The first phase focusses on the design of the system. The goal of this phase is to create ownership configurations which can be used in the second phase. This is done in three steps. The first step focusses on defining the technical system and creating system boundaries. After the first step, the inputs, outputs, boundaries and function of the system are clear. The second step focusses on the breakdown of the system. The system is broken down into components, which can be owned by only one party. After the system is broken down, the third and last step of the first phases focusses on the creation of ownership configurations.

The second phase focusses on valuing the different ownership configurations. The configurations are assessed to that they can be compared in the last phase. The valuing of the ownership configurations is done through risks. This is done in two steps: The risk identification and risk assessment. In the risk identification, risks are identified at the level of the different components. The risks are coupled to the components, the ownership of the component is taken into account here. The second step focusses on valuing the risks. This is done with use of the ATOM method, where the likelihood and impact determined the risk scores of the risks. After all configurations are assessed, ROA moves on to the last phase.

The third and last phase focusses on the interpretation of the configurations of the previous phase. This phase consists of two steps: the interpretation of each individual ownership configuration and the comparison between the ownership configurations. The first step is the analysis of each ownership configuration individually. The first thing done in this phase is the reduction of amount of risks per component. **Only the three highest scoring risks are used per component**. This step continues by identifying different information form the configurations. The total risk scores, owner risk score, component risk scores and biggest risks are identified and set up for the last step. In the last step the configuration information from the previous step is set next to each other. Conclusions are drawn on the different aspects of the system.

4 Case study: Steam system in the Port of Rotterdam area

The research consists of two combined processes. The first process is the problem solving of the case study. The second process is the development of a method. The process of the development happened simultaneously

with the method. The method was developed, applied to the case study and then evaluated and changed if it required change. If the technique was changed, the new technique was applied to the case study.

The case study is based on a previous report "Converting excess wind power into power valuable products"(Stikkelman, 2014). The report provides an analysis on the use of cheap peak electricity in the port of Rotterdam area. The report concludes with several techniques that can provide to be profitable in the future. One of this techniques is the use of steam in the port of Rotterdam area.

The idea behind the system is that an electrical boiler is build next to an existing gas boiler and steam circuit. The system allows to switch between steam from electricity and steam from natural gas, thus letting the operator to have a financial benefit by choosing the cheapest resource (Stikkelman, 2014. With the fluctuating electricity price explained in chapter 1, this could become a viable case. A steam system would look like the system displayed in figure 3.

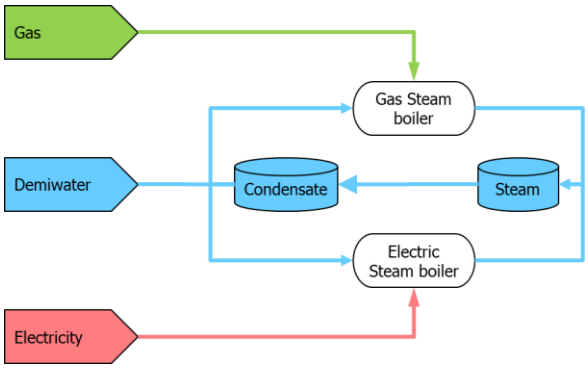

Figure 2: Steam system in port of Rotterdam(Stikkelman, 2014)

The Risk Ownership Assessment is applied on the case study. The case study is ran through the three phases. The first phase provided two configurations. These are shown and described in figure 1 and figure 3. In the second phase, the risks were identified and assessed. Below the configurations are described with the conclusions on these configurations.

Configuration 1

The first configuration is based on the current electricity system. The clients, and suppliers are all different parties. One party is the middleman. This party owns and operates the network. The system operator is responsible for the transportation of the steam and condensate. It also operates the supply and demand of the steam.

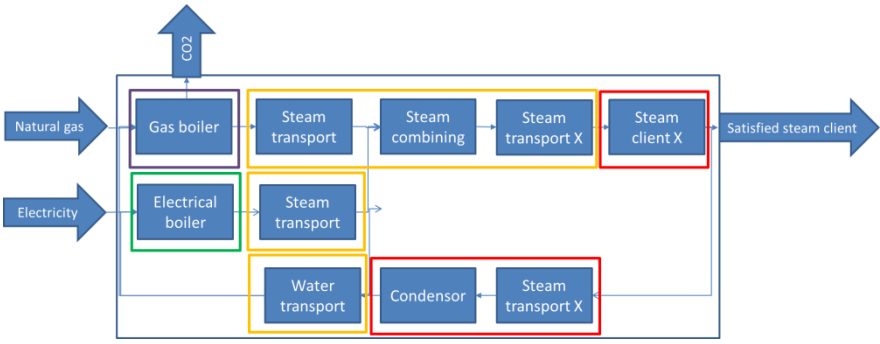

Figure 1: Configuration 1

Configuration 2

The second configuration is that there is already a steam system based on natural gas. This system is owned by 1 party. Another party enters the system with an electrical boiler and will supply cheaper steam whenever the electricity based steam is cheaper than the natural gas based steam.

From this configuration can be concluded that the owner of the gas system carries a relatively low risk and the electrical boiler carries a big risk. This is could to the risk that the big system owner is not dependent on the electrical boiler, but the electrical boiler is dependent on the big system owner. Effects like the CO2 price reduce this effect a bit, but the difference between dependence is a major factor in this configuration.

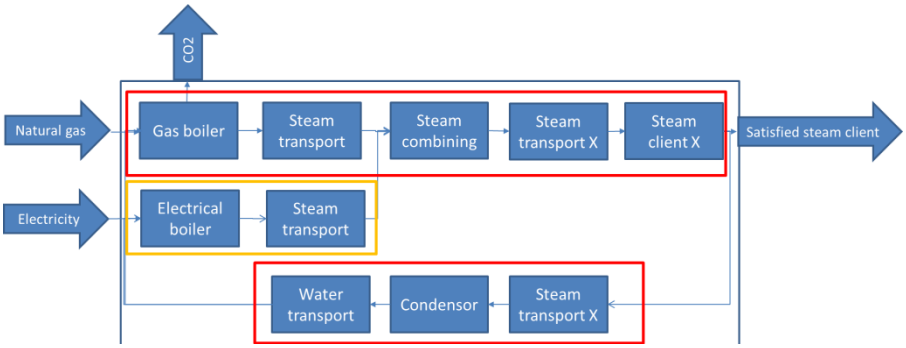

Figure 3:Configuration 2

Comparison

The risks of both configurations do not differ much in total. The difference is in the risks that are carried per owner. In the second configuration, the biggest risks are carried by the biggest party, which can also make the most profit of the system. In the second configuration a relatively high risk is linked to the smaller owner, due to the fact that this small owner could be excluded from the system by the large party in the system.

The information gained from the analysis can be used in the negotiation sessions with other parties. If the ROA is executed internally, Stedin has an advantage in the negotiation sessions with the information and risks available. The alternative is that ROA could be executed with multiple negotiation parties, but more research is necessary for this.

5 Evaluation of ROA

The framework has been evaluated on several aspects. The framework is evaluated on the functionality of the framework as well on the usability. The functionality focuses on the content of the framework. Does the framework what is has to do? The Usability focuses on another goal of ROA. Since the goals is that ROA will be used after this research, the usability focuses on the applicability of ROA on future projects.

Functionality

The power of ROA lies in the same approach for comparing different configurations. Since the analyses are quite qualitative, the results of multiple ROAs should result in the same qualitative results. However, differences could occur in the value of certain risks. These differences in values could provide extra information as decision support.

From a system point of view, the system could be identified differently. From a ROA point of view, it is good that all different possibilities are taken into the analysis. The time lost in the extra components was not that significant. The possibility exists that when these components were not taken into the analysis, the system would miss important information for the decision support.

Usability

The main usability demand for ROA is that the system that is analysed is compatible with ROA. For the breakdown of the technical system, the system needs to consist of components that can be owned by different parties. The requirement is that the technical system needs to be broken down so that multiple ownership configurations can be created, but the technical system still stays the same.

The ROA framework aims to be executable in a reasonable amount of time. The case study is not a reliable benchmark for the execution time, since the case study also led to many improvements of the framework. Another case study should be executed to see if ROA is executable in a reasonable amount of time. Dedicated software could also improve the execution time of ROA. Further research should be done to make this possible.

The aimed users for ROA are experts that know how the system functions. The idea is that these experts come together and share their views on the system. This can be within a company, but also in a negotiation session. With the use of ROA, the goal is reach consensus on a project decision. With a negotiation session, things like contestable

data, opportunistic behaviour and strategic behaviour should be kept in mind.

6 Conclusion and Recommendation

Conclusion

The motivation for this research was to provide a possible solution to the ownership problems that Stedin encounters. Currently, this is a relevant topic because plans for setting up steam systems for cheap peak electricity are made. The goal is to be able to define the most optimal ownership configuration for this sociotechnical system.

Literature has shown that problems in technical systems can often be addressed with a three step-method. In this case, the method should assess the effects of ownership on the system. The method is created and is called the Risk Ownership Assessment.

The first phase of the method focusses on the set up and design of the technical system. The goal of this phase is to create ownership configurations. Techniques that are used are: 'defining the system', 'decomposing the system' and 'applying the ownership configurations'.

The second phase of the method focusses on valuing the different ownership configurations. The configurations are assessed through risks so that they can be compared in the last phase. Techniques that are used are: 'risk identification' and 'risk assessment'.

The third phase focusses on the interpretation of the configurations of the previous phase. This phase consists of two techniques: "the interpretation of each individual ownership configuration" and "the comparison between the ownership configurations".

During the research, the ROA method was improved and validated with a case study at Stedin. The case study focused on a coupling of a gas boiler and an electrical boiler in a steam system in the Port of Rotterdam area. Two ownership configurations resulting from the method's first phase were compared. The first configuration focusses on a split up system, where the electrical boiler, gas boiler, pipeline system and the clients were all different parties. The second configuration focusses on a large dominating party, where a party with an electrical boiler wishes to join the system.

The case study showed that the method was able to assess effects of different ownership configurations and provide qualitative data on the matter. As it turned out, the natural gas boiler carries a bigger risk than the electrical boiler, since the CO_2 price is uncertain in the future. The distribution system carries a relatively large risk. It implicates that this should lead to more revenues for the distribution. A system with a large dominating party is not beneficial for the less dominating parties. However, the whole system does not carry much more risk than with the other configuration.

The case study provided the first level of evaluation. In the case study, practical improvements were made. Many of the developed techniques were clear on paper, but showed some practical problems with the execution.

ROA was evaluated on four points: degrees of freedom, ownership, speed and users. From the evaluation comes forward that the method fulfils its demands, but at this time it can only be executed by experts. This can also cause issues in negotiations. Since ROA is executed by experts. ROA is vulnerable for both strategic behaviour as well as opportunistic behaviour. Also, the method will be more time consuming when the amount of configurations increases. These points should be taken into account when defining improvements for the usability of the method

Recommendations:

The recommendations on this research focus on the possibilities of the method. With an improvement of the method, the trade-off between the comfort of the method and the depth needs to be kept in mind. Since simply asking for more depth in ROA will not do much good for the comfort/speed. There are some possibilities that have smaller trade-off effects and could be used for further research.

The first recommendation is that the Risk Ownership Assessment could be aimed to be executed by a bigger audience. At this time, the Risk Ownership Assessment can only be executed by experts that have knowledge and insight about the analysed system, and the risks that come with it. Further research could possibly adapt the Risk Ownership Assessment to be applicable to a broader audience.

The second recommendation is directly linked to the first one. Since expert are the only executors of the Risk Ownership Assessment at this time, the Risk Ownership Assessment could be used as a consultancy tool. The method could increase the effectiveness of consultants, since the method provides new insights and does not take that long to execute.

The penultimate recommendation is that the method is not yet executed optimally. A dedicated interface could increase the speed if the method drastically, without comprising in the depth of the method. The development of such software costs time and money. The development of an interface did not fall into the scope of this research.

Correa-Henao, G. J., Yusta, J. M., & Lacal-Arántegui, R. (2013). Using interconnected risk maps to assess the threats faced by electricity infrastructures. *International Journal of Critical Infrastructure Protection, 6*(3–4), 197-216. doi: http://dx.doi.org/10.1016/j.ijcip.2013.10.002

Eneco. (2015). Windpark houten.

Gómez, C., Sánchez-Silva, M., & Dueñas-Osorio, L. (2014). An applied complex systems framework for risk-based decision-making in infrastructure engineering. *Structural Safety, 50*(0), 66-77. doi: http://dx.doi.org/10.1016/j.strusafe.2014.03.011

Sánchez-Silva, M., & Gómez, C. (2013). 17 - Risk assessment and management of civil infrastructure networks: a systems approach. In S. Tesfamariam & K. Goda (Eds.), *Handbook of Seismic Risk Analysis and Management of Civil Infrastructure Systems* (pp. 437-464): Woodhead Publishing.

Schrag, D. P. (2009). Storage of carbon dioxide in offshore sediments. *Science, 325*(5948), 1658-1659.

Stikkelman, R., Knop, H, Hemmes, K, Fijn van Draat, S, Lauwen, D, Ros, M, Hooidonk, H, Vrijenhouf, H, Patil, A, Konings, G, van Klaveren-Pleumeekers, hurenkamp, J, . (2014). Converting excess wind power into valuable products, Greening the Port of Rotterdam by “transhipment” of wind.

Van Roekel, A. (2012). CO2 in bodem of lucht hangt af van prijskaartje. *Kennislink.nl*.