Norwegian University
of Life Sciences

Master's Thesis 2016 30 ECTS
Departement of Mathematical Sciences and Technology

Methods for Measuring the Value of R&D projects in Nordic TSOs

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Acknowledgements

This thesis marks the end of six and a half years of study at the Norwegian University of Life Sciences towards a Master's degree in Environmental Physics and Renewable energy.

My interests for technology and renewable energy made me contact Statnett, which resulted in this thesis. The collaboration with Statnett and Fingrid have been exiting, as my supervisors have given me insight into their work with projects as R&D managers.

Special thanks to my main supervisor, Sonja Berlijn at Statnett and my supervisor Jussi Matilainen at Fingrid for giving me the opportunity, and supervision needed to do this thesis. They have shown great interest in my work, and given me inspiration to create the framework provided in the thesis.
To all the others who have been engaged in my work, thank you!

I would also like to thank Håkon Moldestad for helping me understand principles of economics and Silje Amundsen for being there when the frustrations got too big.

Lastly I would like to thank my parents, Geirid and Olav, for always believing in me, my fellow students and my brothers in Broderskapet Unity for making my stay at NMBU an enjoyable experience.

Ås, 13th of December 2016

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Espen Vinsand

Abstract

For R&D managers in TSOs there is a need for an objective method as part of the innovation process, that aid in assessment of project proposals, and evaluates ongoing and finalized projects. As innovation is the key to growth of output and productivity, Statnett and Fingrid initiated this thesis with a goal to find an objective method to select the correct project proposals.

As of today, the selection process is done by the R&D managers themselves, which increases their work load, as the TSOs receives more than 100 project proposals every year. Selection of projects to implement requires the knowledge and experience of R&D managers to be completed successfully. To lessen their workload there is a need for a simple objective method that captures vital elements of project proposals, so less experienced personnel can aid the managers in the selection process.

The literature study conducted was two parted. Firstly, a literature review was performed to inventory existing of project proposal assessment methods. This study showed that there exists little research on the subject. A new literature study was initiated, to find the means of measurement necessary to design a simple and objective method for assessment of project proposals. This literature study searched for literature about portfolio management, decision making methods, success factors of start-ups, cost benefit analysis, project management and earned value management.

The literature study lead to a hypothesis for a method that could capture the essential areas in project selection. Through interviews and meetings with R&D directors in Statnett and Fingrid, this method was developed to the method shown in this thesis.

The method created consists of two parts; innovation assessment and ability assessment. For the innovation assessment two score are used, the innovation potential and opportunity potential. Innovation potential quantifies the aspects of innovation of the project, while opportunity potential quantifies the economic aspects of the project. This allows for projects to be placed in a matrix, and allows the user to see the projects performance.

The second part of the method is ability assessment. This part covers the formal go or no go factors of a project. The go or no go factors of a project is graded on a color scale based on an indicators performance. If an indicator is given red as a score, a project should not be undertaken. This is to give the user warning lights, so that if a project scores great on innovation potential but lacks means of commercialization or involvement of end-users it should advise against implementing the project.

This method for project assessment can also be used for evaluation of ongoing and finalized projects, the indicators needed to conduct these assessments are proposed in this thesis, but require further work before being implemented.

The method created has been tested on two project proposals, and has yielded the same results as when the projects were assessed by R&D managers. The conclusion made is that is possible to create a simple and efficient method to select project proposals.

Sammendrag

FoU-direktører i TSOer har behov for en objektiv metode i innovasjonsprosessen som hjelper til med vurdering av prosjektforslag, og evaluerer pågående og ferdigstilte prosjekter. Siden innovasjon er nøkkelen til vekst av produksjon og produktivitet har Statnett og Fingrid startet denne masteroppgaven med mål om å finne en objektiv metode til å velge de beste prosjektforslagene.

I dag blir utvelgelsesprosessen gjort av FoU-direktørene, noe som øker deres arbeidsbelastning da TSOene mottar over 100 prosjektforslag hvert år. Utvelgelsen av prosjekter til implementering krever FoU-direktørenes kunnskap og ekspertise for å bli gjennomført korrekt. For å lette deres arbeidsbelastning er det behov for en enkel objektiv metode som fanger vitale elementer i prosjektforslag, slik at ansatte med mindre erfaring kan hjelpe til i prosessen.

Den gjennomførte litteraturstudien var todelt. Den første delen bestod av en studie for å finne ut hva som finnes av prosjektutvelgelses metoder. Denne studien viste at det finnes lite forskning innenfor feltet. Den andre ble gjennomført for å finne måleindikatorer nødvendig for å lage en enkel, objektiv metode for evaluering av prosjektforslag. I denne studien ble det undersøkt litteratur innenfor porteføljestyring, beslutnings-teorier, suksess kriterier for oppstarts bedrifter, kost-nytte analyse, prosjekt ledelse og EVA styring.

Litteraturstudien ledet frem en hypotese for en metode som kunne fange essensielle faktorer i prosjektforslag. Gjennom intervjuer og møter med FoU-direktørene i Statnett og Fingrid, har denne metoden utviklet seg til metoden vist i oppgaven.

Den utviklede metoden er todelt; innovation assessment og ability assessment. For innovation assessment blir indikatorer gitt en poengsum basert på innovasjons potensiale og mulighets potensiale. Innovasjon potensiale kvantifiserer innovasjonsaspekter ved et prosjekt, mens mulighets potensiale kvantifiserer de økonomiske aspektene. På denne måten kan prosjekter bli plassert i en matrise som som gjør det mulig å se et prosjekts ytelse.
Den andre delen av metoden kalles ability assessment. Denne delen tar for seg formelle kjør eller ikke kjør faktorer ved et prosjekt. Disse faktorene blir gitt en fargekarakter med grunnlag i deres ytelse. Dersom en av faktorene får karakteren rød skal ikke prosjektet initieres. Dette er for å gi varsellamper slik at dersom et prosjekt scorer høyt på innovasjonspotensiale, men mangler planer for kommersialisering eller deltakende slutt-brukere, skal dette tale imot igangsettelse av prosjektet.

Metoden for prosjektvurdering kan også benyttes for å evaluere pågående og ferdigstilte prosjekter. Oppgaven foreslår indikatorer for disse vurderingene, men de trenger mer arbeid før de blir implementert.

Den opprettede metoden har blitt testet på to prosjektforslag, og har gitt liknende resultater som når metodene ble vurdert av FoU-direktører. Konklusjonen er at det er mulig a lage en simpel og effektiv metode for å velge prosjekter

Table of Contents

Abbreviations

Acronym	Definition
ACWP	Actual Cost of Work Performed
AWM	Aerial Warning Markers
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
CBA	Cost Benefit Analysis
CPI	Cost Performance Index
CV	Cost Variance
DSO	Distribution System Operator
HSE	Health, Safety and Environment
KPI	Key Performance Indicator
MCDA	Multi Criteria Decision Analysis
NMBU	Norwegian University of Life Sciences
NTNU	Norwegian University of Science and Technology
NVH	Norwegian Veterinary Institute
OWGS	Obstacle Warning GPS system
R&D	Research and Development
ROI	Return on Investment
SPI	Schedule Performance Index
SV	Schedule Variance
SWOT	Strengths, Weaknesses, Opportunities and Threats
TRL	Technology Readiness Level
TSO	Transmission System Operator

1 Introduction

1.1 Background

As innovation is the key to growth of output and productivity[1] many companies conduct research and development (R&D) to find new products, methods, technology or services that will provide market advantage. But not all companies are conducting R&D to gain market advantage. For some companies R&D consist of improving their means of delivering a service.

For transmission system operators (TSOs), the service is to operate the main power grid[2]. To improve their performance and lessen their environmental impact, R&D is conducted. In Norway and Finland, the TSOs are Statnett and Fingrid, these enterprises are state owned, and their R&D is focused on what is best for their customers and societies, this is well established in their objectives and missions[3, 4].

As Statnett strives to meet their main objective, "… *To build the next generation main grid to secure a stable supply of electricity, promote value creation and pave the way for better climate solutions*"[2], they have divided their R&D department into three focus areas. Each of these focus areas has their own goals they follow to get closer to reaching the main objective. Whereas Statnett's R&D programs are; sustainable grid development, innovative technology and smart grid[5].

Fingrid has a similar mission, "*We work for the benefit of our customers and Finnish societies: We transmit electricity reliably, We promote the electricity market actively, We develop the transmission system with a long time span."* [4]

For Statnett and Fingrid to have successful R&D departments it is imperative that their innovation process is used to gain strategic advantage. Searching for innovation possibilities and ensure projects with the best potential to success are chosen for implementation, see figure 1.

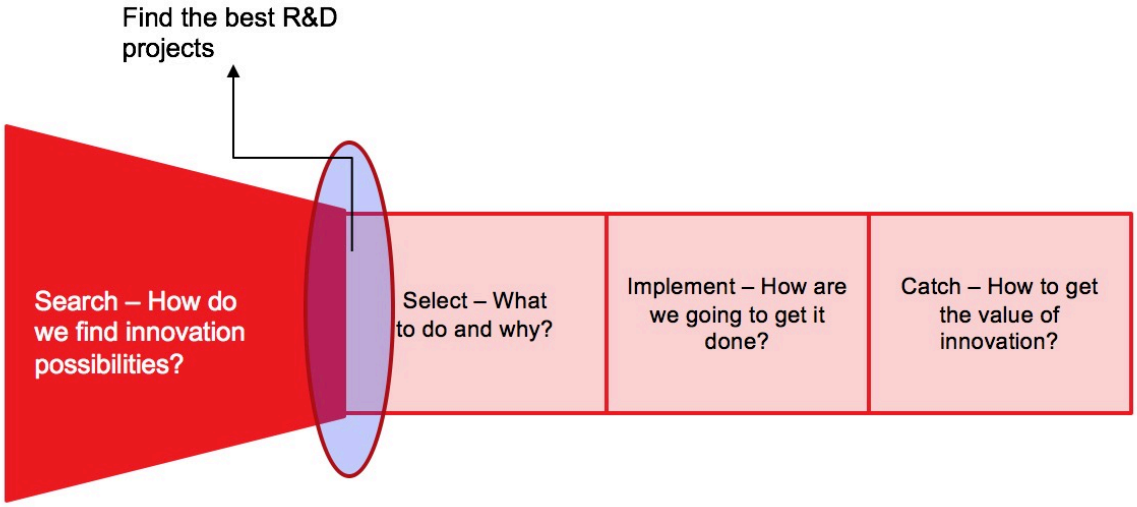

Figure 1: General model for innovation provided by Statnett, translated by Espen Vinsand

As of today, it is the R&D managers themselves who do the selection, because the selection requires knowledge and experience only they have. This has been proven to be a time-consuming activity as the companies must assess more than 100 project proposals each year. Therefore, Statnett and Fingrid initiated this thesis to look for

objective methods that can allow personnel with less experience aid with the selection process, and thus empower their employees.

Therefore, a literature study has been conducted to identify such a method. The literature in this field was inconclusive in finding a method as wanted by the R&D managers of Statnett and Fingrid. The methods found are complex, with a high grade of statistics and mathematics to estimate the potential of success [6-9] . Another finding is that there is little public information to how successful R&D companies perform their project selection[10] . This concluded that there is a need for a simple and efficient method to select the projects that have the biggest potential to be successful.

The method developed should also be applicable for evaluation of ongoing and finalized projects, as this will give R&D managers better insight into their R&D portfolios, and provide a full overview of all R&D projects. Therefore, indicators are proposed for these stages of a project, but the focus is on assessment of project proposals.

1.2 Research questions

The main research question asked to find assessment systems for R&D projects are established by the mission and objectives of Statnett and Fingrid:

How to ensure R&D efforts of TSOs contribute to reaching the company main strategy?

To create the best possible method for project assessment the main research question is followed by three sub-questions:

1. *How to ensure the best R&D projects are selected for implementation?*
2. *What are the criteria of successful R&D projects?*
3. *How to ensure R&D outcomes will be as expected?*

1.3 Research Methods

This literature study focused on finding methods for portfolio management, decision making, success factors of start-ups, cost benefit analysis, project management and earned value management. The databases used to gather information were; Elsevier, ProQuest, Harvard Library, Research Gate and International Society for Professional Innovation Management, alongside extensive searching in google scholar and textbooks.

The literature study provided the knowledge necessary to establish a hypothetic assessment method. Through interviews and discussion with R&D directors lead by the author the hypothetic assessment method was developed.

The method was developed through brainstorming with R&D directors of Statnett and Fingrid, this was important to find the necessary indicators needed to cover the most important elements of a project.

At the final stage, the method was tested on actual projects, and allowed more indicators to be found. Figure 2 shows the research process in this thesis.

Figure 2: The research process used in the thesis.

1.4 Definitions

Research and development:

There is a need to differentiate between R&D activities, and non-R&D activities. According to the Oslo manual [11] the basic criteria that distinguishes R&D from non-R&D activities is “the presence in R&D of an appreciable element of novelty and the resolution of scientific and/or technological uncertainty” or “result in new knowledge or use of knowledge to devise new applications”. This implies that a particular project may be R&D if undertaken for one reason, but not if carried out for another [11]. R&D activities can further be divided in two categories, business intelligence and analytics intelligence explained below.

Business intelligence[12]:

R&D activities that classify as business intelligence are projects that create new business (e.g. mobile phones) or new methods for doing the business in (e.g. Uber, e - mail). They comprise usually large steps in innovation. Projects classified as business intelligence are very uncertain, but can potentially produce a big return on investment (ROI). These projects favor big steps in technology readiness levels (TRLs), research on the ‘’edge of science’’ and are low in chance of success.

Analytics intelligence [12]:

R&D activities that classify as analytics intelligence are projects that improve the way the current business is performed (e.g. office word vs typewriter). They are typically smaller steps in innovation. Projects in this classification favor small increments in TRL, but are safe projects that generates income as they have a high chance of success.

Consortium:

The consortium is “a group of two or more individuals, companies or governments that work together toward achieving a chosen objective” [13].

2 Literature review

2.1 Portfolio management

An important part of R&D management is choosing projects that fit the department's R&D portfolio. The chosen projects must fill the gaps missing in the portfolio to restore balance. Project portfolio management is defined by Harvey A. Levine in his book Project Portfolio Management as follows [14]:

> *"Project Portfolio Management is a set of business practices that brings the world of projects into tight integration with other business operations. It brings projects into harmony with the strategies, resources and executive oversight of the enterprise and provides the structure and process for project portfolio governance."*

This implies that a company should strive for finding the optimal mix of projects that meets their vital overall strategic goals [15].

Matheson states [16] that most R&D organizations spend 5 – 15 percent of their budget on early stage discovery research. This is research on the edge of science that leads to new discoveries, but is also research with a high amount of uncertainty. Research conducted at this level supports high-level business and technology strategy decisions, and develops technology and capabilities that will create new project opportunities to support existing business [16].

The remaining 95 – 85 percent of the budget is directed towards projects with identifiable paths to commercialization and value creation. These projects range from long term to short term and are different in uncertainty; some are easily achievable, and some are less likely to be achieved [16]. In order to have a full perspective an analysis framework is needed, which Matheson proposes in his Project Portfolio Matrix shown in figure 3 [16]:

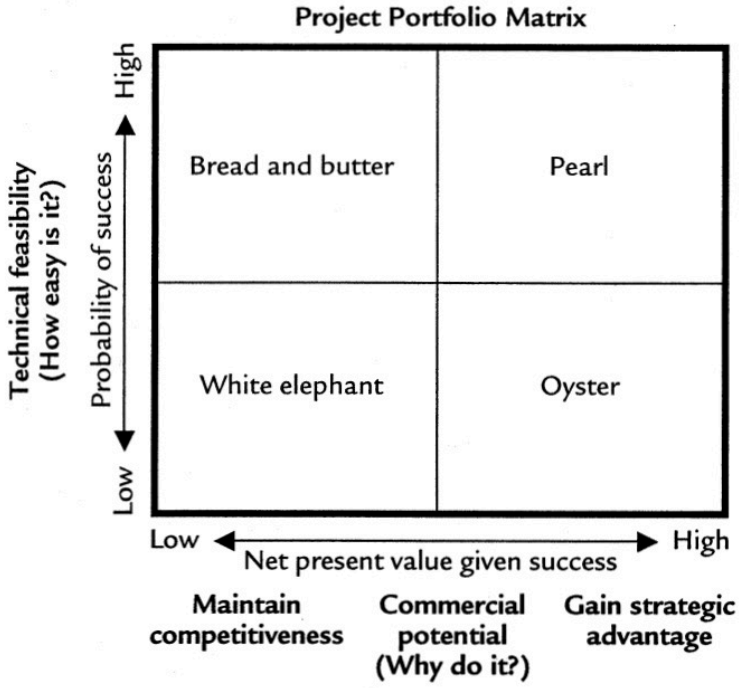

Figure 3: Matheson's R&D grid: Project Portfolio Matrix [16]. Projects are placed in the matrix according to their fit into the categories: Bread and butter, Pearl, Oyster and White elephant.

In his matrix projects are divided into four categories depending on their technical feasibility and net present value given success. The four categories are described according to Matheson's book "The Smart Organization Creating value through strategic R&D" [16] below.

Bread and butter: This category represents projects with high probability of success and good commercial value. These projects usually focus on evolutionary improvement to current products and processes in existing business areas. Projects in this quadrant fulfill the need to produce regular results for existing business units and to support short-term profit objectives.

Pearls: Projects with the greatest potential for both commercial and technical success. These projects address revolutionary commercial applications, and they deal with proven technical advantage. Each project in this quadrant is poised to produce long-term competitive advantage.

Oysters: Projects classified as oysters are early stage, and designed to produce new strategic advantage. They have block-buster potential but breakthroughs are needed to unlock this potential. Projects in this quadrant address high potential payoff, but the probability of success is initially low. The majority these projects are expected to fail.

White elephant: In this quadrant are the projects that consume resources, displace more promising projects, and are unlikely to enjoy technical success or growth in commercial value. These are bread-and-butter or oyster projects that have failed.

This approach is backed by Mikkola [17] in a study done in 2000, which presents a similar matrix and categories of projects.

Matheson makes a good prerequisite into creating a R&D project evaluation framework. Chapter 2.2 addresses methods that can be used to acquire measurements that allows projects to be placed in a portfolio matrix. The methods found are given an explanation to how they will be used in the method created.

2.2 Methods addressed to find indicators

This chapter will review the literature that covers methods that can be used for project evaluation. Firstly, two decision making methods are reviewed. Then methods related directly to indicators are reviewed. Lastly, economic analyses are reviewed.

2.2.1 Multi criteria decision analysis

Multi criteria decision analysis (MCDA) is a method used by decision makers to compare different paths to a goal [18]. This approach is an operational evaluation and is suitable for addressing complex problems with high uncertainty, conflicting objectives and different data information [19]. E.g. it is a strategy where a scale is defined, and all the different objectives are measured on the same scale.

There are numerous ways to perform MCDA, Belton and Stewart suggests a classification of MCDA as follows [20]:

1. Value measurement models: Numerical scores are constructed to represent to what degree one option is preferred against another.
2. Goal, aspiration or reference level models: Desirable or satisfactory levels of achievement is established for each of the criteria.
3. Outranking models: Alternate courses of action are compared pairwise, initially in terms of each criterion, to identify the extent to which a preference over another is asserted.

Classification 1, value measurement models is the method of approach in this thesis, as it allows for comparing projects based on the same criteria. Value measurement models yields a comparison matrix that compares different paths towards the same goal. This method requires that a 0-alternatives is stated, the 0-alternative is usually what will happen if no change is applied to the current project. The other paths will reach the goal, but the paths will yield different results [18, 21]. In the literature, the data or measured criteria is weighted so the weights sum up to 100 %.

A model example is taken from research conducted by Jordanger et al at NTNU Norwegian University of Science and Technology) [18]. Their report provides an example from the localization of the Norwegian Veterinary Institute (NVH). The report states the alternatives:

- Alternative 0: Current situation
- Alternative 0b: Limited upgrading and co-organization with UiO (University of Oslo)
- Alternative 1: NVH is located at Adamstuen and co-organized with UiO
- Alternative 1b: Localization at Adamstuen and NVH remains independent
- Alternative 2: NVH is localized in Ås, and co-organized with NMBU (Norwegian University of Life Sciences)

The alternatives are then evaluated on different demands, so that some alternatives can be rejected. The alternatives succeeding are then given scores based on different consequence aspects, such as sustainability, ethics and innovation by stakeholders.

Multi decision criteria analysis is a mixture of quantitative and qualitative measures, where the qualitative measures require that the decision maker is trained in addressing such measures [18, 22]. Addressing this methodology is important when assessing project proposals as well as evaluating ongoing and finalized projects as it states the need to find similar data for all projects.

2.2.2 SWOT analysis

A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis is a tool made for analyzing internal and external environments in order to attain a systematic approach and solution for a decision situation [23]. The process involves making a matrix that lists all strengths, weaknesses, opportunities and threats related to a project, and as with MCDA the inputs should be weighed according to their importance [24].

Weaknesses and strengths are internal factors are factors which are controllable [25]. By controllable it is understood that they can be acted upon e.g. staff turnover. Threats and opportunities are uncontrollable external factors that cannot be acted upon. As Chermack and Kasshanna [25] cites Thompson [26]:

> "Strengths are 'those elements of success such as a strong competitive position' (p. 57), weaknesses are 'those elements which prevent the organization from achieving that competitive advantage' (p. 57), while opportunities are 'maximized to fit the organization's values and resources' (p. 58) and threats are the 'factors that the organization is not well equipped to deal with' (p. 58)."

A SWOT analysis is useful when assessing project proposals, because it forces the decision maker and the project proposer to reflect over the positive and negative sides of the project.

Figure 4: SWOT analysis diagram. The matrix shows the four categories; Strength, Weaknesses, Opportunities and Threats, and their relation to external or internal origin. Photo by Xhienne via Wikipedia Commons.

2.2.3 Lessons from investors

Innovation is the key to growth of output and productivity [1]. Therefore, it is important to have indicators that measure how innovative a company is. There are different ways a company can be innovative; this thesis will only look into those concerning R&D activities as defined above.

There are numerous ways to measure innovation, e.g. patent counts and citations [27], but as many state, these are not the best metrics for measuring innovation [28, 29]. Patent counts as well as citations does not give accurate information about how well a company is performing, as the value of each patent may vary [30]. Figure 5 [31] shows where the results of R&D are received and implemented. To find the innovation measurements that provide useful information about projects, information about input and output inside the R&D organization must be addressed.

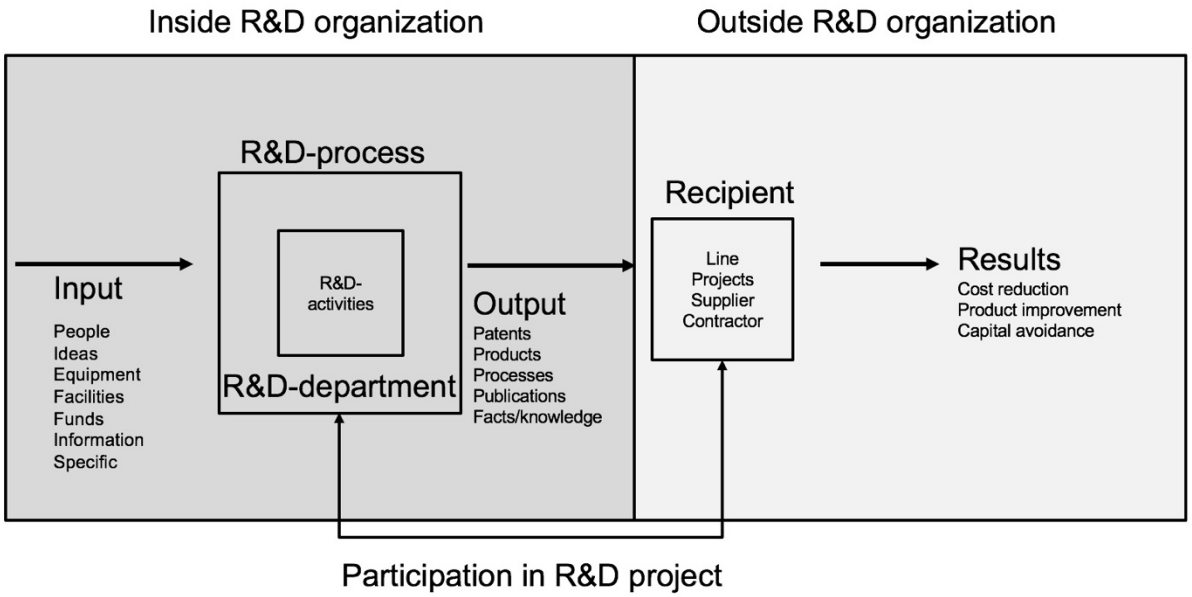

Figure 5: The R&D process. Measuring of innovation in R&D departments must be measured inside the organization as suggested by Brown & Svenson [31]. Figure provided by Statnett and translated by Espen Vinsand

When assessing a project proposal, an insight into what investors look at when selecting startups to fund can give set of metrics that makes a basis for assessment. This is not an easy task, as when selecting a project proposal, as well as selecting a startup to fund, many managers and investors has a certain gut feeling which influence a decision. The problem of attempting to measure this gut feeling is to interpret the feeling as qualitative data [32]. It is important to state that this gut feeling is present as a result of experience. Thus, such a selection must be done by a person trained in such selections. There are many indicators from innovation that suits this thesis' approach, table 1 shows the most common and versatile.

Table 1: Indicators from Innovation, own compilation based on indicators found in the literature and through personal communication. The source of each indicator is shown the table.

Indicator	Comment
Goodness of idea [33]	Is the idea good? Does it have a potential to improve performance?
Utilization [33]	Is someone willing to pay ‘’full price’’ for the project?
Expansion [33]	Is it possible to make money on it?
Distinctiveness [32]	Clear detailed and explicit distinction with the existing solutions
Craziness [32]	Crazy idea that sound impossible, but with obstacles fully described and at least a plan / ideas to overcome them
Funding [32]	Number of funds already raised
Company’s strategy [34]	How well does it correlate with company’s strategy?
Founders field of expertise [32]	Are the founders capable of producing the proposed idea?

The indicators found above makes a good basis to create indicators specifically relevant to R&D projects. These indicators can be associated with both net present value given success and technical feasibility.

2.2.4 KPIs in the eyes of the project manager

A key performance indicator (KPI) is according to Eckerson, a measure of how well the organization or individual performs an operational, tactical, or strategic activity that is critical for the current and future success of the organization [35]. Kerzner defines this as high-level snapshots of how a project is progressing towards predefined targets, as this is more suitable for projects [36].

To find the key performance indicators (KPIs) that are relevant, there is a need to look at what defines a project manager. A Guide to the Project Management Body of Knowledge proposes as follows [37]:

> *"Project management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project. Meeting or exceeding stakeholder needs and expectations invariably involves balancing competing demands among:*
>
> - *Scope, time, cost, and quality.*
> - *Stakeholders with differing needs and expectations.*
> - *Identified requirements (needs) and unidentified requirements (expectations).*

The definition above, along with a short perspective view can be summed down to The Iron Triangle of project management [38, 39]:

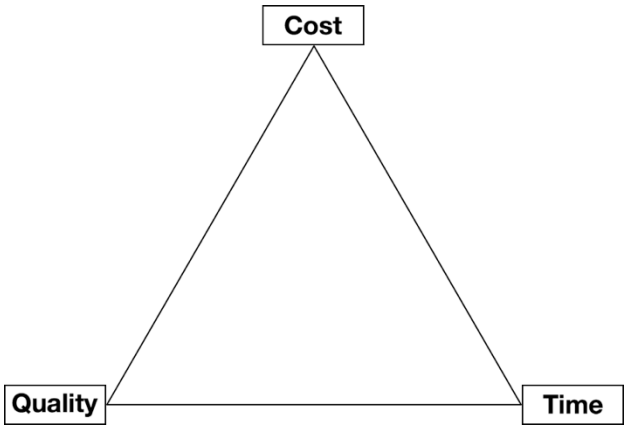

Figure 6: The Iron Triangle of Project Management.
Figure made by Espen Vinsand.

Figure 3 suggests that a project needs to be evaluated according to cost, time and quality. Thus, there is a need to find the KPIs that evaluates these in the literature, but this raises another question, what defines a good KPI? Eckerson proposes twelve characteristics of effective KPIs shown in figure 4 [40].

SPOTLIGHT 11.2 TWELVE CHARACTERISTICS OF EFFECTIVE KPIS

1. **Aligned.** KPIs are always aligned with corporate strategy and objectives.
2. **Owned.** Every KPI is "owned" by an individual or group on the business side who is accountable for its outcome.
3. **Predictive.** KPIs measure drivers of business value. Thus, they are "leading" indicators of performance desired by the organization.
4. **Actionable.** KPIs are populated with timely, actionable data so users can intervene to improve performance before it is too late.
5. **Few in number.** KPIs should focus users on a few high-value tasks, not scatter their attention and energy on too many things.
6. **Easy to understand.** KPIs should be straightforward and easy to understand, not based on complex indexes that users do not know how to influence directly.
7. **Balanced and linked.** KPIs should balance and reinforce each other, not undermine each other and suboptimize processes.
8. **Trigger changes.** The act of measuring a KPI should trigger a chain reaction of positive changes in the organization, especially when it is monitored by the CEO.
9. **Standardized.** KPIs are based on standard definitions, rules, and calculations so they can be integrated across dashboards throughout the organization.
10. **Context driven.** KPIs put performance in context by applying targets and thresholds to performance so users can gauge their progress over time.
11. **Reinforced with incentives.** Organizations can magnify the impact of KPIs by attaching compensation or incentives to them. However, they should do this cautiously, applying incentives only to well-understood and stable KPIs.
12. **Relevant.** KPIs gradually lose their impact over time, so they must be periodically reviewed and refreshed.

Figure 7: Eckerson's twelve characteristics of effective KPIs as presented in his book Performance Dashboards: Measuring, Monitoring and Managing Your Business [40].

This requires that there are few KPIs used to measure projects, but the measurements provided must be relevant and applicable to every project. Even though it is stated that KPIs must change in time, the goal for this thesis is to create a measurement system that is applicable to a wide range of projects. The definition of project manager and the characteristics give a reliable basis to find the measurements needed.

Cost analysis is given by Earned Value Management, explained in the next chapter. Time on the other hand is easier to provide a metric for. Simply asking the question "Are we meeting project milestones on time?", assesses the time aspect. To get a complete oversight of a project, quality and other aspects must be taken into consideration.

To give an example of how KPIs can be formulated, table 2 presents a set of KPIs and evaluation approach as they are presented in the literature study by Luu, Kim and Huynh [41]. Note that these KPIs are intended for large contractors, not the R&D perspective, but it illustrates how KPI measurements can be done.

Table 2: Major KPIs with evaluation approach for large contractors as presented by Luu, Kim and Huynh [41]

Code	KPIs	Evaluation approach
KPI-1	Construction cost Performance	The percentage of construction cost variance = $\frac{actual\ construction\ cost - estimated\ constructon\ cost}{estimated\ construction\ cost} x\ 100$
KPI-2	Construction time performance	The percentage of construction time variance = $\frac{discounted\ construction\ time}{revised\ construction\ time}\ x\ 100$ where, revised construction time = actual construction time – revised construction duration, revised construction time = original construction duration + the extension of time
KPI-3	Customer satisfaction on services	The degree of customer satisfaction on the contractor's construction services is measured by a 10-point Likert-type mark (from 1 = "extremely dissatisfied" to 10 = "extremely satisfied")
KPI-4	Customer satisfaction on products	The degree of customer satisfaction on the contractor's construction products is measured by a 10-point Likert-type mark (from 1 = "extremely dissatisfied" to 10 = "extremely satisfied")
KPI-5	Quality management system (QMS)	The degree of QMS performance is measured by a five-point Likert-type mark (from 1 = "very bad performance" to 5 = "very good performance")
KPI-6	The project team performance	The project team performance at the project level is measure by a five-point Likert-type mark (from 1 = "very bad performance" to 5 = "very good performance")
KPI-7	Change management	The change management performance at the project level is measure by a five-point Likert-type mark (from 1 = "very bad

		performance” to 5 = “very good performance”)
KPI-8	Material Management	The material management performance at sites is measured by a five-point Likert-type mark (from 1 = “very bad performance” to 5 = “very good performance”)
KPI-9	Labor safety management	The labor safety performance at the project level is measured by a five-point Likert-type mark (from 1 = “very bad performance” to 5 = “Very good performance”)

Table 2 shows coherence with the Iron triangle of project management in figure 3. KPI-1 is in relation to cost, KPI-2 is in relation to time and, KPI-3 to KPI-9 are related to quality of the project. It is also important to state that the perspective in this thesis is in relation to a program manager, not project manager, but to fully understand how to measure projects, an insight into project management is important.

2.2.5 Quality

As set by the triple constraint in figure 3, quality is an important part of evaluating projects. Quality itself may refer to several aspects, in the book Project Quality Management by Kenneth H. Rose it is explained as "*the ability of a set of inherent characteristics of a product, system, or process to fulfill requirements of customers and other interested parties*" [42]. This definition can be interpreted into project quality as the inherent characteristics of a project that fulfill the requirements of interested parties. Hereby the interested party is the enterprise and stakeholders conducting the project.

Amongst the KPIs presented in table 4, the two first are related to cost and time, whereas the rest are measures of quality. These measures need to be adapted to be applicable for an R&D project related approach. To better understand what measures are needed, Statnett has provided two project status reports. These reports answer general questions about an ongoing project, and are important to assess whether a project is successful or not. The reported data are [43, 44]:

- Milestones
- Health, safety and environment (HSE)
- Economy
- Other deviations or events
- Risk
- Technology Readiness Level
- Results and progress

The reported data gives important input to what measures that should be included in a method for evaluating ongoing projects, but also gives input to what measures are important when assessing finalized projects.

2.2.6 Cost benefit analysis

For a project to be pursued it must be viable [45]. A textbook approach suggests a method to ascertain if an investment in a project is viable by economic approaches [46]. The following explanation of cost benefit analysis (CBA) is covered by the book Project Management Planning and Control.

Cost benefit analysis is a method that compares the costs in relation to the perceived benefits of a project, and should be carried out in the selection phase of project proposals [46]. A cost benefit analysis is a strict financial analysis and should be justified for being used. An easy answer to this is the importance for companies to address what the possible benefits from a project might be. Benefits are not strictly financial measures, CBA takes into account what a project can give in return [45].

When assessing whether or not a project should be undertaken the results of the project can be tangible, but in many cases they are intangible [46]. In the case that a project yields tangible deliverable that will produce financial revenue CBA is relatively easy to conduct, as it is simple to compare investment costs to expected return of investment (ROI). ROI is calculated by the formulae below:

$$ROI = \frac{Average\ return\ per\ year * 100}{Investment}$$

Whereas the average return per year is calculated by:

$$Average\ return\ per\ year = \frac{(num.years * yearly\ return) - Investment}{num.years}$$

But a project can yield much more than financial results, and this is why CBA is needed, to address the intangible results, such as: risk reduction, productivity, safety, reliability, cost reduction [46] etc.

Cost benefit analysis needs to be conducted when assessing project proposals to address what is possible to get in return for undertaking a certain project. This forces the project proposer to consider what the benefits for their project is, and allows the decision maker to get a better understanding to why a project should be undertaken.

2.2.7 Earned Value Management

The earned value concept was originally introduced in American factories by Frederick W. Taylor a century ago. The concept compares actual schedules and budgets against the planned schedules and budgets [47]. The concept give some interesting parameters that are easy to understand and easy to plot in such a way that the relationship between the ongoing and planned project can be assessed. Earned Value Management also opens the opportunity to forecast project costs [48]. In order to use this method, a basic set of parameters must be set, shown in table 5 [49]:

Table 3: Earned Value Management parameters as explained in Project Management Body of Knowledge [49]

Parameter	Explanation	Formula	Comment
BCWS	Budgeted Cost of Work Scheduled		Cost estimate planned to be spent on the activity during a given period.
ACWP	Actual Cost of Work Performed		Total of direct and indirect costs incurred in achieving work on the activity during a given period.
BCWP	Budgeted Cost of Work Performed		Percentage of the total budget equal to the percentage of the work actually completed.
CV	Cost Variance	$CV = BCWP - ACWP$	
SV	Schedule Variance	$SV = BCWP - BCWS$	
CPI	Cost Performance Index	$CPI = \frac{BCWP}{ACWP}$	
SPI	Schedule Performance Index	$SPI = \frac{BCWP}{BCWS}$	

The intention of this method is that the project is measured at each milestone that is met. For each milestone, there should be a planned budget and schedule. Earned Value Management compares the actual status of the project and the planned status. This method yields two parameters that are interesting when evaluating projects, the CPI and SPI, that also are good indicators for predicting the future [36]. How earned value management can be plotted to give a considerable amount of information about a project is shown in figure 5.

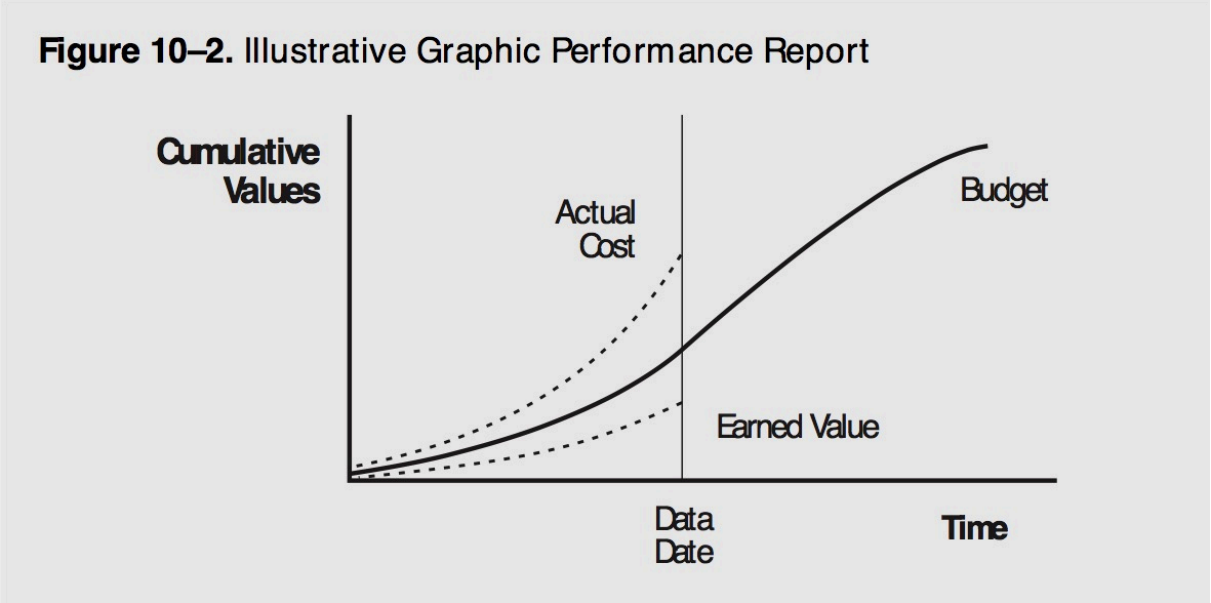

Figure 8: Illustrative Graphic Performance Report, Project Management Body of Knowledge [49]

The ability to monitor the cumulative value of projects is important, but in this case the thesis will only consider whether the project is running within budget.

Measurements of CPI is relevant for both ongoing and finalized projects as this covers if the project is or is completed within budget. This parameter is below 1 if the project is running over budget and is over 1 if the project is within the budget. If the parameter yields a result of 1 it means that the project is on budget.

3 Development of hypothetic method

3.1 Draft of indicators used for assessing project proposals

The indicators found in the literature chosen for further work are shown in table 4.

Table 4: Indicators for assessing project proposals as found in the literature study. The indicators shown are used as a basis for creating new ones that fit the R&D perspective.

Indicator	Explanation
Goodness of idea[33]	How good is the idea?
Distinctiveness[32]	How well is the project proposal defined?
Craziness[32]	How big and farfetched is the idea?
End-user[33]	Is there and end user for the output/result
Portfolio[16]	How well does it fit into the portfolio?
Strengths[25]	What is good about the project?
Weaknesses[25]	What is bad about the project?
Opportunities[25]	What can the project do for us in the future?
Threats[25]	What are possible setbacks during the project?
Cost benefit analysis / expected ROI[46]	What are the economic benefits of choosing the project?

This table gives a good basis; the indicators have been presented to and discussed with R&D directors of Statnett and Fingrid[12, 50, 51].

Distinctiveness should not only cover how well the project proposal is defined, but rather how well the goal is stated and if there are other similar proposals that are better.

End-user should identify who the potential user / customer of the projects output / result is, and if they are included in the consortium.

How well the project fits into the portfolio is an important factor, as this firstly will explain if the project fits into Statnett's R&D programs, and exclude projects that aren't relevant to the company.

The SWOT analysis is a tool for strategic analysis that can be used on project proposals. The reason for including this analysis is to force the decision maker to reflect over positive and negative strategic aspects of a project. Through discussion the SWOT analysis gave the indicators shown in table 5.

Table 5: Development of indicators addressed by the SWOT analysis.

Indicator
Quality of consortium?
Who will commercialize the end-result?
What is the financing model for the project?
Quality of the project team?
What methods are chosen for surveillance of progress in outside R&D world

3.2 Draft of indicators used for evaluation of ongoing and finalized projects

The indicators found in the literature chosen for further work are shown in table 5.

Table 6: Indicators found for evaluation of ongoing projects in the literature. Indicators create a basis for evaluation of ongoing projects.

Indicator	Explanation
Budget – CPI calculation[41]	Is the project within budget?
Time[41]	Is the project meeting milestones on time?
HSE incidents[41, 43, 44]	Has there been any HSE incidents?
TRLs – raised[43, 44]	How many TRLs have been raised?
Other deviations or events[43, 44]	Unforeseen deviations?
Result and progress[43, 44]	Is the project returning expected results and progress?

Through brainstorming with R&D directors of Statnett and Fingrid [12, 50, 51]. There has been stated a need that ongoing and finalized projects are divided in two groups with different indicators as they are not equivalent. The indicators for budget, time, HSE incidents and TRL are good as they are and fit both ongoing and finalized projects.

For ongoing projects, other deviations or events is addressed by if the project is deviating from original idea and if the idea is still novel. Results and progress can be addressed by if the project is becoming more feasible, if risks in the risk analysis are being solved and if there still exist end-users for the output.

To better evaluate the success of finalized projects other deviations and events, and result and progress must be further explained. Other deviations and events can be addressed as how close is the output to the project proposed and how well it is executed. Result and progress gives a large set of indicators: is the project handed over to technology qualification, if the technology risks still open or closed and if the project lead to new projects.

3.3 Draft of assessment matrix

Matheson's matrix[16] provides a basis to create and R&D project assessment matrix. Discussion[2, 51, 52] showed that the x- and y-axis, "net present value given success" and "Technical feasibility" can be better explaned. Net present value given success is changed to potential return on investment, and technical feasibility to innovation potential.

Indicators should be divided into groups regarding their association to potential ROI or potential risk. Some indicators can be scored on both.

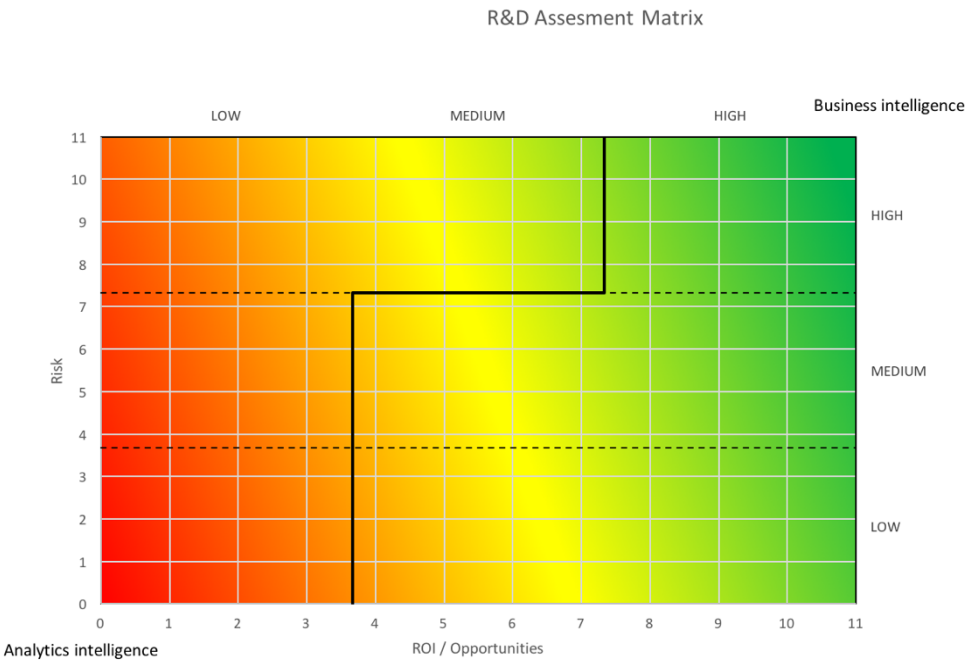

Figure 9: First draft of assessment matrix. Figure created by Espen Vinsand.

The proposed matrix emerged the thought that there is a need to develop the method so that the technical aspects are separated from formal aspects of the project. This birthed the idea of having a two-parted method, where one part is innovation assessment and the other is ability assessment. The complete explanation to the method is explained in chapter 4. The first draft of an assessment matrix is shown in figure 10 in the next chapter.

4 Draft of evaluation method

4.1 R&D Assessment matrices

In collaboration with Statnett's and Fingrid's R&D directors a framework for monitoring R&D projects has been developed. They state the need to divide project assessment into two aspects; innovation assessment and project ability assessment. Where innovation assessment covers the technology of a project, and ability assessment covers formal go or no go factors such as funding. This is to allow the method to stop implementation or continuation of projects that aren't viable. A project can have a big potential ROI and be big in innovation, but if the project is missing required funding or the project team is poorly constructed it must not be considered as a viable project.

Projects are divided into three phases; project proposal, ongoing project and finalized project. The innovation assessment matrix and ability assessment should be used in all phases. Appendix A gives a side by side view of all indicators.

4.1.1 Project Innovation Assessment Matrix

Matheson's R&D matrix[16] gives a good basis for creating a measurement framework for R&D projects in relation to the technology being developed. The goal for this matrix is to see how a project develops from project proposal to a finalized project, and thus measure its success. The matrix is a 3x3 matrix where quadrants are classified as low, medium and high on both the horizontal and vertical axes. The horizontal axis represents opportunity, while the vertical axis represents craziness. The matrix is shown in figure 10.

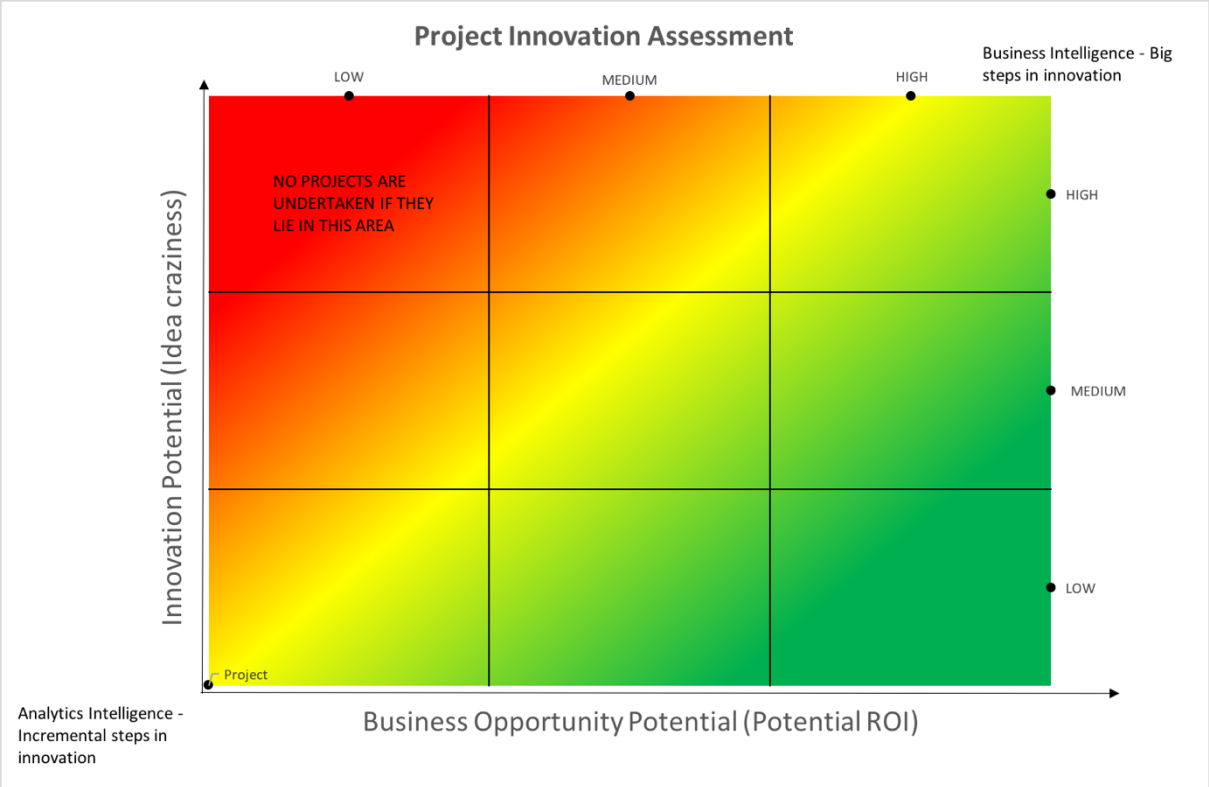

Figure 10: Innovation assessment matrix. Projects are placed in the matrix due to their performance in technology. Measurements are divided into categories depending on their relation to innovation potential, ROI potential or both. Figure made by Espen Vinsand.

Indicators related to innovation assessment are given scores based on their performance on opportunity, craziness or both.

The measurement scale used is explained in table 7:

Table 7: Scale for innovation assessment

Scale for innovation assessment	
Value	Explanation
0	Poor score
1	Low score
2	Medium score
3	Good score

This allows projects to be scored on craziness and opportunity, which is transformed into a point in the matrix. Business opportunity potential is the potential ROI, which will be denoted as opportunity. The innovation potential shows how crazy and unfeasible a project can be. Innovation potential is denoted as craziness. The background of the matrix is associated with a project's desirability or performance. Red indicates bad performance. Yellow indicates that the project needs to change as it should perform better. Green indicates good project performance. The point of this is to see the development of a project. If a project starts out as green, and as the project progresses it falls into the red area, the R&D manager should decide if actions should be taken to save or dismiss the project [16].

4.1.2 Project ability assessment

Project ability assessment grades the go or no go factors for a project[50, 51].

Indicators are given a color score based on the “traffic light’’ scale. Table 8 shows the colors and their meaning in each project phase.

Table 8: Traffic light scale. Indicators under ability assessment are given a score based on this scale.

Traffic light scale			
Color / project phase			
Project proposal	No go	Needs improvement	Go
Ongoing Project	Need major improvement	Needs minor improvement	Continue project as planned
Finalized project	Identifications of lessons learned	Identifications of lessons learned	Success

If an indicator in evaluation of project proposals or ongoing projects is marked as strict it means that if the indicator is red, the project should not be implemented or continued. Not all indicators are of equal importance, so there is a need for indicators that can stop bad projects from progressing. This grading of indicators is not necessary for finalized projects. For a finalized project that receives a red indicator, measures must be done to understand why the project failed on this indicator.

When using the method, a conclusion should be made based on both tests. A project might have all the formal criteria necessary, but might be too challenging to complete. Use of this method should be done by a person trained in making such decisions.

An example for use of the method is presented in chapter 4, proof of concept.

4.2 Indicators for innovation assessment of project proposals

The indicators given in this chapter have been developed through co-operation with R&D directors of Statnett and Fingrid, and are shown in table 9 and 10[12, 50, 51].

4.2.1 Innovation Assessment of project proposals

Table 9 shows the indicators that are used in innovation assessment of project proposals. The indicators are given a score as explained in chapter 5.1.1, and plotted in the innovation assessment matrix.

Table 9: Indicators for innovation assessment of project proposals. Indicators are divided into two groups depending on their fit to potential ROI or innovativeness.

<table>
<tr><th colspan="2">Indicators for Innovation assessment of project proposals</th></tr>
<tr><td>Opportunity</td><td>Craziness</td></tr>
<tr><td colspan="2">Type of project: Business or analytics intelligence?</td></tr>
<tr><td colspan="2">How novel Is the idea?
- How can we be sure this is a novel idea?
- How crazy is the idea?</td></tr>
<tr><td>Type of end-result?
- Product
- Technology
- Method
- Service
- Know-how</td><td>Technical challenges: How impossible is the project to complete?</td></tr>
<tr><td>How does it look in terms of funding and possible savings?</td><td>What is start TRL?</td></tr>
<tr><td>Does the result eliminate HSE risk for Statnett and contractors?</td><td>How great are the future implications?</td></tr>
</table>

4.2.2 Ability assessment of project proposals

Table 10 shows the indicators used for ability assessment of project proposals. Indicators are graded on the traffic light scale explained in chapter 4.1.2. If an indicator marked strict is graded as red the project should not be undertaken.

Table 10: Indicators for ability assessment of project proposals. The table shows the indicator and its significance in the method.

Indicators for ability assessment of project proposals	
Indicator	Type
Does the project fit into Statnett's portfolio?	Strict
Quality of the consortium?	
Who will commercialize the end-result?	Strict
What is the proposed financing model for the project?	
Quality of the project team?	
Price VS ROI?	
Is the goal clearly stated?	
Are other proposals better for this type of project?	Strict
Who is the end user for the new technology? Is it in the consortium?	Strict

4.3 Indicators for evaluating ongoing projects

The indicators given have been developed through co-operation with R&D directors of Statnett and Fingrid, and are shown in table 10 and 11[12, 50, 51].

4.3.1 Innovation assessment of ongoing projects

Table 11 shows the indicators that are used in innovation assessment of ongoing projects. The indicators are given a score as explained in chapter 4.1.1, and plotted in the innovation assessment matrix.

Table 11: Indicators for innovation assessment of ongoing projects. Measures are divided into opportunity or craziness depending on their association.

Indicators for innovation assessment of ongoing projects	
Opportunity	Craziness
Is the project deviating from original idea? Are we expecting other results than planned?	
Is the idea still novel or are other people already working on similar things? If so, how are their results compared to ours?	
Are the opportunities still the same as estimated?	Did the project increase TRL?
Same or more end users? Are more or fewer end users taking interest in the project?	Is the project becoming more feasible?
How close to completion is the project?	Are some of the high-risk development solved?

4.3.2 Ability assessment of ongoing projects

Table 12 shows the indicators used for ability assessment of ongoing projects. Indicators are graded on the traffic light scale explained in chapter 5.1.2. If an indicator marked as strict is graded as red, the project should be discontinued.

Table 12: Indicators for ability assessment of ongoing projects. The table shows what the indicators used and their significance for the assessment.

Indicators for ability assessment of ongoing projects	
Indicator	Type
Is the project running within budget? CPI calculation	
Is the project running to schedule?	
Has there been HSE incidents?	Strict
Are there still end-user(s) for the product?	Strict
How are the results of outside R&D surveillance? Are we co-operating with others conducting the same research?	

4.4 Indicators for evaluating finalized projects

Together with R&D directors of Statnett and Fingrid, the indicators have been developed, and listed in table 13 and 14 [12, 50, 51].

4.4.1 Innovation assessment of finalized projects

Table 13 shows the indicators that are used in innovation assessment of project proposals. The indicators are given a score as explained in chapter 5.1.1, and plotted in the innovation assessment matrix.

Table 13: Measurements for Innovation assessment of finalized projects. The scores are divided into two groups with their relation to opportunity or craziness.

Indicators for innovation assessment of finalized projects	
Opportunity	Craziness
Did the project generate valuable patents, projects, time saved, reports and / or citations?	
How big a technical achievement is the result?	
How close is the finalized project to the original project proposed?	
Is it handed over to technology qualification? Is it being implemented?	Are the technology problems / risks resolved? How well?
Same or more end users – do they actually use the result? Why, why not?	How is the end TRL?
Did it eliminate HSE risk for Statnett and contractors?	Could one solve all high risk developments?
How does it look in financial terms? Good earnings or savings?	If others have been doing same type of project, how successful were Statnett compared to them?

4.4.2 Project success assessment

Table 14 shows the indicators used for ability assessment of ongoing projects. Indicators are graded on the traffic light scale explained in chapter 5.1.2. If one or more indicators are graded as red, the project should not be regarded as successful.

Table 14: Indicators for ability assessment of finalized projects

Indicators for project success assessment
Did the project finish within budget? CPI calculation
Did the project finish on time?
Has there been any HSE incidents?
Is the project handed over to technology qualification? Is the project being used?
If others have been doing the same type of project, how successful were Statnett in comparison to the others?
How content is the end users / those proposing the project / stakeholders with the project?

4 Proof of concept

This chapter will show the proof of concept for project proposals. Two project proposals have been provided by Statnett for assessment. The reason for this chapter is to show how to use the method, and show new indicators found through testing.

4.1 Test Obstacle Warning GPS System

Statnett has provided project information about a proposed project for making an Obstacle Warning GPS system [52-56]. The data has been reviewed and used in the method for assessment of project proposals.

Ability assessment of OWGS:

Table 15: Implementation assessment of OWGS. The overall grade of the project is considered; the table shows that the project should not be implemented.

Indicator	Color score	Comment on score
Does the project fit in Statnett's portfolio?		The project has a big potential to increase safety for aerial vessels around Statnett's sites.
How is the quality of consortium		Sintef and Nobilesoft's maternal company. They lack a reliable IT professional. They will get data from Statnett and Energi Norge.
Who will commercialize the end-result?		Does not state.
How is the proposed financing model for this project?		The funding approved from Skattefunn, co-operation with Sintef, Statnett and Energi Norge.
How is the quality of the project team?		NobileSoft is created with the sole purpose of creating the system, has no formal employees. Too little IT competence in this type of project is a huge risk.
How does it look in terms of price vs ROI?		Possible international innovation and good socioeconomic outcome, but big market risk as there is no business model.
Is the goal of the project clearly stated?		Yes.
Does it exist other proposals that are better		No good existing solutions to problem. There exists aerial obstacles data, but

for this type of project?		they are poor and of bad quality.
Who is the end-user for the technology?		Yes, but it is missing the end-user as a partner for the project.

The result of this test shows that there are three no go factors of the project, and it is strongly recommended against implementing the project.

Innovation assessment of OWGS:

Table 16: Innovation assessment of OWGS - Opportunity measures. The scores given indicate that the project has a low potential ROI.

Opportunity		
Measurement	Score	Comment on Score
Business vs analytics intelligence	1	Big innovation, little potential ROI for Statnett as Statnett will not be an end-user.
How novel is the idea?	1	There is no competition for the project, but it will yield a low ROI as there will be costs for AWM anyway.
Type of end-result	2	End-result is a new technology that will replace an already existing technology, just slightly better.
How does it look in terms of funding and savings?	1	Funding approved from Skattefunn. Low potential ROI as it is not very useful for Statnett and misses a partner that commercializes the product.
Has it the potential to eliminate HSE risk?	3	The project can greatly reduce the risk of using aerial vessels near Statnett's and others overhead lines.
Opportunity score	8	

Table 17: Innovation assessment of OWGS - Craziness assessment. The table shows that the project has a big innovation potential.

Craziness		
Measurement	Score	Comment on Score
Business vs analytics intelligence	3	Big innovation, but high risk in commercialization
How novel is the idea?	3	There is a need for this technology, and there is no competition at this point.
Technical challenges	3	Technically challenging, as it is hard to collect and distribute data, and gain the trust of pilots
Start TRL	1	Starts at TRL 3, they have formulated the technical concept
Future implications	3	Can have huge implication for safety in maneuvering aerial vessels
Craziness Score	13	

The scores are translated to the point (8,13), shown in the matrix in figure 11.

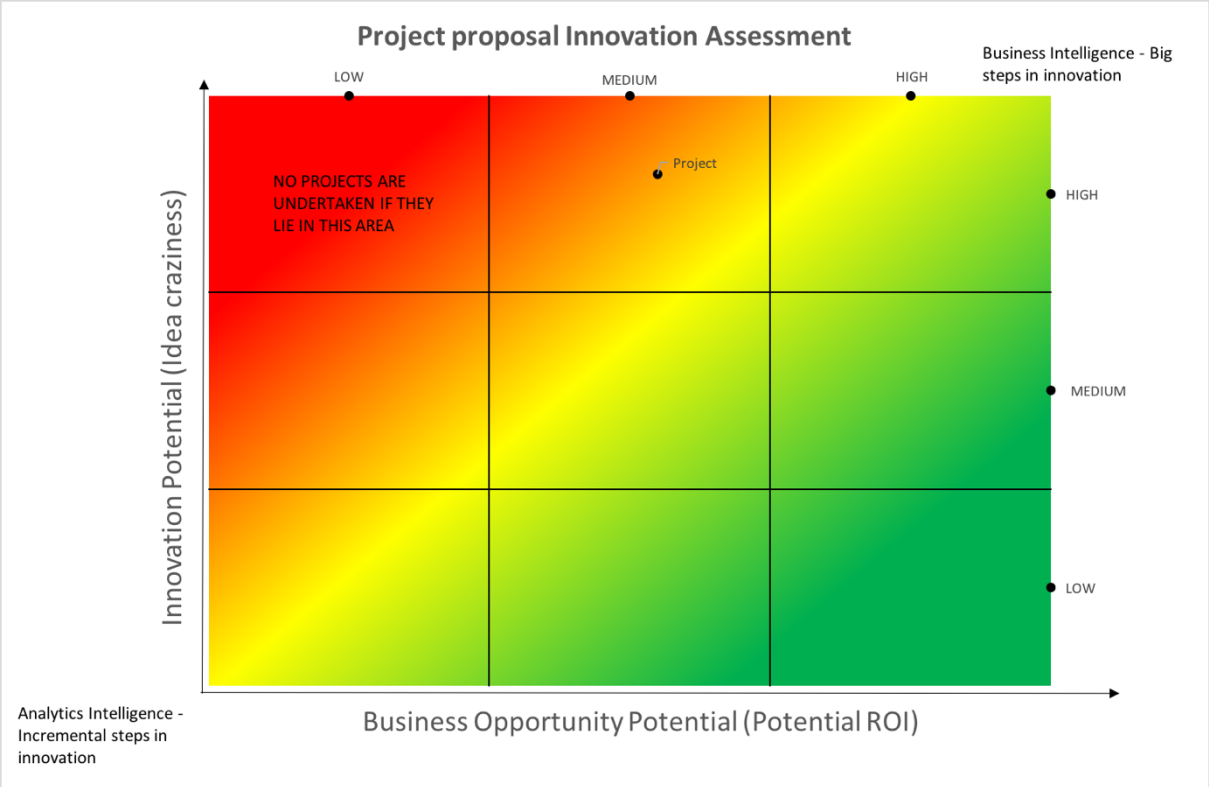

Figure 11: Innovation assessment matrix – OWGS. The project has been given scores and is plotted in the matrix. The matrix speaks for the project, as it can potentially give a big ROI, but the project is associated with a big potential innovation, that can be difficult to achieve. Figure made by Espen Vinsand.

Conclusion:

The ability assessment indicates that the project is a clear no go project.

The innovation assessment shows that the project has a big innovation potential, but this potential is not justified for by the low potential ROI. For a project with such a high innovation potential to be implemented, it requires that there is a big potential ROI. This is not the case in this project. The recommendation is to not implement the OWGS project.

4.2 Test Prevention of conflicts between birds and overhead lines

Statnett has provided a project proposal for a project concerning birdlife around their overhead lines [57]. The project proposal has been reviewed and tested with the method.

Ability assessment of prevention of conflicts between birds and overhead lines project:

Table 18: Ability assessment of prevention of conflicts between birds and overhead lines project. The table shows that there are too many insecurities at this point for the project to be implemented.

Indicator	Color score	Comment on score
Does the project fit in Statnett's portolio?		Potential to decrease environmental impact of lines, will decrease chance of birds flying into overhead lines.
How is the quality of consortium		The consortium looks good, with participants from Statnett's D&M, NINA. Potential assets from NVE and Fylkesmannen have not yet been granted.
Who will commercialize the end-result?		This is firstly a research assignment, but the results can be used to lessen environmental impact.
How is the proposed financing model for this project?		Missing financing.
How is the quality of the project team?		The project team looks good with participants from Statnett's D&M, NINA delivering R&D and collaboration with NVE and Fylkesmannen
How does it look in terms of price vs ROI?		The project has the possibility to decrease the environmental impact on birds, and thus increase public accept of overhead lines. But no clear financial potential.
Is the goal of the project clearly stated?		Yes, but missing a clear roadmap.

Does it exist other proposals that are better for this type of project?		No
Is there an end-user for the technology?		Yes, Statnett and DSOs, but at this stage no DSOs are not part of the project. (Maybe this one is red aswell?). This research can lead to new projects that will lessen environmental impact.

Innovation assessment of prevention of conflicts between birds and lines project:

Table 19: Innovation assessment of prevention of conflicts between birds and lines project, opportunity scores. The table shows that the project has low chance to generate income.

Opportunity		
Measurement	Score	Comment on Score
Business vs analytics intelligence	1	No potential ROI, other than social accept. But the result can be used by TSOs and DSOs to lessen their environmental impact.
How novel is the idea?	0	Not novel in the sense that it can generate ROI.
Type of end-result	1	Knowledge about environmental impact overhead lines have on birds, and potentially lessen the impact.
How does it look in terms of possible savings and funding?	0	No clear financial plan in terms of what the result will yield financially for Statnett.
Has it the potential to eliminate HSE risk?	1	Not for personnel, but can increase knowledge about birds around overhead lines and towers.
Opportunity score	3	

Table 20: Innovation assessment of conflicts between birds and lines project, craziness scores. The table shows that the project is not very innovative.

Craziness		
Measurement	Score	Comment on Score
Business vs analytics intelligence	0	Not a very innovative idea.
How novel is the idea?	0	Not a very novel idea, the project will mainly consist of data gathering.
Technical challenges	1	No technical challenges as far as gathering new knowledge. There is a potential to use this knowledge to mitigation (TRL 1 or 2)
Start TRL	1	Idea has been formulated
Future implications	2	It will give knowledge about birds' behavior around lines, and can lead to methods lowering environmental impact of towers and lines.
Craziness Score	4	

The scores are translated to the point (3,4) in the matrix, and is shown in figure 12.

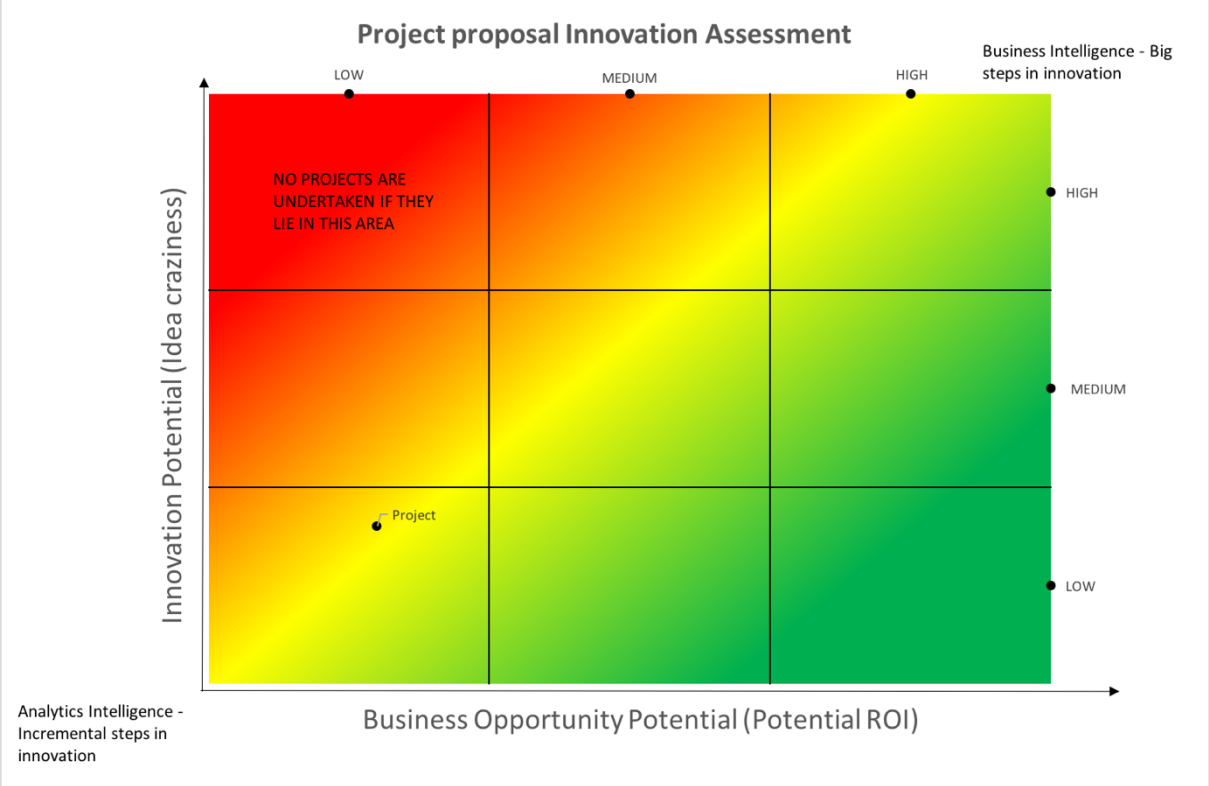

Figure 12: Innovation assessment matrix of conflicts between birds and lines project. The figure shows that the project need to improve to be implemented.

Conclusion:

The ability assessment shows that there are many insecurities in the project, these need to improve for the project to be implemented.

The innovation assessment shows that the project does not have high enough potential ROI, though it will be an easy project to complete as it will mostly consist of data gathering. How the acquired knowledge will generate ROI is uncertain, but the project can lead to new valuable projects that can lessen the environmental impact of Statnett.

The overall evaluation of the project proposal, is that it should not be implemented.

4.5 Indicators emerging

For both projects an indicator for ability assessment is emerging, for selecting a project it is useful to address what methods are used for surveillance of progress in outside R&D world. Perhaps a joint R&D effort to one of the projects tested could had saved them from rejection?

5 Conclusion and suggestion for further work

5.1 Conclusion

"How to ensure R&D efforts of TSOS contribute to reaching the company main strategy?" has been the main research question of this thesis.

To ensure R&D efforts contribute to reaching the company's main strategy, R&D must select the right projects to ensure.

When the right projects are chosen for implementation, they must be carefully monitored to ensure that they will deliver what is expected.

When projects are finished one must learn from them, experience from failure and success should be transferred into the project selection phase.

The goal of this thesis was to create a simple, yet objective method to assess project proposals, that did not require an experienced persons' expertise to use. The literature study conducted showed that there did not exist such a method.

The method proposed in this thesis has been tested on two cases provided by Statnett, a proposal to develop an Obstacle Warning GPS System proposal, and a proposal for a study of conflicts between birds and overhead lines.

The OWGS project did not pass the method due to many insecurities in the project around the company proposing the project, they did not have a clear business strategy formulated, nor the required competence to complete the project. The project was not chosen for implementation by Statnett because of this. The method was especially simple to use on this project, as the data provided was very descriptive due to applications for funding.

The other project tested, the study of conflicts between birds and lines, showed that there were too many insecurities in the project and it missed the potential to generate an opportunity, in tangleble and intangible assets for Statnett. The conclusion drawn to this project was that it should not be implemented, as was the conclusion made by Statnett.

It is important to note that the author may have been biased during testing of these projects as it was known that neither of them were chosen for implementation. Though, the author did not know why the projects were rejected. The reason why the projects were rejected found with the method were similar to the reasons why the projects were rejected by Statnett.

The two cases show that with a critical mind-set, the method can be a powerful tool in assessment of project proposals. The method was tested by the author of the thesis, and yielded similar results as when the projects were assessed by Statnett. This proves that the method works. Thus, the goal of this thesis is considered reached and the method can be used as a tool for younger inexperienced staff to assess project proposals.

This method to assess project proposals has shown that it has great potential. During work with the thesis the method was presented ENTSOE-RDIC by Statnett. The method can have big implications in lessening the workload of R&D managers in TSOs and empower their employees.

5.2 Suggestion for further work

The method provided gives a good starting point for further development. To improve the method, further testing must be undertaken to verify that the method works. By extensive testing of the method, new indicators can emerge, and some of the existing indicators can be disregarded.

To improve the method, R&D directors of Nordic and European TSOs should be contacted. With their help, the methods can be critically reviewed, coefficients for the indicators can be implemented and thus make the method more accurate.

The indicators used for evaluation of ongoing and finalized projects require further work before being implemented as they need to be verified.

Lastly, one can develop a web-based program that tracks all projects. This will simplify input, and gives the user the option to easily compare projects against each other.

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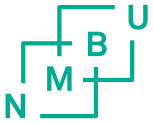
Appendix A

Project Proposal		Ongoing Project		Finalized Project	
Innovation Assessment		**Innovation Assessment**		**Innovation Assessment**	
Opportunity	Craziness	Opportunity	Craziness	Opportunity	Craziness
Type of project: - Business Intelligence: a new technology - Analytics Intelligence: incremental improvements - Is there an end user for the result?		Is the project deviating from original idea? Are we expecting other results than planned?		Did the project generate valuable patents, project, business, saved time, reports and/or citations?	
How novel is the idea? - How can we be sure this is a novel idea? - How crazy is the idea?		Is the idea still novel or are other people already working on similar things? If so what are their results compared to ours?		How big a technical achievement is the result?	
Type of end result: - Product - Technology - Method - Service - Know how	Technical challenges: - How impossible is the project to complete?	Are the opportunies still the same as estimated?	Did the project increase TRL?	How close is the finalized project to the original project proposed?	
How does it look in terms of funding and	What is start TRL?	Same or more end users? – Are more	Is the project becoming more	Is the project handed over to	Are the technology problems / risks

possible savings?		/ less end users (stakeholders?) taking interest in the project?	feasible?	technology qualification? - Is it implemented?	resolved? How?
Does the result eliminate SHE risk for Statnett and contractors	How great are the future implications?	How close to completion is the project?	Are some of the high risk development solved?	Same or more end users – do they actually use the result? Are more people using it? Why/why not?	How is the end TRL?
				Did it eliminate SHE risk for Statnett and contractors?	Could one solve all high risk developments?
				How does it look in financial terms? Good earnings or savings?	
Project Ablilty Assessment		**Project Ablility Assessment**		**Success Assessment**	
Does the project fit into Statnett's portfolio?		Is the project running within budget?		Did the project finish within budget?	
Quality of consortium?		Is the project running to schedule?		Did the project finish on time?	
Who will commercialize the end-result?		Has there been HSE incidents?		Has there been anyHSE incidents?	
What is the proposed financing model for		Are there still end-user(s) for the		Is it handed over to technology	

the project?	product?	qualification?
How is the quality of the project team?	Are there still end user(s) for the product?	If others have been doing same type of project, how successful were Statnett in comparison to the others?
Price vs ROI?	How are the results of outside R&D surveillance? Are we co-operating with others conducting the same research?	How content is the end users / those proposing the project / stakeholders with the project?
Crazy idea?		
Is the goal of project clearly stated?		
Are other proposals better for this type of project?		
Is there an End user for the new technology?		
What methods are chosen for surveilling of outside R&D world?		



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