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NCE Raufoss

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Preface

Innovation Norway has commissioned Samfunnsøkonomisk analyse to evaluate the Norwegian Innovation Clusters program. The program is organised by Innovation Norway, in joint effort with Siva (The Industrial Development Corporation of Norway) and The Research Council of Norway. The Norwegian Innovation Clusters (NIC) program was launched in 2014 and aims at increasing growth by promoting and improving collaborative activities in the clusters.

Seven cluster projects were completed in 2016. These are evaluated as part of the commissioned program evaluation. The seven projects consist of four Norwegian Centres of Expertise (NCE) projects and three Arena projects.

We would like to thank everyone who willingly took the time to answer all our questions. We would also like to thank members of the reference group for interesting discussions and useful feedback.

The evaluation was conducted during the period from March to October 2017. Samfunnsøkonomisk analyse is responsible for all content in this report.

Oslo, 05.03.2018

Rolf Røtnes
Project manager
Samfunnsøkonomisk analyse AS

Summary

NCE Raufoss is a company cluster that aims to become a national competence centre for lightweight materials and automated production processes. The companies in NCE Raufoss have a turnover of about NOK 13 billion and an export share of approximately 85 percent. In total, the cluster employs about 5 000 individuals, distributed between companies ranging from 10 to 1 000 employees. Several of the companies are part of global consortia.

The cluster environment has its core competence in the manufacturing industry, especially the refinement of aluminium and plastic composites. Its biggest competitive advantage, and thus technological focus, is its expertise in the use of lightweight materials and automated production processes. The largest markets are the global automotive industry, the defence industry and the electronics industry. About 60 percent of the cluster is involved in the production of vehicles.

The cluster has its geographical core in Raufoss Industrial Park, but the cluster extends beyond this park. Several of the companies, especially among the SMEs, are spread throughout the Gjøvik region.

Most cluster projects divide their members into four groups; core members, other active companies, R&D and educational institutions and public development actors. We have narrowed the range of core members in the individual cluster projects to joint-stock companies located in the Gjøvik region. For analytical purposes, we have excluded research institutes from the core members group. With our definition, NCE Raufoss has 31 core members.

Interviews show that there is little competition between cluster members in product markets, but that there is some competition in competence, especially in higher skill levels (college/university level). However, most sources emphasise that similarities in competence demand and great geographic proximity has provided opportunities for the exchange of skills and labour in periods where business cycles have affected the companies differently.

According to the application for NCE status, the overall vision of NCE Raufoss is as follows:

Through extensive cluster cooperation, the industrial environment will strengthen its market positions internationally and develop new profitable markets based on products and services with high levels of competence.

We find that the cluster, throughout the NCE period, has continued to initiate and complete activities based on potential synergies between actors, and that they have continued investing in cluster development to strengthen the relational basis of the cluster. We also find that the initiated activities have been relevant for further strengthen the long-lasting value creation in the cluster.

NCE Raufoss has managed to realize the cluster's main objectives, strategical and quantitative. However, they have not been able to reach their target of new businesses with turnover of NOK 1 billion or more and

250 new employees, despite increased efforts during the last project period. We do however believe that this target may be reached in the future.

The average core members have grown, employee-wise, during the project period, despite a strong productivity increase. This may imply an increased economic activity in the cluster.

In available economic data, we have found that the cluster has increased the average value added per core member during the project period, and that this increase has been relatively stronger than for other NCEs and other LLCs within comparable manufacturing industries. It is also observable that the cluster's contribution to the total added value has been developing along a positive trend throughout the project period.

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1 Introduction

The program Norwegian Innovation Clusters (NIC) was launched in 2014. The program is a continuation of the Arena program launched in 2002 and Norwegian Centres of Expertise (NCE) launched in 2006. With the introduction of NIC it was also introduced a third, and new level, Global Centres of Expertise (GCE) targeting mature clusters with a global position.

Norwegian Innovation Clusters aims to promote and enhance collaborative activities in clusters. The objective is to increase the cluster dynamics and attractiveness, the individual company's innovativeness and competitiveness.¹

Norwegian Innovation Clusters is a collaborative project and jointly owned by the funding agencies; Innovation Norway, the Research Council of Norway and Siva. Innovation Norway has the main responsibility for managing the program. The program is funded by the Ministry of Trade, Industry and Fisheries and the Ministry of Local Government and Modernisation.

Innovation Norway, the Research Council and Siva² have commissioned an evaluation of the Norwegian Innovation Clusters program as well as an evaluation of the following seven completed cluster projects:

- Arena Biotech North
- Arena Lønnsomme Vinteropplevelser
- Arena Smart Water Cluster
- NCE Instrumentation
- NCE Micro- and Nanotechnology
- NCE Raufoss
- NCE Systems Engineering

This report addresses the final evaluation of NCE Raufoss. For a more detailed introduction to the cluster program Norwegian Innovation Clusters, we refer the reader to our main report for the evaluation of the program.³

The following sections provide a brief introduction to the purpose of Norwegian Centres of Expertise (NCE), the theoretical justification for a cluster program, and how to understand the cluster mechanisms. Chapter 2 gives a description of NCE Raufoss. The project's activities are presented in Chapter 3, while results and achievements are discussed in Chapter 4. We summarise the project in Chapter 5.

1.1 Norwegian Centres of Expertise

Norwegian Innovation Clusters support cluster projects on three levels. These levels differ from each other in two important areas; (i) *target group* and (ii) *duration of support*. Arena targets immature clusters and the projects are supported for a period of three to five years. NCE targets mature clusters with a national position, whereas GCE targets mature clusters with a global position. NCE and GCE supports projects for 10 years.

Norwegian Centres of Expertise (NCE) was established in 2006 based on prior analyses and inspiration from other countries. NCE is intended to focus, improve and accelerate already on-going development processes in clusters that have established systematic collaboration, with potential for growth in both national and international markets.

NCE has supported 15 cluster projects since 2006, of which 11 are currently active (a list of projects and

¹ <http://www.innovationclusters.no/english/>

² The Industrial Development Corporation of Norway

³ Samfunnsøkonomisk analyse (2017) *Evaluation of Norwegian Innovation Clusters*, Rapport 76-2017

their features are presented in the evaluation's main report).

1.1.1 The purpose of the projects

NCE targets clusters with an established organisation with well-developed services, partners with experience and achieved results from collaborative projects, well-established national position and further national and international growth potential.

Table 1.1
Objectives for Norwegian Centres of Expertise

Impact targets	
Increased value creation within the cluster	
Output targets	
Innovation skills	Increased innovation activity through systematic collaboration between firms and R&D institutions
International orientation	Increased collaboration with international partners
Access to competence	Better access to relevant competence through strategic collaboration with educational institutions
Attractiveness and visibility	Increased recognition as a nationally important environment for innovation and growth
Interaction and collaboration	Increased targeted collaboration internally and externally

Source: Program description Jan. 12th, 2015

Each cluster project establishes its specific objectives, based on the clusters established position and prerequisites for further development and the specific objectives for the individual program level (cf. table 1.1).

1.1.2 Selection and funding of projects

There are no restrictions on who can apply for admission in the cluster program. But, applicants must meet a set of requirements for how the cluster project is organised, e.g. a legal entity as formal applicant, a defined partnership between actors in the cluster, a board representing the partnership and an operational management.

NCE offers financial and professional support to cluster projects with a duration of five years. If the cluster project is recruited directly into NCE (not following an Arena project), it may apply for a second contract period of five years. If the cluster started out as an Arena project, the years in Arena is deducted, so that the project period does not exceed 10 years. A status assessment is conducted after two years, and after seven years if the project is extended. NCE projects are subject for external evaluation after five years to assess the grounds for extension, and at the end of the project period.

NCE clusters may apply for participation at the next level (GCE) during the project period. Approval of the application implies that the current agreement is terminated and replaced by a new agreement in accordance with requirements at the new level.

The size of the annual grants is determined by the cluster project's format, level of activity and the program's financial resources. NCE projects can receive annual grants between NOK 4 and 6 million.

1.2 Theoretical justification for cluster support

A precondition for public intervention, such as the cluster programme, is the existence of one or more forms of market failures that limits firm's or industries' ability and will to reach their value creation potential.

Cluster theory states that the value creation potential of a cluster is affected by positive collaboration and localisation externalities. Such externalities are not always obvious to the individual actor and is therefore not considered in their investments. That is, production is lower than what is economically optimal if the market failure is not corrected. Public involvement in cluster development can thus be justified by market failures limiting firm's ability and willingness to carry out necessary investments in collaboration.

Examples on market failures can be:

- Production of public goods: Goods that does not yield direct or exclusive benefits for any single individual entity
- Knowledge externalities: Knowledge is diffused and used by other parties' than the party whom developed it
- Asymmetric information: Firms have limited information on potential benefits of collaborating with other businesses or R&D actors
- The free-rider problem: The risk that collaboration partners may reap the benefits of the collaboration without contributing themselves

The free-rider problem is especially challenging in situations where there is low level of familiarity and trust between the companies in the cluster.

Causes of market failures such as public goods production, knowledge externalities or asymmetric information lead to the fact that the production and development of common goods and knowledge, as well as the degree of cooperation will be lower in an economy without public intervention than what is optimal. The reason is that businesses does not internalise the benefit (or disadvantage) of these market failures in their profit maximisation. The free-rider problem is especially a problem in situations

where there is a low level of familiarity and trust between the cluster members.

The cluster program, including NCE, can contribute to higher quality of and more research and innovation than what would have been without public intervention, thereby realizing the potential effects of cluster formation on value creation and innovation. The program can contribute to this, for example, by providing necessary technical and financial support for the clusters to initiate new, or to strengthen and accelerate ongoing, collaborative projects. By formalising collaboration in cluster projects, the risk of single companies reaping unfair advantages can be reduced. This will minimize challenges associated with the free-rider problem.

The program's main objective shows both why and how NCE supports cluster development:

NCE should contribute to increased value creation through the release and amplification of collaboration based innovation and internationalisation processes in clusters with clear ambitions and growth potential.

1.3 Cluster mechanisms

Jakobsen and Røtnes (2011) analysed how public cluster support could be understood within a formalised framework and developed a conceptual model for cluster-based development to illustrate typical cluster characteristics and how they lead to improved performance (see figure 1.1 **Error! Reference source not found.**). The solid lines in the figure illustrate direct effects, whereas the dashed lines illustrate long-term effects generated by system dynamics.

Capability and willingness to initiate and carry out collaboration processes to realise potential synergies depend on the groups' relational basis for collaboration. If potential synergies are significant and the relational basis is in place, actual collaboration processes will result in gains such as innovation, improved productivity and/or internationalisation, and consequently growth and profitability (illustrated by the solid lines in the model).

Even though potential synergies between the actors in a cluster clearly exist, they might still not be realised. Actors might lack sufficient information about other actors' activities to know when collaboration might result in mutual benefits.

The incentives to invest in collaborative relationships might also be unevenly distributed. Trust is in

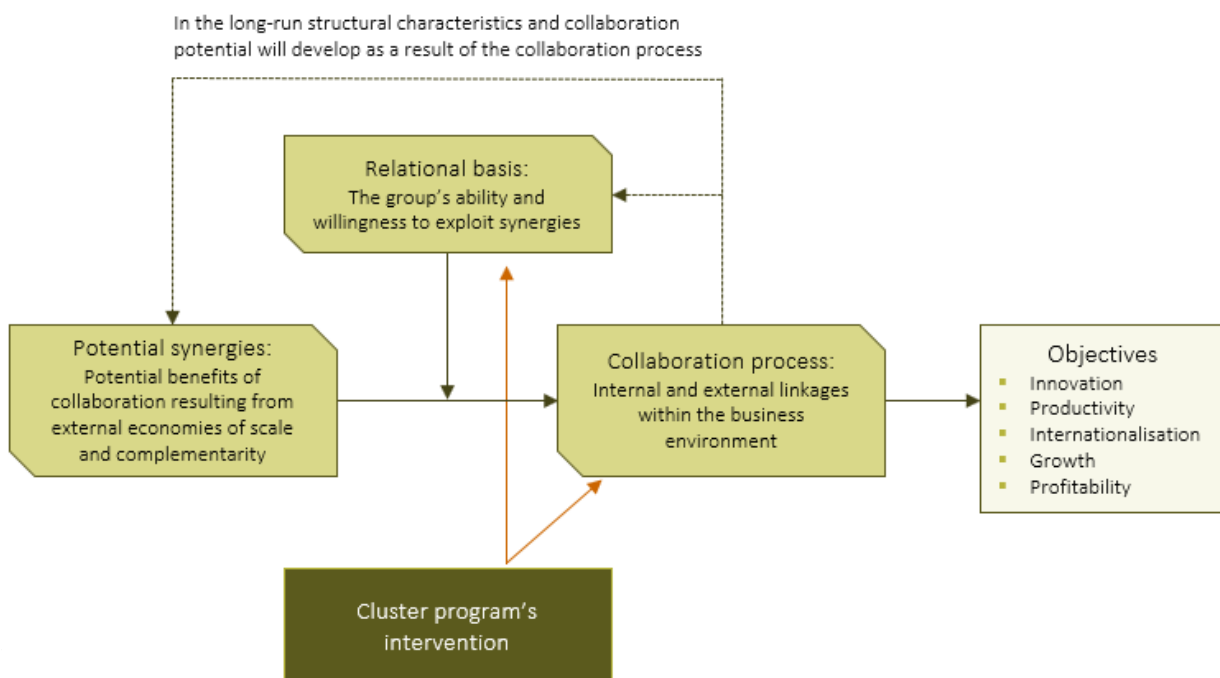
many cases the decisive factor to make collaboration work in practice, and if there is a lack of trust, collaboration may seem like too much of a risk. In other words, the actors' ability to realise potential synergies through collaboration processes depends on their relational basis for collaboration, i.e. whether they trust each other enough to be willing to share their knowledge and invest in the community.

The conceptual model is elaborated in more detail in the evaluation's main report.

1.4 Evaluation of the project

The evaluation is organised according to OECDs criteria for evaluating development assistance.⁴ That is, the evaluation is structured around three

Figure 1.1
Conceptual model of cluster-based development



Source: Jakobsen and Røtnes (2011)

main criteria: relevance, effectiveness (incl. impact) and efficiency.

To assess the abovementioned, we have reviewed project descriptions, annual reports, Innovation Norway's survey to the cluster participants and previous evaluations. Further, we have interviewed relevant stakeholders, participating firms in the cluster project, as well as the project manager.

In addition, we have mapped firms' R&D network by analysing their R&D collaboration in projects with public funding.

As part of the evaluation of the cluster program we have analysed effects in firm performance from participating in a cluster project by comparing growth in selected performance indicators (e.g. employment, revenues and productivity) for core members in the clusters with growth in similar firms not participating in a cluster project.⁵

Due to data requirements, it is not feasible to conduct a complete impact assessment for the individual projects, and the reader is referred to the main report for the results of this analysis.

Data and our evaluation approach is described in more detail below.

⁵ That is applying a matched difference-in-differences procedure.

2 NCE Raufoss

In this chapter, we will give a short description of NCE Raufoss and account for its objectives and strategies, potential synergies and relational basis.

2.1 About NCE Raufoss

NCE Raufoss is a cluster project which aims to become the national competence centre for lightweight materials and automated production processes. The companies in NCE Raufoss have a turnover of about NOK 13 billion and an export share of approximately 85 percent. In total, the cluster employs about 5 000 individuals, distributed between companies ranging from 10 to 1 000 employees. Several of the companies are part of global consortia.

The cluster environment has its core competence in the manufacturing industry, especially the refinement of aluminium and plastic composites. Its biggest competitive advantage, and thus technological focus, is expertise in the use of lightweight materials and automated production processes. The largest markets are the global automotive industry, the defence industry and the electronics industry.

The cluster has its geographical core in Raufoss Industrial Park, but the cluster extends beyond this park. Several of the companies, especially among the SMEs, are in the Gjøvik region as a whole.

The industrial environment at Raufoss dates back to 1873 and the establishment of a match factory, and later a cartridge plant in 1895. This cartridge plant, called Raufoss Ammunition Factory from 1920, was

the starting point for most of the companies now involved in NCE Raufoss.

The cluster project was in the NCE programme from 2006 to 2016.

2.1.1 Core members

Most clusters divide their members in four groups; core businesses, other active firms, R&D and educational institutions and public development actors. However, it appears that there are different practices among the clusters of how they categorise their members, especially when distinguishing between core members and other active firms. Hence, for both presenting different cluster characteristics and the econometric analysis (main report) it has been necessary to refine the selection of core members in a more consistent matter.

Our definition of core members is based on the list of participants categorised as “core businesses” and “other active firms”. In accordance with previous evaluations of effects of participation in a cluster project, we have chosen to limit the selection of core members to limited liability companies (LLC).⁶

Further, we have limited the selection of core members in each cluster to LLCs located in the economic region⁷ we consider to be the cluster's geographic localisation (see next paragraph). As we want to focus on firm performance, we have chosen to exclude research institutes organised as limited liabilities.

⁶ The econometric analysis presented in chapter 4 largely follows the method used in yearly evaluations of effects on firm performance of support from Innovation Norway (Cappelen, et al. 2015). Further, to study effects on and development in number of employees, value creation, productivity, etc. it is a prerequisite that the cluster members are present in accounting data. All LLCs are liable for accounting and by refining the

selection of core members to these firms we ensure that we have the necessary information on all firms in our sample.

⁷ Economic region is a regional classification for the level between county and municipality. The main criteria used for defining the regions are labour market and trade. The classification corresponds to the NUTS 4-level in EU's regional classification.

With our definition, NCE Raufoss is located in Gjøvik and has 31 core members.

Table 2.1
Number of core members, mean firm age and number of employees in enrolment year

Enrolment year	Members	Firm age	Employees
2006	26	11 years	39.2
2009	1	43 years	174.0
2013	1	21 years	135.0
2014	1	7 years	2.0
2016	2	16 years	61.5
Total	31	13 years	49.1

Source: Samfunnsøkonomisk analyse

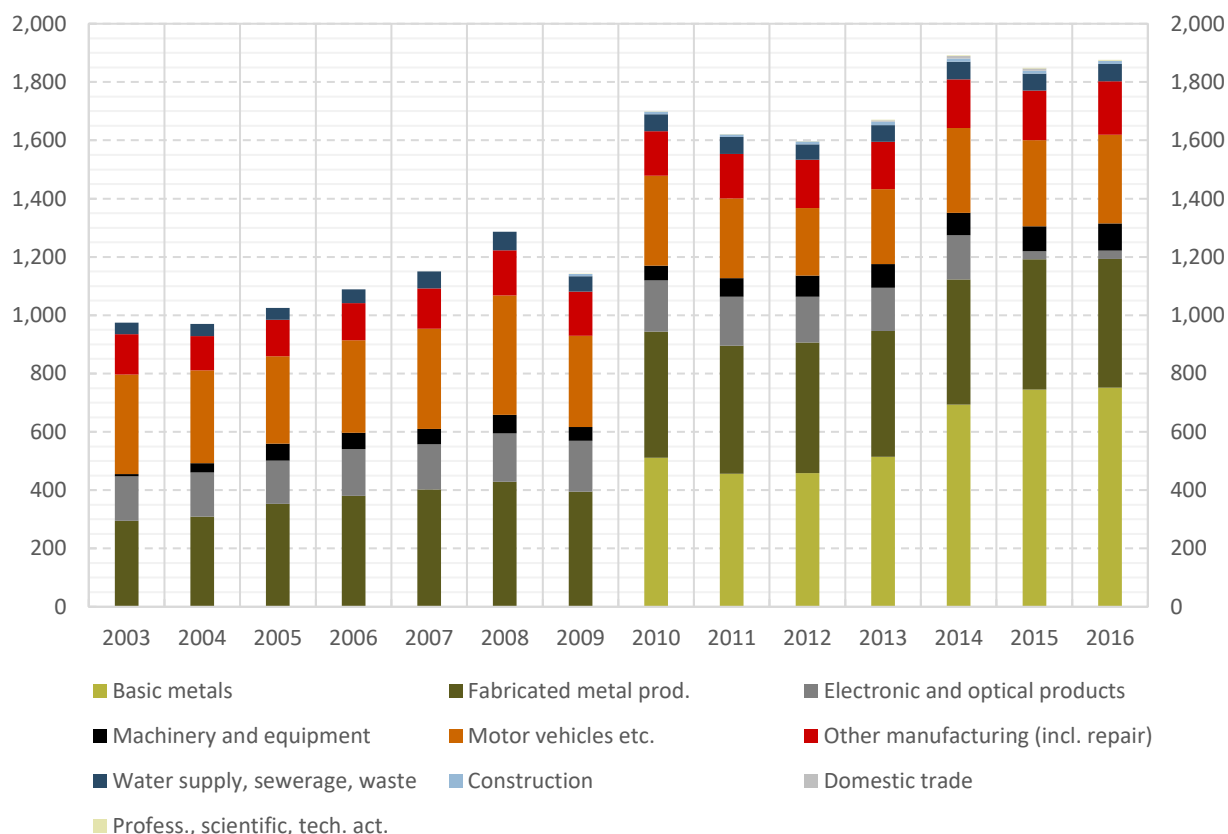
2.1.2 Industrial distribution

NCE Raufoss members are mainly in manufacturing industries. Measured by number of employees, the largest industry represented in the cluster is manufacturing of basic metals and fabricated metal production. Manufacturing of motor vehicles is also a significant industry measured in number of employees (cf. figure 2.1).

2.2 Objectives and strategy

The project's objective and strategy are meant to be directives for the project period. NCE Raufoss has had the following vision and objectives. During the

Figure 2.1
Number of employees by industry. Core members in NCE Raufoss. 2003-2016



Source: Samfunnsøkonomisk analyse

project period, there has been certain adjustments, as shown below.

2.2.1 Objectives and strategies for the entire project period

According to the application for NCE status, the overall vision of NCE Raufoss is as follows:

Through extensive cluster cooperation, the industrial environment will strengthen its market positions internationally and develop new profitable markets based on products and services with high levels of competence.

NCE Raufoss divided its main objective into the following aspects:

- 1) **Existing companies and networks:** Success in existing companies through productivity growth and innovation – 150 jobs per year; globally competitive rate of improvement adapted to companies' markets; $2 - \frac{1}{2} - \frac{1}{2} - 0$ - Double performance – half the time – half the price – zero error
- 2) **New establishments:** Develop and establish new companies with a turnover of NOK 1 billion with 250 employees
- 3) Total NCE-driven development activity in the cluster 5 times the size of the NCE funding
- 4) Develop a joint strategic plan for the industrial cluster and the network

Aspect 1) and 2) are further concretised by the following secondary objectives:

- 1) **Existing companies and networks:**
 - a. By 2015, the Raufoss cluster should be a recognised and preferred partner in material processing and automated production for the manufacturing industry

- b. "Produced in Raufoss" should be an international trademark, representing advanced industry production and give market access to new companies
- c. Develop infrastructure, services and R&D projects that provide competitive advantages with lasting value, including the EU's 7th framework program
- d. Develop an attractive study environment for technology subjects together with NTNU and Gjøvik University College. Contribute to SMEs' competence development and internationalisation
- e. Establish and develop meeting places for discussion and exchange of experiences
- f. Contribute to exchange of experience and cooperation with other Norwegian industrial environments to increase competitiveness in international markets
- g. Establish corporate consortia to win contracts in markets that require system providers

2) **New establishments:**

- a. The Raufoss cluster should be an attractive location for the establishment of new business
- b. Succeeding in the insourcing of high-technology companies with complementary expertise
- c. Establish a professional innovation structure with innovation funding at a level of NOK 150 million

It was also apparent from the application that NCE Raufoss should work according to the following strategies:

1) **New business**

- a. Initiate projects and product ideas that the companies cannot handle individually
 - b. Establish an apparatus that can support entrepreneurship
- 2) **Infrastructure**
 - a. Build a comprehensive centre for analysis, testing and verification of products, manufacturing processes and automated production systems
- 3) **Technology:** Facilitate national and international R&D projects. Particularly by focusing on the following technology areas
 - a. Lightweight materials
 - b. Automated production
- 4) **Practical academia** – Link education and research institutions with the industry
- 5) **Commercialise R&D results**
 - a. Prove and facilitate industrial application of research results

2.2.2 Adjustments during the project period

The objectives and strategies rendered above has largely been kept during the project period, with some exceptions.

In the second project period, the cluster has focused more on new business and commercialising R&D results. In addition, the cluster focused on achieving GCE status, and later to achieve Clusters for Conversion status.

2.3 Potential synergies

2.3.1 Organisation

Formal contract partner and project leader in NCE Raufoss is SINTEF Raufoss Manufacturing AS (formerly Raufoss Technology & Industrial Management AS). The company has expertise in materials technology, laboratory and engineering services, as well as production technology. As evidenced by the

change of name, the company has evolved into a distinctive part of SINTEF during the NCE project, and has become a major development and competence partner for the companies in the cluster.

The project leadership consisted of 7 individuals, at least during the last few years. In addition, the cluster had a steering committee consisting of 30 members, of which 24 were business representatives.

The members have paid NOK 2 million in membership fees annually.

2.3.2 Potential synergies: Economies of scale, common features and complementarities

Potential synergies between members of the cluster – also known as potential external economies of scale – exists if there are economies of scale in activities that are *common* for the participants and that are *non-excludable*. Examples include, but are not limited to, infrastructure, common features or complementarities in markets, competence, activities or resources.

2.3.3 Common traits and complementarities

The company cluster has its geographical core in Raufoss Industrial Park, but the cluster extends beyond the industrial park. Several of the companies, especially the SMEs, are in the Gjøvik region as a whole.

The cluster environment has its core competence in the manufacturing industry, especially the refinement of aluminium and plastic composites. In addition, brass, steel and more special metals are also important to the cluster.

The cluster's biggest competitive advantage, and technological focus, are expertise in the use of lightweight materials and automated production processes. About 60 percent of the cluster is involved in the production of vehicles.

There are also companies working with electronics, defence materials and oil and gas. However, with few exceptions, all members are production companies, and they thus have a common interest in the development of new or improved production technology, methods and processes.

Interviews show that there is little competition between cluster members in product markets, but that there is some competition in competence, especially in higher skill levels (college/university level). However, most sources emphasise that similarities in competence demand and great geographic proximity has provided opportunities for the exchange of skills and labour in periods where business cycles have affected the companies differently.

The companies in the cluster are highly export oriented, mainly as a result of being part of the automotive industry, and several of the companies are major global corporations.

2.3.4 Economies of scale

A high degree of geographical proximity is often viewed as an important precondition for releasing the potential of economies of scale. The cluster members are mostly situated in or close by Raufoss Industrial Park, which is a geographically limited area. The cluster members have clear commonalities in labour and competence demand, and the geographical proximity is assumed to facilitate the attraction of labour and competence through self-reinforcing mechanisms. Locations with clustered same-demanding businesses often attract labourers and competence, which attracts even more business, and in turn more labourers and competence.

Close geographical proximity also facilitates knowledge spill-overs, which means that knowledge developed or imported by one firm, is more easily

diffused to nearby firms. Thus, knowledge development in the cluster can be assumed to benefit the whole cluster, leading to a multiplier effect on value creation of any knowledge developed or imported by the cluster.

2.4 Relation basis in the cluster

This part of the evaluation presents the relational basis through members' knowledge of each other, their trust and confidence in each other, as well as the degree of collaboration and co-operation within the cluster.

2.4.1 Members' knowledge of and trust in each other, and information sharing

As the cluster has its starting point in an historical community, many companies knew each other well, even before the NCE programme was established. There has generally been a high level of trust among the companies, and the willingness to share competence, both in formal and informal situations, has been present the whole period. The cluster project has contributed to strengthening existing relations, and building new ones for the few companies that had little to no knowledge of each other. One has managed to open the community in the industrial park to companies around the area.

2.5 Earlier evaluations

NCE Raufoss has been evaluated at two earlier occasions, by Econ Pöry in 2009, and Damvad and Menon in 2012.

The last evaluation found that NCE Raufoss was an industrial environment that was ahead in both markets and technology, and that the activities that NCE Raufoss had so far prioritised had contributed to the further development of the strong industrial and technological characteristics of the cluster.

The cluster activities had thus contributed to value creation in the region.

They did however find that there was reason to assume that there were still unresolved synergies to be found if one continued the on-going processes, and they recommended that these activities were to be continued.

It was also noted that the cluster was behind schedule, per objectives on new establishments, and that activities meant to promote new establishments should be initiated during the remaining period. One also suggested that the cluster should consider the possibility of exploiting its international networks in this regard.

3 Activities

In this chapter, we will present activities that have been initiated or completed during the project period, as well as what the cluster wanted to achieve with these. The chapter is based on available annual reports and conducted interviews.

3.1 Activities

3.1.1 Activities for cluster development

The cluster has each year initiated several permanent meeting arenas, open forums and professional networks aimed at developing the relational basis and fellowship within the cluster. Interviews emphasise the importance of these activities, and the noticeable effect the relative reduction of such activities in 2016 had on the relational basis within the cluster.

3.1.2 Knowledge activities and collaboration

From the annual reports, we learn that the cluster has initiated several projects aimed at increasing knowledge or developing new or improved educational offers to the cluster, each year, see Table 2.

During the last project period, the cluster initiated several activities aimed at enhancing the competencies of the existing workforce, for example through activities aimed at lean production processes. In collaboration with NCE Systems Engineering, they have worked to develop a vocational school education in the field of plastics and composites, as well as single-grade courses at the university college level. The cluster has also collaborated with NTNU and Fagskolen Innlandet. Activities in the form of cluster internal competence networks have also been initiated, covering topics such as women in the

Table 2

Self-reported activities in available annual reports

Activity	2014	2015	2016
Number of permanent meeting arenas, open forums and professional networks	30	30	20
• Number of participants	>500	>500	>400
Number of collaborative relationships (agreements or project collaborations) with other clusters	NA	8	6
Number of collaborative relationships w/ foreign companies or institutions	25	25	NA
Number of innovation projects (with participants from several members) where the project has been the initiator or an active contributor	26	25	36
• Number of which were collaboration projects with R&D actors	26	25	5
• Number of which were collaboration projects with international partners	11	10	3
• Number of which included joint applications for funding from Innovation Norway, the Norwegian Research Council, the EU or other public funding.	26	25	5
Released R&D/innovation funds from funding agencies, in NOK mill.	140	120	51
Number of projects aimed at internationalisation (incl. study trips, knowledge acquisition, partnership search, networking, market research et cetera)	10	10	5
Number of projects aimed at increasing knowledge	9	7	4
Number of projects aimed at developing new/better educational offers to the cluster	5	4	2
Number of projects aimed at establishing new companies or number of newly established companies (number of employed)	2	2	2

Source: Annual reports – NCE Raufoss. 2014-2016

workforce, continuous improvement processes and market knowledge.

The trainee scheme «Trainee Innlandet» has been used as a common recruitment base during the last years. In practice, cluster companies have collaborated to recruit trainees and develop attractive trainee modules. Within the field of competence, one has also focused on familiarising local students with the business community in the region, as well as opportunities for summer jobs and thesis writing.

3.1.3 Innovation activities and collaboration

NCE Raufoss has reported many innovation projects with participants from several members during the last three years. Until 2016, all projects were in collaboration with R&D actors within and outside of the cluster, and almost half included international partners. The cluster has an active applicant for funding from national and international funding agencies, and has released between NOK 5 million and NOK 1 million in funding per project on average.

The cluster has worked continuously with the development of its New Business and Commercialisation department in collaboration with NTNU, development of its incubator, participation in SIVAs foresight process for future innovation and a new model for innovation in SMEs.

Further commercialisation of R&D results has also been emphasised in relation to SFI Manufacturing.

3.1.4 Cluster-to-cluster collaboration

The cluster has initiated or participated in multiple activities with other clusters, both formal and informal. We have not been able to measure cluster-to-cluster collaboration before 2015, but have learned from interviews and earlier evaluations that the cluster has initiated or taken part in several cluster-to-

cluster collaborations earlier. In 2015 and 2016, annual reports show that the cluster has initiated or taken part in 8 and 6 collaborations respectively. Together with NCE SEM in Halden and NCE SE in Kongsberg, the cluster has worked towards Clusters for Conversion status in latter time, as well as collaborated on an additional five separate projects with GCE Subsea, Greater Stavanger, NCE Eyde, iKuben and i4Plastics.

During the last project period, NCE Raufoss has also established cluster-to-cluster relations with foreign clusters, as described below.

3.1.5 Measures for increased internationalisation

The cluster has initiated between 5 and 10 projects or measures aimed at increasing the clusters degree of internationalisation each year.

A large share of the cluster members has an export share of 90 percent or more, and take part in global value chains. Therefore, the cluster has focused on strengthening cluster members in their value chains. In this work, activities related to SFI Manufacturing and projects funded by EU or other international sources, have been important contributions. Notable projects to position the cluster globally include the initiative Knowledge Innovation Community – Added Value Manufacturing.

In 2014, the cluster took over responsibility for the further development of the Gjøvik Region International School. The school is developed amongst other reasons to create a better foundation for the import of foreign expertise and business.

The cluster has also collaborated with foreign clusters or R&D environments. For example, annual reports show that the cluster has participated in the steering committee of a SME development programme in Sweden, as well as gone into cooperation deals with Swerea IVF, Technische Universität

München, the universities of Madrid and Freiburg, as well as the Gold Label cluster Kunststoff Cluster upper Austria.

3.2 Relevance of activities

As part of the evaluation, we will assess the relevance of the activities. Specifically, we will consider whether:

- The interaction processes are based on potential synergies between the actors
- The project has invested sufficiently in the development of relational assumptions – i.e. communication arenas, trust and identity-building processes – and,
- The activities are designed to lead to appropriate project results and long-term value creation effects.

3.2.1 Are the activities based on the potential synergies between the actors?

It is our understanding that most of the cluster activities have been based on potential synergies between the actors. This is especially true of the knowledge and competence enhancing activities, which for example have been aimed at strengthening the competence of the existing workforce, as well as developing vocational school education offers in the field of plastics and composites – important materials for a large share of the cluster members.

3.2.2 Has the cluster invested sufficiently in the development of the cluster's relational basis?

The cluster has each year initiated several meeting arenas, open forums and professional networks aimed at developing the relational basis and fellowship within the cluster. Interviews emphasise the importance of these activities for bringing the members together and increase their will and ability to

cooperate. In chapter 4, we will show the results of these activities, but it is our understanding that the cluster has invested sufficiently in the development of the cluster's relational basis, at least until the last year of programme support. Interviews reveal that there was a relatively large reduction in the number of such activities in 2016, which lead to an immediate weakening of the relational basis. This is both a testament to the importance of the activities initiated by the cluster, and to an argument that the cluster could have invested more in such activities in 2016.

3.2.3 Have the activities been designed to lead to appropriate project results and long-term value creation effects?

The cluster has initiated and completed numerous activities aimed at strengthening competence and knowledge, developing new products, gaining access to new markets or strengthening their position in existing ones, and strengthen their competitiveness. It is our understanding that these activities to a large degree has been designed to lead to appropriate project results and long-term value creation effects.

We will now consider the results from these activities.

4 Results and objective achievement

The overall vision of NCE Raufoss has been, through extensive cluster cooperation, to strengthen its market positions internationally and develop new profitable markets based on products and services with high levels of competence. For a more detailed description of its objectives, please see chapter ---.

We will now evaluate the results and objective achievements within different fields by drawing up concrete results from the cluster project. The NCE programme is part of the NIC programme, which aims to create economic growth, and we will therefore also assess any eventual economic effects.

4.1 Cluster and network development and collaboration

Interaction, collaboration and co-operation have always been a prominent feature of the cluster, but

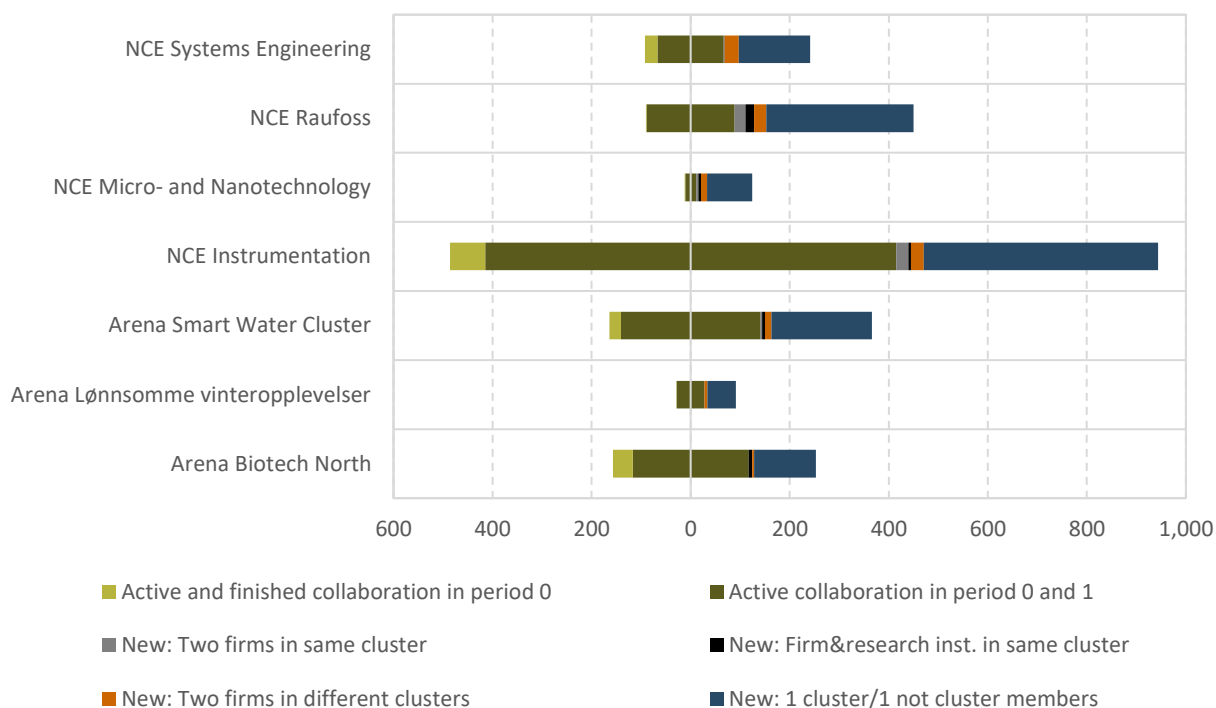
have been further enhanced by the programme. Older questionnaires show that a clear majority of the respondents have participated in collaborative activities during the project period, and interviews supports this notion.

The companies collaborate on everything from infrastructure in the park to elaborate R&D projects. They do not, however, collaborate much on product development, but rather in knowledge development and production processes and methods.

The cluster has developed cooperation forums where everyone has had the opportunity to contribute in all parts of the cluster operation, which has further contributed to a positive development in co-operation and interaction between the firms, interviewees tell us.

Figure 4.1

Increase in R&D collaboration through cluster network



Kilde: Samfunnsøkonomisk analyse

One interviewee told us that even though they had not participated in many collaborative projects, they had certainly collaborated more with R&D actors than they would have had if the cluster never existed. Most interviews state that the cluster project has also contributed to more collaboration with companies and actors outside of the industry park.

This development can be clearly seen in empirical data for collaborative cooperation between actors in different clusters (cf. figure 4.1). We have measured the extent to which members of the cluster have increased their R&D-oriented cooperative networks after joining the cluster. Compared with other clusters we have measured in this evaluation, NCE Raufoss has had a relatively large increase.

The cluster has also developed in other respects, for example by achieving Gold Label status. The Gold label status is a testament to the cluster facilitator's ability to operate the cluster effectively.

One of the most important results when it comes to cluster development is the realisation of SFI Manufacturing in 2014. The realisation was a result of a targeted effort by NCE Raufoss, SRM, NTNU and the University College of Gjøvik, and will be instrumental in for example the commercialisation of future R&D results.

The cluster did not achieve GCE status during the project period.

4.2 Competence and knowledge development

One of the most important areas the cluster has focused on, is the development, strengthening and diffusion of new and existing knowledge and competence within the cluster.

The cluster completed several competence or knowledge initiatives or projects within the fields of light-weight materials, lean production processes, national and international market knowledge, and so on. Many of these initiatives involved several cluster members working together.

Several projects have led to increased interaction with students, which is believed to have positive long-term effects on future recruitment to the cluster. For an example, the trainee scheme Trainee Innlandet, where cluster members worked together to develop new modules for trainees, led to a strengthened development of, and access to, labour with cluster-related competence.

The cluster has also secured competence funds for training future professionals, and has managed to develop several educational offers believed to lead to more relevant work supply. For example, the cluster was instrumental in establishing a vocational education offer in plastics and composite materials at Tinius vocational school, as well as college education offers at the University College of Gjøvik.

In 2013, Leanlab was relocated from Gjøvik to the Raufoss' industry park. Interviewees emphasise this as an important result. Through Leanlab, the cluster has managed to develop several new courses in lean production processes and related subjects, as well as trained their work force.

The 2014 annual report refers to two important results for the cluster's ability to develop new knowledge in the coming years – the grant of SFI Manufacturing, as well as continued base funding for SINTEF Raufoss Manufacturing.

Conducted interviews tell us that the cluster's competence and knowledge activities have resulted in

competence and knowledge build-up within the cluster during the project period.

4.3 Innovation

From the annual reports, we read that the cluster has completed many collaborative innovation projects per year, of which a majority were in collaboration with R&D actors and included joint applications for funding from Innovation Norway or other funding agencies. These activities have resulted in large sums of released funds and several new innovations yearly.

For the years of which we have access to annual reports, the cluster has reported around 10 new, and 30 improved, products or services each year, as well as around 45-50 improved production processes. The cluster has also realised new business, in the form of new companies, throughout the project period.

Questionnaires completed in 2015 and 2016 shows that about 50 percent of all respondents on average participated in at least one innovation project these two last years.

The grant of SFI Manufacturing must be seen as an important contributor to innovation activity and results in the cluster.

Throughout the second project period, the cluster has managed to secure a large sum of innovation funding from public funding agencies. This, in addition to private funding and local investments, has contributed to a strong growth in R&D costs, which in the last year had grown to about NOK 400 million per annum, from just NOK 40 million the year before becoming a NCE project.

From interviews, we have learned that cluster members have become more and more acquainted with the funding agencies, and that the positive development of relational basis has been important to facilitate collaboration in innovation projects and applications. Interviews also emphasise that the cluster has achieved positive results with connecting SMEs to the larger companies in innovation activities.

Table 3
Self-reported results and effects in available annual reports

Results	2014	2015	2016
Number of new innovations related to project activities:			
• Number of new companies	2	2	1
• Number of employees in new companies	NA	4	5
• New products or services	10	10	NA
• Improved products or services	35	30	NA
• Improved innovation processes	NA	10	NA
• Improved production processes	45	50	NA
• Improved organisational forms	15	10	NA
• New educational offers	NA	1	NA

Source: Annual reports – NCE Raufoss. 2014-2016

4.4 Internationalisation and market access

Throughout the second project period, the cluster has consistently been involved in a large number of collaborative relationships with foreign companies and institutions. A large number of the cluster's initiated innovation projects have also included international partners. The numbers have been mostly stable from what we can see in the annual reports. Interviews reveal that while most members had multiple international relations before the cluster was established, the cluster project has contributed to an increase or strengthening of such relations.

The cluster has also developed new insight in potential markets and possibilities abroad through foresight processes and projects aimed at internationalisation. Through meetings and gatherings, an increased understanding of each member's position in their respective global value chains has been achieved.

The establishment of Gjøvik International School must be seen as an important step towards increased internationalisation. This establishment is expected to create better conditions for growth in the region, and facilitate the insourcing of international expertise and investments.

During the last project period, the amount of foreign investment in the Raufoss cluster has continued to grow. In the last few years, one interviewee estimates that there have been investments in the size of about two billion kroner. For an example, an investment of NOK 250 million to develop new types of aluminium was recently made by a foreign actor. We have been told that the level of investments by foreign investors has never been higher, and that the cluster's position and network is emphasised as important reasons for this.

The cluster's participation in the international Knowledge Innovation Community initiative is, in annual reports, said to be a result of the active efforts to position the cluster, and Norway, in the midst of EU financed R&D and network activity. The cluster also participates in the steering committee of a Swedish SME development programme, which is expected to lead to an increased availability of Swedish suppliers and subcontractors to the Raufoss cluster.

4.5 Cluster-to-cluster collaboration

During the last years, the cluster has collaborated with at least eight national or international clusters. Examples include participation in the pilot project for Clusters for Conversions together with NCE Systems Engineering and NCE SMART Energy and the development of educational offers in collaboration with NCE Systems Engineering.

While it is hard to measure, the extensive cluster-to-cluster collaboration and networking NCE Raufoss has participated in can be expected to contribute to competitiveness in international markets.

4.6 Quantitative results

The cluster has had several quantitative objectives, of which we have been able to assess only a few.

The cluster had an ambition to develop and establish new companies with a turnover of NOK 1 billion and a total of 250 new employees. Our interviews reveal that this objective was not met, though the cluster did come far.

The cluster also had an ambition that the total NCE-driven development activity in the cluster were to be 5 times the size of the NCE funding (which is capped at maximum NOK 10 million per annum). In the annual reports for 2014 and 2015, the cluster

reports the release of NOK 140 million and NOK 120 million in R&D and innovation funding from funding agencies, which is a clear indication that they met this ambition in these years. In 2016, they only reported NOK 51 million released, but they also received just NOK 2.5 million in NCE funding that year. In addition, interviewees told us that the cluster had total R&D costs of NOK 400 million in year 2016.

4.7 Objective achievement

The cluster's stated objective concerning cluster development and collaboration includes the establishment and development of meeting places for discussion and exchanges of experiences. It is our belief that the cluster has worked efficiently and well towards meeting this objective. The cluster has been successful in developing well-attended meeting places that have led to increased collaboration and strengthened ties amongst cluster members.

Another stated objective has been to develop an attractive study environment for technology subjects together with NTNU and Gjøvik University College. It is our belief that the cluster has managed to do this through its work with developing educational offers in co-operation with said institutions and its work with the trainee scheme Trainee Innlandet. These, and other, cooperative activities have also contributed to linking education and research industries with the members, as per stated strategy.

We believe that the cluster has managed, to a high degree, to develop the necessary infrastructure to strengthen its competitive advantage. The establishment of SFI Manufacturing is an example of common infrastructure that will help to develop the cluster's competitive advantage and provide lasting value. The increased knowledge and competence

within the cluster, also at the SME level, also contributes to strengthened competitive advantage, as well as cementing the image of a dependable cluster with a robust network. Further, it is our belief that the innovation results, especially concerning the improved production processes, greatly contributes to a strengthened competitiveness, both nationally and internationally.

Regarding internationalisation, the great number of collaborative relationships with foreign companies and institutions, as well as the new insight in potential markets and possibilities abroad gained through foresight processes, also leads us to believe that the cluster to a high degree has achieved its stated objectives for internationalisation and attractiveness. The establishment of Gjøvik International School must also be seen as a small but important step towards increasing attractiveness.

While it can be hard to measure what the cluster has achieved concerning the attractiveness of the Raufoss cluster, the level of foreign investment and international collaboration, as well as the large number of foreign-owned companies that have decided to locate their operations in Raufoss, shows that the cluster has come a long way in this regard.

It is also clear that the cluster has managed to achieve good results concerning their more quantitative objectives. While we have only been able to assess a few of these objectives, conducted interviews have led us to believe that the only stated quantitative objective that was not met, was the objective of achieving a NOK 1 billion turnover in new businesses.

All in all, it is our belief that NCE Raufoss has a high degree of objective achievement.

Figure 4.2

Average number of employees. Core members in NCE Raufoss, compared with other limited liabilities in the same industry¹ (nationally, excl. all cluster participants). 2003-2016²

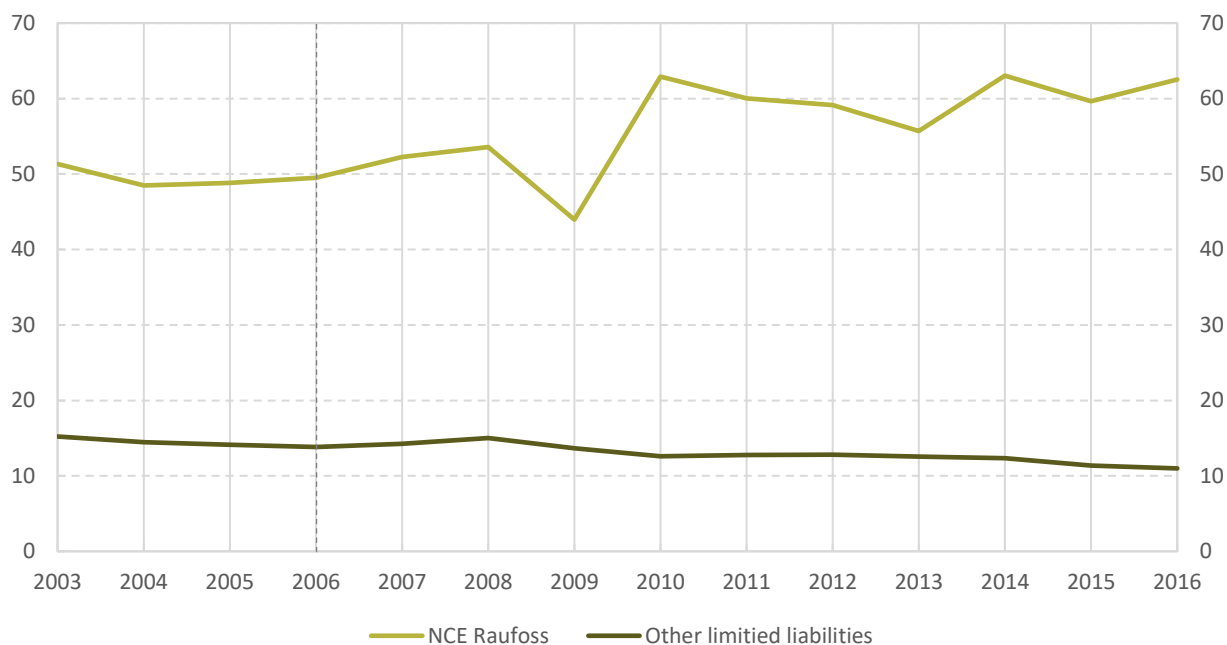
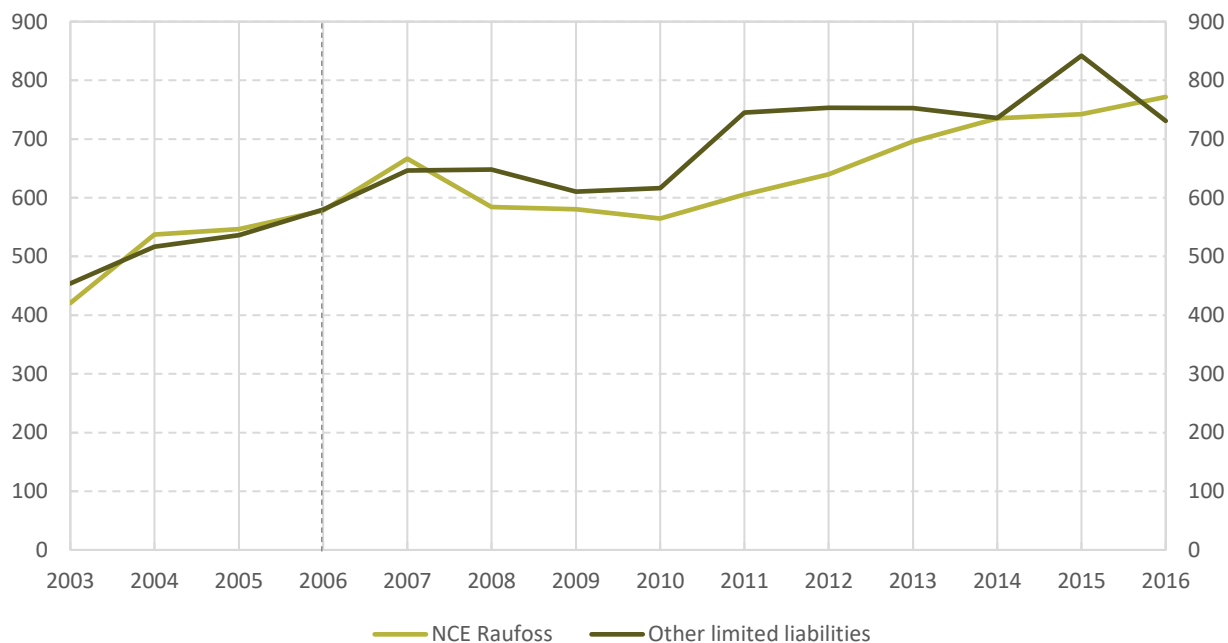


Figure 4.3

Average labour productivity³. Core members in NCE Raufoss, compared with other limited liabilities in the same industry (nationally, excl. all cluster participants). NOK 1 000. Current prices. 2003-2016



Source: Samfunnsøkonomisk analyse

1) Manufacturing of 24 basic metals, 25 fabricated metal prod., 26 electronic and optical products, 28 machinery and equipment and 29 motor vehicles etc.

2) NCE Raufoss was enrolled in the cluster program in 2006

3) Value added per full-time equivalent (FTE)

4.8 Economic effects

Based on annual reports, previously conducted surveys and our interviews with cluster members and facilitators, we believe that the cluster project has achieved their stated objectives and objectives to a high extent. We are now investigating whether this has led to measurable economic effects in terms of increased employment or increase value creation.

4.8.1 Employment and productivity trends

The total number of employees among core members has been quite stable throughout the second project period. However, number of employees has slightly increased in firms operating within fabricated metal production and the basic metals (cf. figure 2.1).

The average number of employees among core members in NCE Raufoss has been weakly growing over the project period, implying that the average core members has become larger. This is an indication for economic growth in the cluster. The development in NCE Raufoss is clearly better than in other LLCs within selected manufacturing industries (cf. figure 4.2).

In their annual reports, the cluster has reported an average productivity increase of about 5 percent yearly. This positive trend is confirmed in our data.

Average labour productivity⁸ among core members in NCE Raufoss has, overall, had a positive development throughout the period 2003-2016, and similar to other limited liabilities (LLCs) within the same manufacturing industries (cf. figure 4.3).

Whether this is a result of the project period is another matter. It is however our belief that the activities aimed at improving production processes, could be a valid explanation for this.

4.8.2 Value added

The fact that we find that the core members have experienced both employment growth and increased average labour productivity during the project period, implies that we should expect to find increasing value added among the core members as well.

The development in value added among the core members of NCE Raufoss is similar to their development in number of employees. Average value added is significantly higher than among other limited liabilities in the same industries (cf. figure 4.4).

Looking at growth in total value added for the core members of the cluster project, it is apparent that they also have experienced significantly higher growth than similar firms in the period after the start of the cluster project (cf. figure 4.5).

We cannot conclude that the higher growth among the core members in NCE Raufoss is an effect of the cluster project itself, based on the abovementioned comparison. However, our interviewees do emphasise that they themselves believe that the project activities and results have been important to their own economic growth. Our belief is that this may very well be the case.

⁸ Value added per full-time equivalent (FTE)

Figure 4.4

Average value added. Core members in NCE Raufoss, compared with other limited liabilities in the same industry¹ (nationally, excl. all cluster participants). NOK 1 000. Constant 2016-prices. 2003-2016²

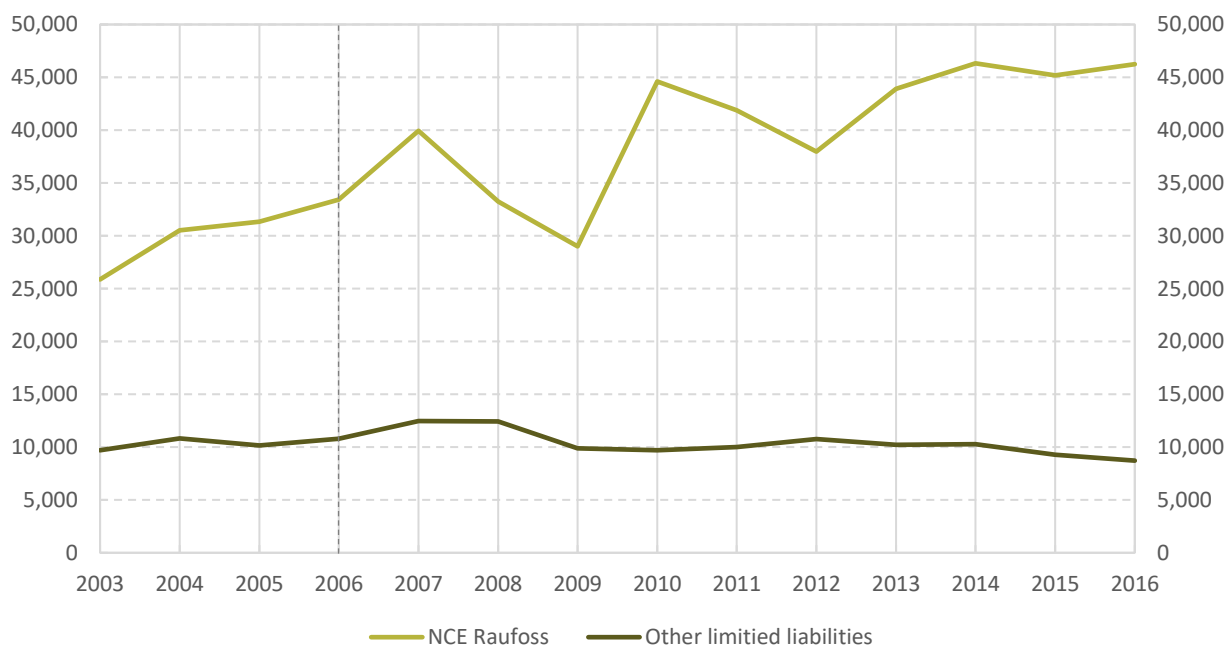
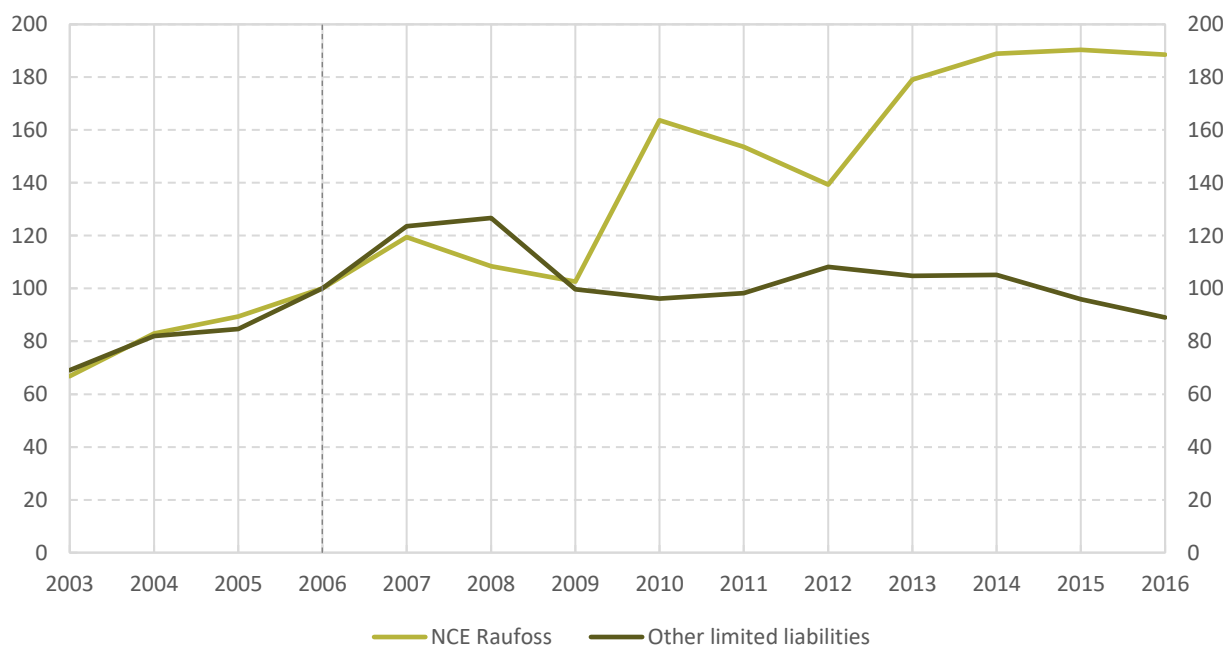


Figure 4.5

Total value added. Core members in NCE Raufoss, compared with other limited liabilities in the same industry (nationally, excl. all cluster participants). Index (2006=100). Constant 2016-prices. 2003-2016



Source: Samfunnsøkonomisk analyse

1) Manufacturing of 24 basic metals, 25 fabricated metal prod., 26 electronic and optical products, 28 machinery and equipment and 29 motor vehicles etc.

2) NCE Raufoss was enrolled in the cluster program in 2006

5 Overall assessment

NCE Raufoss is a cluster project which aims to become the national competence centre for lightweight materials and automated production processes. The companies in NCE Raufoss have a turnover of about NOK 13 billion and an export share of approximately 85 percent. In total, the cluster employs about 5 000 individuals, distributed between companies ranging from 10 to 1 000 employees. Several of the companies are part of global consortia.

The cluster environment has its core competence in the manufacturing industry, especially the refinement of aluminium and plastic composites. Its biggest competitive advantage, and thus technological focus, is expertise in the use of lightweight materials and automated production processes. The largest markets are the global automotive industry, the defense industry and the electronics industry. About 60 percent of the cluster is involved in the production of vehicles.

The cluster has its geographical core in Raufoss Industrial Park, but the cluster extends beyond this park. Several of the companies, especially among the SMEs, are in the Gjøvik region as a whole.

The last evaluation (Menon and Damvad, 2012) found that NCE Raufoss was an industrial environment that was ahead in both markets and technology, and that the activities that NCE Raufoss had so far prioritised had contributed to the further development of the strong industrial and technological characteristics of the cluster. They did however note that continued investment into cluster development could be beneficial for future results.

We find that the cluster has continued to initiate and complete activities based on potential synergies between actors, and that they have continued invest-

ing in cluster development to strengthen the relational basis of the cluster. We have further concluded that the initiated activities have been relevant to further strengthen the long-lasting value creation in the cluster.

NCE Raufoss has managed to realize the cluster's main objectives, strategical and quantitative. However, they have not been able to reach their target of new businesses with turnover of NOK 1 billion or more and 250 new employees, despite increased efforts during the last project period. We do however believe that this target may be reached in the future.

The average core members have grown, employee-wise, during the project period, despite a strong productivity increase. This implies increased economic activity in the cluster.

In available economic data, we have found that the cluster has increased the average value added per core member during the project period, and that this increase has been relatively stronger than for other NCEs and other LLCs within comparable manufacturing industries. It is also observable that the cluster's contribution to the total added value has been developing along a positive trend throughout the project period.

6 References

For this evaluation, the following documents have been used:

- NCE Raufoss' annual reports for 2014, 2015 and 2016
- Various articles on nceraufoss.no
- IN's questionnaires from 2014-2016
- Programme descriptions for NIC and NCE
- Earlier evaluations by Econ Pöyry (2009) and Damvad & Menon Business Economics (2012)

In addition, we have conducted interviews with the cluster management and cluster members.



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