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Networking for knowledge
An Evaluation of the SGC Model

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Abstract

The competitive advantages of companies as well as nations are assumed to arise from innovativeness. Research and development efforts might be organized in different ways - some better than others. In this paper, the Swedish Gas Centre model is discussed. It is based on creating and exploiting a focussed network of highly competent specialists from academia and business. By pooling resources from the government, the leading energy companies and a number of project partners, the SGC model gives synergy effects, leading to more and larger projects than if the R&D budgets were separate.

The Centre offers a window on technology. It functions very well in the initial stages of the innovation process from idea generation to selecting and monitoring development projects. It must also be judged as successful concerning promoting competence development within its special field and in building and dissemination information about energy gas R&D. Making new knowledge available for free to all comers via reports and via the web is beneficial to society at large. However, the commercialisation and marketing stages of the process ought to be given more attention. Other actors than SGC should be responsible for these functions, but more could be done by SGC to prepare for their activities. For instance, questions of ownership of the innovation ought to be clarified.

Introduction

Innovations, in the Schumpeterian sense of the term, are created by entrepreneurs who see a chance of making a profit that others have neglected (Schumpeter 1966). Thus they drive economic progress. Schumpeter predicted, however, that the large corporations would increasingly take over this role. The innovating function would be administered within their organizational framework. Today, the big progressive companies spend huge sums on research and development. Other actors are, however, also active in this field. The state administers, or at least tries to administer, the process of innovation. New structures are being built, but do they function according to the intentions behind their creation? In this paper, the particular Swedish Gas Centre (SGC) model for supporting research and development within the field of energy gases will be analysed and discussed.

Innovating through networks

The literature on the management of knowledge, innovation management and new product development is rich in both descriptive and prescriptive titles (see for instance Burgelman 2001, Cooper & Kleinschmidt 1990, Cooper , Edgett &

Kleinschmidt 1998, Cooper 2001, Farson 2002, Feldman & Link 2001, Lynskey & Jonekura 2002, Phillips 2001, Tidd, 2001). The main bulk of this literature, however, concerns the intra-firm innovation process, that is how companies manage or should manage their R&D and product development processes. During the last decades, however, the interest concerning innovations and new product development in networks of companies has grown, that is the inter-firm perspective has increased in importance (Håkansson 1987, 1989). An organization, working in such an environment needs to understand how the different, necessary competencies are distributed among the components of the network. In building the network, the relevant contacts should be located and chosen so that they do not overlap (Burt 1992). SGC is an example of how research and development might be organized according to the network principle, that is through creating a number of virtual temporary organizations.

Promoting innovation has become a recurrent theme in the industrial policy of developed nations. Innovation is perceived as the main driver behind the development of international competitiveness of companies as well as nations. Sweden is no exception to this rule and the Swedish Government has taken several policy measures to strengthen the country's innovativeness. Public agencies for implementing the industrial policy have existed in Sweden for a long time. Only recently, however, a special agency, Vinnova, for innovation systems was created. A number of other organizations with governmental support have also been created to promote innovativeness, which means the innovation is no longer only an intra-firm process but also an intra-organization process.

The early governmental intervention seems to have been based on the assumption that the bottleneck in the process of transforming inventions[1] into innovations consisted in lack of risk capital for new business ventures. Lately more attention has been paid to the earlier steps in the process, for instance coupling knowledge creation with business interests. The universities were seen as an under-utilized source of new knowledge. Seven Teknikbrostiftelser, foundations for bridging the gap between university research and business, were created in 1994 to complement the existing administrative structures. These foundations were endowed with circa 7 million euros each and they each received another 3 million euros later from the wage earners' funds. At that time, the large Swedish universities already had a special internal function aimed at creating contacts with the business environment and society at large. Some universities had also created special development organizations and

[1] The term invention refers to a newly created intellectual or material artefact. The term invention refers to the commercial application of an invention. An innovation might, for instance be a new product or service, a new way of organizing, a new method of production or the opening of a new market.

business incubators. In summary, in Sweden several different models exist for transforming university produced scientific knowledge into commercial use, as well as for increasing the awareness of the researchers concerning which problems business needs scientific help in solving. Svenskt Gastekniskt Center, (SGC), is a part of this complex pattern.

Innovating is a risky business, but at the same time, not innovating will destroy a company's or a nation's competitiveness in the not so long run. Research in business administration has shown that most product ideas that go into product development never reach the market, many of the products that do reach the market are not successful and successful products tend to have a shorter life than new products once had (Kotler 2000, p 330-331). Hence, it is important to study different models for organizing inter-organizational innovation, especially when the state is involved, to learn more about what seems to work.

This paper will discuss and evaluate the SGC *model* for generating new knowledge that might result in innovations, which means that, for instance, the scientific level of papers produced in the SGC context, its administrative routines et cetera will be discussed only briefly. In the discussion of the SGC model, comparisons with the bridging foundations and other inter-organizational arrangements for supporting and diffusing innovations will be made, but this paper is not intended to give an account of the whole organizational landscape concerning what is being done to create and support innovativeness in Sweden.

This report is based on written information and interviews with key persons[2]. Published and non-published reports from the Centre, information from its home-page and earlier evaluation reports as well as reports and home-pages of the seven bridge-foundations, Swedish National Energy Administration and the Danish Gas Centre have been analysed in search of descriptions of organizations and functions. The yearly summaries of SGC's activities have been a valuable source (Energigasteknisk utveckling). Interviews, mainly concerning how SGC functions, have been conducted with the employees of the Centre and with key persons representing business and university partners in SGC's programs and projects.

A small selection from the vast scientific literature on innovations has been used to outline the frame of reference of innovation as an inter-organizational process.

A snapshot picture of SGC

SGC, that is Svenskt Gastekniskt Center (literally translated: Swedish Gas Technical Centre), was created in 1990 to support competence development concerning the use

[2] A list of the interviewees is given at the end of the report.

of natural gas and to increase the leverage of the separate research budgets by a number of energy companies that were also suppliers of natural gas in, primarily, southern Sweden. Natural gas played, and still plays, a very minor role in the Swedish energy supply, as it accounts for circa 1% of the total energy use. Industrial users and heating and power plants use about 80%, and households use circa 20%. A marginal amount is used for vehicles (STEM 2002). Sweden does not exploit any major gas sources of its own, instead natural gas is imported from Denmark with Nova Natural Gas as the sole importer. The political attitude in Sweden to increased use of natural gas from gas fields has been rather negative, as it is a fossil fuel. However, biogas, which is generated from renewable sources, is regarded in a more friendly light. Great expectations are also tied to the future use of hydrogen[3]. The international use of energy gas is predicted to increase both as an environmentally friendly replacement of oil and coal and to cover a growing demand for energy. This provides an opportunity for innovative Swedish companies to enter new markets. The role of SGC concerns supporting such a development by providing a window on technology development.

SGC is owned by the Swedish Gas Association and five energy companies. According to the policy of SGC, its main task concerns efficiently coordinating Swedish research, development and demonstration concerning the uses of energy gas. Building competencies in this field is an important task. Dissemination of information and building networks are also integral parts of SGC's policy. The Centre collates and disseminates information via reports, information booklets, the so-called Gas Academy and via the portal www.GasOnline.nu. Sponsoring demonstration projects, where applications are shown to work in practical settings outside the laboratory, is also part of SGC's activities.

The Centre is financed jointly by the owners (circa 20%), The Swedish National Energy Administration (circa 30%) and industry (circa 50%). The Energy Administration (STEM) has allocated funding for collective research programs for different periods. The current three-year program has received 1,5 million euro from STEM.

A board and five program councils make the policy decisions, while a CEO and four other employees manage the operational side of the Centre's activities. The board consist of six members, three chosen by industry and three by STEM.
The Centre's activities are organized in five program areas. A Program Council, one for each program, assesses the relevance for the actors in the gas industry of the project proposals.

[3] The energy gases with which SGC works are natural gas, LPG, biogas and hydrogen.

The Centre has no money of its own for project funding, but it can cover up to 40% of a project's budgeted costs from contributions from STEM. A special committee, consisting of three persons, nominated by STEM and three by the energy companies, decide which projects shall be financed by STEM. The five energy companies are free to choose which projects to fund and the amount of funding. The partners in the actual project are expected to cover the remaining 60 % of the project's budget. In 2001 1,2 million euro was spent on projects, while administering the Centre cost nearly 0,4 million euro.

SGC has concentrated its efforts in five areas or programs, (Energigasteknisk utveckling 2001).

- *The environment – environmental effects of the use of energy gases.*
  One project in this program concerns emissions of NO_x from gas stoves in apartments and how these emissions might be reduced. These are considered as health hazards. Another project compares the effectiveness, emissions etc. of different solid, fluid and gaseous fuels.

- *Distribution and storage of energy gases*
  One project in this area concerns visualization of gas for the utilities and for the environment (VOGUE), the purpose of which is to develop remote detection of gas leaks systems. The project budget is circa 3 million euro. Another project concerns mobile ground radar, the purpose of which is to detect underground pipes and cables. In another project plastic and steel pipes are compared, both from an economic and a technological standpoint.

- *Biogas*
  Adding gas from biomass to the gas grid is one project within this program. Another project concerns developing quality assurance systems for biogas.

- *Practical applications* (within several fields, for instance hydrogen)
  One project within this program concerns an optimised microturbine energy system (OMES). This is a demonstration and evaluation project where microturbines are used in real-life settings. Another project, "the cucumber turbine", shows how to enhance cucumber growth by emissions from a microturbine. The project "Low emission gas engines for vehicles" aims at developing a robust gas engine. Partners in the project are, among others, Volvo and Scania. Other projects concern natural gas as raw material for chemicals and engine fuel, and the development of catalytic IR-panel. Other projects concern hydrogen technology, for instance mixing hydrogen in the fuel for gas buses in order to lower total energy use.

- *Gas turbines, combined heat and power (cogeneration).*
  The single project in this program concerns the evaluation of a new gas turbine. The project budget is circa 0,5 million euro, which makes this one of the larger projects.

Business and academia in the innovation process

Inventions, or new knowledge from academic research, do not automatically lead to innovations, in the sense of the term that is used here. A transformation of the ideas for business purposes has to be made. The process leading to successful innovations can be imagined as a series of functions. The critical functions in an evolutionary process as this consist of the generation of variation, the selection of certain variations and the rejection of others, and the retention and spread of the selected varieties (Aldrich 1999). This means that a function for generating a variety of ideas of possible innovations must exist, which must then be coupled with a function for selecting the ideas that seem worthwhile to develop. A function for monitoring their development must also exist, which at the same time allows for the sorting out of failures. Failures might occur due to bad project management, as when budgets and time frames are not respected. They might also arise from the insight that the idea lacks potential commercial viability or does not make sense as a scientific effort. The quicker the failures can be detected and sorted out, the more effectively the process works (Farson 2002). Finally a function for implementing and disseminating the remaining ideas into organizational frameworks for commercial use must exist. The organization exploiting the innovation might either be a company created for the purpose or an already existing one.

In the business administration literature, the ingredients in the successful management of innovations are usually described in roughly the same way, that is an effective organizational arrangement for idea generation and screening, product development, test marketing and commercialisation. Time to market has become an important measure of R&D performance. The early models of diffusion of innovations, concerning its adoption at various rates by different categories of consumers/users are now being replaced by more complex models where “relevant social groups” compete about the social construction of the new facts and artefacts (Rogers 1983, Bijker et al 1987). In the SGC model “relevant social groups” cooperate to develop new knowledge about energy gas.

The SGC model

The generative role

SGC works in an environment where new knowledge is created through the creative collaboration between people representing scientific knowledge and people representing business interests and having practical problems. In this respect, SGC is not wholly unique, as the seven bridging foundations and the universities themselves have similar roles. Their organizational arrangements, however, differ from SGC's on several points.

A combination of representatives of business and academia has the potential of generating a host of possible innovation projects. It seems that both government and academia mean that spontaneous cooperation occurs too seldom, the encounters between competencies and problems have to be administered. The existing policy rests on a metaphor, saying that the bridge allowing smooth two-way traffic between the world of academic research and the world of business is too narrow.

The main Swedish universities all have a function for catching possible ideas for commercialisation, as well as for piloting practical problems from business into the relevant research. These institutions, however, are often engaged mainly in what might be called “trawling” for ideas among the university departments and researchers, which gives a catch of a very wide variety of both good and bad ideas with no guarantees for not missing some very good ideas and not catching some very bad ideas. Some of the input of ideas to the bridge foundations is created through this trawling activity, but the bridge foundations also receive ideas that have not been caught in the university net. The foundations are able to offer better incentives in the form of development help and financing than the university can, and some academic researchers prefer to go straight to the foundations, especially those who want to found their own company.

SGC solves the idea generation problem by establishing a wide network in both worlds, so that the right partners can be joined. SGC might be seen as an example of the multiplier effects of efficient networking. In comparison with the universities’ and the bridging foundations’ ways of working, the SGC model seems to generate fewer but better ideas by being focused on a certain area of research and application, hence being able to pinpoint relevant specialist competence. Gas technology is not a well-defined discipline. It covers such fields of knowledge as combustion sciences, chemical engineering, heat transfer, civil engineering, materials technology and mechanical engineering (STEM ER 6:2000). The possible applications of gas technology are also manifold. This means that SGC’s contacts have to come from several different departments in the universities and from many industry branches.

SGC also has to locate those persons who represent the forefront in research and commercial use.

The universities and bridging foundations generate the main bulk of ideas for further development from inside the universities. In the case of SGC, a number of ideas also stem from the researchers. The main idea flow to SGC, however, comes from the business side, that is from the owners and from other companies. This is also advantageous, as ideas generated by users have a better chance of success than those generated by "technological push" (von Hippel 1988, Jewkes, Sawers & Stilleman 1969).

The selective role

Academic researchers are seldom good at appreciating the commercial potential of their ideas. They are sometimes not interested in possible commercialisation, or if they are, they lack training in how to go about it. Consequently, the university or the bridging foundation has to provide help to carry out even the simple analyses of projected supply and demand conditions that are taught at business schools. The cost and the quality of this help vary. Often outside consultants are called in who might be experts at doing market and competitor analyses, but do not have a special insight into the industry in question.

During the last years, SGC has evaluated between 130 and 140 ideas for research and development projects per year. Usually 30 - 40 projects per year are undertaken. Most of the projects have budgets of less than a half million euro.

SGC has several built-in selective mechanisms that help it to focus and to use both scientific and commercial expertise[4]. The Board decides on a three-year program that is continuously updated and evaluated. A Program Council for each of the five programs implements the policy, for instance by judging the relevance of the project proposals.

According to its current program for research and development, the Centre works only in the field of energy gases. Hence, projects concerning other uses of gas are excluded. It works only with applied research projects. Hence, basic research on energy gases and ordinary product development projects are filtered away. Finally, it focuses on projects within five program areas, which excludes projects concerning other uses of energy gases. Discussions with researchers and practitioners, travels, study visits and conference participation provides the input to the program. SGC is not, however, only reacting on signals from its environment, it can also actively

[4] The notion that ideas have to pass through a number of filters, before they are accepted and implemented is discussed in Persson 1982. It could however be added that an idea is transformed during the passage through the various filters.

promote ideas for research and development projects of common interest that other development agencies are neglecting. For instance, SGC now runs projects concerning biogas and hydrogen.

Due to the risk of "free-riding" single companies are reluctant to engage in projects where one or a few companies have to bear the development costs and failure risks, while the eventual benefits are shared among others, such as companies inside or outside the industry in question and consumers in general. Economists would say that such projects generate positive externalities. SGC is able to fill this gap. Examples of projects with large potential positive externalities that have been undertaken by the Centre are ground radar (to detect buried pipes and lines) and maintenance technology. When the results from these projects are implemented, cost-savings for a number of different users will be achieved.

The question whether the taxpayers' money should be used for development projects that benefit a single company might be raised, as a conflict between private and public interests in the exploitation of the results exists. A company will want to hoard the knowledge to sharpen its competitive advantage, while the public interest concerns spreading and sharing it – at least within the industry or the nation.

So far, the problem has not arisen. Most of the projects undertaken by the Centre do not reach into the commercialisation phase. To close the gap between R&D and commercialisation might be very costly. Large companies which participate in a project has to fulfil this function. The "Low emission gas engine" where Volvo and Scania are among the partners is an example of such a project.

The economic filter incorporated in the bridging foundations' construction consists in that the government has stipulated that the original capital has to be returned to the Government, when the foundations are dissolved in 2007. The assumption is that this will make the bridging foundations more interested in making profitable investments. Unfortunately, the bridging foundations are confronted with a double message – on the one hand they are expected to support very risky projects, that other venture capital institutions are not interested in, on the other hand, they must keep their original funds intact. SGC is not faced with such demands. Yet the filter that stops most of the ideas for projects that are turned down is the economic filter. Only projects where partners and the owners provide the necessary financing can pass. However, no large numbers of ideas fall on that hindrance – most projects are not very expensive, and for the big companies, pitching in a few thousand euros into an interesting idea is perceived as a rather cheap option.

The SGC model also incorporates a scientific relevance filter. The researchers involved in any project are pursuing their academic careers, hence they will engage only in projects that are seen as having a scientific value. SGC has helped financing several doctoral and licentiate dissertations. This makes SGC an important part in the production of competence. It is worth noting that SGC's networking activities also build bridges both among universities and across university disciplines, which is an advantage. One example of this bridge-building activity is a greenhouse project, concerning gas fired IR-panels in greenhouses, where technological and agrarian competencies from different departments of two universities were involved (Näslund & Schussler 2002).

The Danish Gas Technology Centre (Dansk Gasteknisk Center) which is owned by the Danish gas companies is more application oriented than SGC. Furthermore, it is expected to cover its costs. In comparison, the SGC model seems to generate more positive externalities for society than the Danish one.

The SGC model also contains an economic relevance filter that universities and bridging foundations lack. The owners' contributions to a project are voluntary, and as the participants in each actual project have to bear the main part of the financial burden, only projects that are judged as having a fair chance of becoming commercially worthwhile will be considered. Projects having only marginal chances of success will be filtered away. As the owner companies and the companies participating in the projects have deep knowledge of the industry in question, the probability of their picking winners and turning down losers ought to be high. As an extra bonus, no outside consultants have to be paid. In 1999 the relevance of the Centre's work for academia and industry was evaluated, with a favourable result (ER 6:2000).

It should be underlined that the nature of the projects SGC undertakes has changed over the years. They used to be focussed on questions that were mainly interesting for the gas/energy companies. Today the projects are more application oriented, as circa 50 % of the total project budget is covered by manufacturing companies. In this respect, the Centre compares favourably with the universities and the bridge foundations, which often have to contribute to forming an organization to host the further development of an idea. The mortality of these start-up companies is high, and the performance of the survivors is in general not impressive. Implanting an idea in an already existing organization means efficiency gains, for instance that time-to-market will be significantly shorter.

It is worth noting that many of the partners in SGC's projects are small and medium sized companies. This is both a strength and a weakness. It is usually quite hard to

involve SME's in development work with academic connections. However, SME's are seldom able to finance the development and marketing efforts that are needed to turn a prototype into a successful commercial offering. Here SGC might take a more proactive role and if not actually widen its network to venture capital companies, at least make these aware of the commercial possibilities that SGC projects might generate. As was said earlier, the use of energy gas is predicted to increase significantly, which means that the possible market for innovative companies also grows.

The monitoring role
SGC ensures that the projects that are started will be managed according to the principles of project management (Nicholas 2001). The budget, the time schedule, the project leader and the project team as well as the defined task must be approved, before the activities in any SGC project can begin. (See appendix 1). The routines to be followed are documented in a special PM, to ensure the high quality of the end products (PM Arbetsformer inom SGC, rev 2001-08-14). The large projects are monitored by a reference group, which often provides good viewpoints and interesting discussions, according to interviewed researchers. The progress reports have to be submitted regularly and deviations from the plans are followed up by SGC. Serious deviations from the budget and time schedule might result in termination of the project. This has, however, occurred very seldom. SGC also engages very actively in informal contacts with its project leaders, hence deviations from project plans can be attended to before they grow large.

SGC helps the project groups by taking care of the necessary paperwork in connection with the financing from STEM. According to the interviewed researchers SGC is seen as a good partner. The Centre keeps a close watch on the project while being flexible and informal.

The implementing role
While SGC is acquitting itself quite well as a research and development agency, its results are to a very small extent carried over into offerings of products and services for the home market or the growing international market. The projects result in a report, a demonstration or a prototype and that is where SGC's responsibility ends. The main results of SGC's activities today might be seen as production of new knowledge and competence. If further work is needed to take the invention/innovation to the market, this role rests with the project partners. The question of ownership of the idea, however, seems to be rather unclear (interviews). The partners in a particular project all have a right to claim the idea on a first come, first serve agreement. So far, this arrangement has not caused any conflicts. The bridging foundations seem to have a better organization for solving ownership

problems, as they work with a system of different standard contracts. The bridging foundations might also become owners of patents, licences and companies in their own right, if no suitable other suitable solutions is found, which means that an idea always has an organizational support. SGC cannot play these roles. Adding such responsibilities to the Centre would not be suitable, as it would mean that the distinctive competence profile SGC now has would become blurred. SGC might, however, demand that commercialisation aspects are included in the project plans. SGC could also be more proactive concerning the small and medium sized companies, by alerting venture capitalist to interesting R&D projects in these companies.

The disseminating role
As SGC's activities concern the very early stages of technical development, it is difficult to tell if commercial successes have emanated from its projects. The later stages and the commercialisation of the products have to be undertaken by companies in the industry, which means that several years might pass before a concrete product is launched on the market. A few projects are perceived as having great potential, such as the low emission gas engine that is now being developed by a number of partners. The cost-saving potentials of the ground radar and the maintenance projects are great, but have to be exploited. As was pointed out earlier, SGC's main function today is producing and dissemination new knowledge.

Assessment
The established networks and the networking activities of the Centre ensure that ideas from business and academia for R&D concerning energy gases are generated and developed. The focussed structure of the program and the inbuilt scientific and economic filters ensures that the chosen projects have a high probability of successful conclusion. SGC monitors its projects efficiently and is perceived as an interested, flexible and non-bureaucratic organization by project partners both from academia and business. The dissemination of information about new developments in the field seems to work well. That the information is provided for free is a positive externality of the Centre's activities.

The SGC model seems to work very well for research and development efforts within a limited field where both academic research traditions and business interests have been established. SGC creates new knowledge and competence by efficient networking, building virtual temporal organizations. The SGC receives ideas for projects from both industry and research, but it can also initiate projects itself in areas that otherwise might have been neglected. The pooling of research resources from the state, the leading energy companies and various project partners allow for synergy effects. SGC could, however, be more proactive in ensuring that the projects will

result in products and services for the market. This is especially important concerning R&D projects in small and medium sized firms. It is also important that questions about ownership of the ideas being developed are clarified. The administration costs of SGC seem low in relation to the total budget. In view of the growing national and international interest in energy gases, the Centre is probably undercapitalised.

Interviewees

Mohsen Assadi, Värme- och Kraftteknik, LTH

Staffan Ivarsson, Sydgas AB

Jan Jensen, Dansk Gasteknisk Center

Owe Jönsson, development engineer at SGC

Agne Karlsson, Alstom Power AB

Sven-Åke Ljungberg, Högskolan i Gävle, Institutionen för byggd miljö

Christer Morén, Linde/AGA

Corfitz Norén, development engineer at SGC

Christer Olsson, Öresundskraft Produktion

Johan Rietz, CEO of SGC

Fredrik Silversand, Catator AB

Katherine Smedberg, administrator at SGC

Hans Stymne, Högskolan i Gävle, Institutionen för byggd miljö

Stig Stenström, Kemicentrum, Kemisk apparatteknik

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Årsredovisningar 1996-2001 för Svenskt Gastekniskt Centrum

Project management at SGC *Appendix 1*

Generation Scientific & Economic filters Monitoring Retention & Dissemination

Project ideas

Assigning priorities, planning

Project proposals

SGC/STEM
Program Councils
Other backers

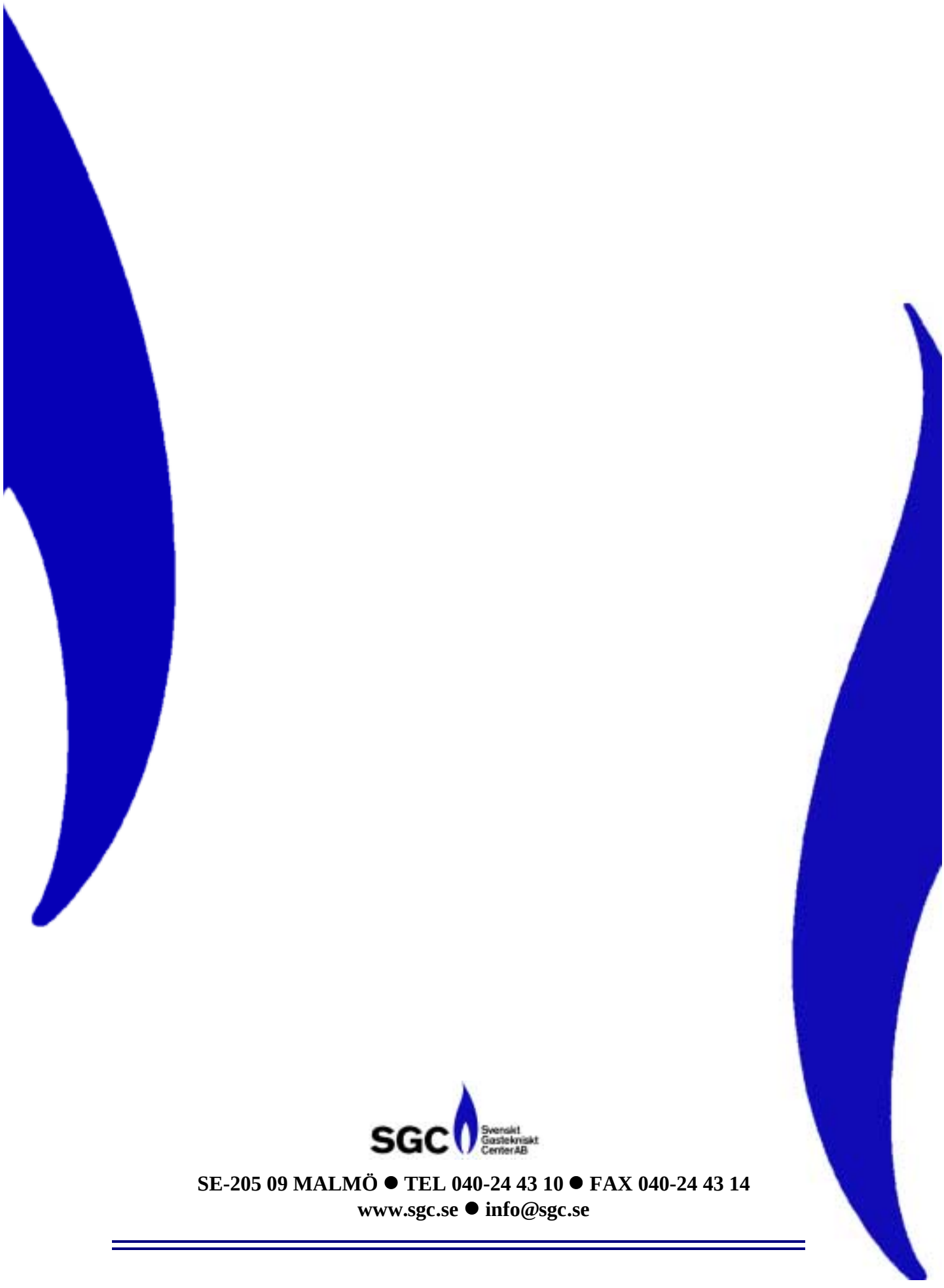
Project order

Reference groups

Reports

Final report

Information about results,
SGC reports & web-page



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