Evaluation report

Research projects initiated by Formas-BIC 2003–2006

formas

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Content

Preface

Formas, the Research Council for Environment, Agricultural Sciences and Spatial Planning, and the Swedish Construction Sector Innovation Centre (BIC) have since 2003 made a number of joint calls for research grant applications, the aim being to combine their efforts to give Swedish construction research a strong position, both nationally and internationally, in the pursuit of sustainable development and economic growth. A declaration of intent to this effect was signed in December 2002. So far, fourteen joint calls have been completed, half of them international (within Erabuild/Eracobuild).

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The first five calls have been evaluated previously (2006). At that time no supporting documentation was available in the form of concluded projects, and so the focus of attention was on the smoothness of co-operation. The conclusions indicated that co-operation and project generation had worked well on the whole, but that where follow-up and communication of findings were concerned there was room for improvement.

By the time of the present evaluation (2010), several research and development projects had been concluded, which meant that a platform now existed for analysing, for example, the scientific quality, practical relevance and benefit of the projects funded. Particular importance has been attached to implementation, a special requirement in these calls having been for the construction industry to account for at least half the funding and for all projects to have an implementation leader. A total of 71 concluded projects emanating from five calls between 2003 and 2006 were evaluated..

The evaluation was performed by an international panel made up of five active researchers from the engineering research community. The evaluation highlights the scientific quality of the projects, the relevance of the scope and research questions as well as the quality and quantity of the output and its impact on the construction industry and society as a whole.

Most of the research was considered to be of acceptable quality by international comparisons.. However, the panel also identified some challenging areas in need of improvement, e.g. scientific dissemination and the transfer of relevant knowledge from scientists to stakeholders. The societal benefits and the benefits gained by the companies involved were on average found to be acceptable, but with too many projects performed unacceptably in the implementation phase, even though a respectable number of projects performing excellently in this respect have also been identified.

Formas is grateful to the evaluation panel for its important and excellent work and would especially like to thank Professor Henrik Stang, Technical University of Denmark, for his excellent work as chairman of the panel. The recommendations of the evaluation panel are highly appreciated by Formas, and hopefully also by scientists, universities and university colleges, and stakeholders/end-users.

Stockholm July 2011

Rolf Annerberg
Director General
Formas

Executive summary

An evaluation is presented of the research funded through the Formas-BIC collaboration*, which has been ongoing since 2003. The evaluation, which covers 71 projects initiated in the period 2003–2006, highlights the scientific quality of the projects, the relevance of the scope and research questions as well as the quality and quantity of the output and impact on the construction industry and society as a whole. The added value of the Formas-BIC collaboration has been evaluated through specific considerations of the quality and success of the implementation plans, which constitute an integrated part of the project plans submitted in response to the Formas-BIC calls.

The evaluation committee consisted of five researchers from the civil engineering research community with competences covering the entire scope of the projects under consideration. The 71 projects were divided into six thematic areas to facilitate analysis across smaller groups and to separate research environments, companies and stakeholders across the construction sector. Each project was reviewed by two reviewers – in a few cases more – according to the thematic area of the project and the competences of the reviewers. The working methodology of the committee is summarized and the results discussed in detail.

The review of the projects resulted in a numerical evaluation between 1 and 5 (5 indicating highest quality or relevance) in a total of 13 questions. Commentaries on each question were added as well, to further substantiate the evaluation.

Overall it is concluded that the Formas-BIC effort was worthwhile and that the projects funded covered a broad range of relevant and contemporary research issue in the building sector. The overall project score is acceptable, the distribution of the score showing only six projects (approx. 8 %) being ranked as somewhat insufficient and a single project being close to insufficient and twenty projects between good and excellent.

*) In 2010 IQS - the Swedish Centre for Innovation and Quality in the Built Environment – was founded as a result of a merge between the Swedish Construction Sector Innovation Centre (BIC) and the Council for Constructing Excellence (BQR)– www.iqs.se.

Formas collaboration with the Swedish construction sector continues within the framework of IQS in order to encourage research, implementation of research results, quality work and innovation processes.

The scores on questions related to research quality show weaknesses particularly in the area of scientific dissemination, where the score is significantly below the acceptable limit. There seems to be a discrepancy between the project performance in this respect and the potential of the project plans and project groups.

When it comes to evaluation of the overall research issues and the communication and impact of the results and evaluation of the benefits for the involved companies and society as a whole, the average performance of the projects is acceptable. However, it is considered somewhat discouraging that the performance specifically in implementation is not evaluated higher – considering the specific emphasis on implementation in the project setup and the high emphasis on implementation in the calls and their thematic areas. It appears that more than 20 projects either did not succeed in making a difference to the companies involved or that the differences made cannot be evaluated at present and/or the tools to make this evaluation are not forthcoming.

More detailed conclusions are drawn in each of the six thematic areas.

Finally – after discussing the main strengths and weaknesses of the project portfolio – a set of recommendations for continuation of the Formas-BIC type of calls is given:

- *The size of the projects* in the calls considered is of some concern, and there are indications that some are simply below a critical size. It should be considered to establish a lower limit or a range of acceptable project size.

- *The way in which implementation is integrated in research projects* in future calls should be carefully considered. It is recommended that the following issues be carefully and explicitly evaluated during the evaluation process:

    - Previous experience and qualifications of the research partner(s) and project leader in implementation (and possibly innovation) work.

    - Previous experience and qualifications of the industrial partner(s) and implementation leader in implementation (and possibly innovation) work as well as academic background.

- The quality of the implementation plan including the resources associated. The implementation plan should be evaluated upfront together with the research plan and the links between the two should be carefully considered.

- *Cross-disciplinary research* should be encouraged in future calls.

- *The follow-up and reporting procedures* imposed on the project leaders should be improved. Reporting forms, including original project and implementation plans together with output reports, including links to reports, conferences and papers, should be made readily available on the Internet.

Sammanfattning (Executive summary in Swedish)

Rapporten redovisar en utvärdering av den forskning som finansierats inom ramen för samarbetet mellan Formas-BIC (Byggsektorns Innovationscentrum), vilket pågått sedan 2003. Utvärderingen omfattar 71 projekt initierade under perioden 2003-2006 och belyser såväl projektens vetenskapliga kvalitet, relevans och forskningsfrågor som resultatens kvalitet och kvantitet samt dess inverkan på byggsektorn och samhället i stort. Mervärdet av Formas-BIC-samarbetet har utvärderats genom specifika överväganden av kvalitet och framgång med den implementeringsplan, som enligt utlysningarnas krav har varit en integrerad del av respektive projektplan.

Utvärderingsgruppen har bestått av fem byggforskare, vars kompetenser täcker hela bredden av bedömda projekt. De 71 projekten delades in i sex tematiska områden för att underlätta analys i mindre grupper och för att särskilja forskningsområden, företag och intressenter inom byggsektorn. Varje projekt bedömdes av två granskare – i några fall fler – med utgångspunkt från projektens ämnesområde och granskarnas kompetens. I rapporten sammanfattas gruppens arbetsmetod och utvärderingsresultatet diskuteras i detalj.

Projekten rankades på en skala från 1–5 med avseende på totalt 13 frågor (där 5 indikerar högst kvalitet eller relevans). Granskarna har också haft möjlighet att utöver poängen lämna kommentarer.

Sammanfattningsvis bedömer utvärderingsgruppen att Formas-BIC-satsningen varit värdefull och att de finansierade projekten täckt ett brett spektrum av forskningsfrågor som är relevanta och aktuella inom byggsektorn. Det sammanvägda resultatet är acceptabelt – endast sex projekt (cirka 8 %) har rankats som något otillräckliga, ett enda projekt som i det närmaste otillräckligt och tjugo projekt som bra eller excellenta.

Bedömningen av de frågor som relaterar till forskningskvalitet visar på svagheter, främst vad gäller vetenskaplig

spridning av resultaten. Poängen där ligger väsentligt under den acceptabla nivån. Det verkar finnas en skillnad mellan genomförandet av projektet i detta hänseende och projektplanens respektive projektgruppens potential.

Vad gäller utvärderingen av de övergripande forskningsfrågorna, kommunikationen och resultatens genomslag samt utvärderingen av fördelarna för involverade företag och samhället i stort, är projektgenomförandet i genomsnitt acceptabelt.

Det är dock något nedslående att implementeringen inte fått högre poäng – med tanke på den speciella betoningen på implementering i projektuppläggen och den likaså starka betoningen av implementering i utlysningen och dess tematiska områden. Det visar sig att mer än tjugo projekt antingen inte medfört något mervärde för de deltagande företagen eller att den förändring som projektet medfört inte kan utvärderas för närvarande och/eller att verktygen för att göra denna utvärdering inte är tillgängliga.

Mer detaljerade slutsatser dras för vart och ett av de sex tematiska områdena.

Avslutningsvis – efter att ha diskuterat de huvudsakliga styrkorna och svagheterna i projektportföljen – ges ett antal rekommendationer inför kommande utlysningar av samma karaktär:

- *Projektens storlek* bör beaktas. Det finns tecken på att vissa projekts storlek helt enkelt ligger under en kritisk gräns. Formas bör överväga att sätta en lägsta gräns eller ange spännvidden för en acceptabel projektstorlek.

- *Det sätt på vilket implementeringen integreras i forskningsprojekten* bör noga övervägas. Rekommendationen är att följande frågor tydliggörs och noga bedöms under utvärderingsprocessen.

    - Vetenskapliga samarbetspartners och projektledarens tidigare erfarenhet och kvalifikationer vad gäller implementering (och eventuellt även innovation).

    - Industripartners och implementeringsledarens erfarenhet och kvalifikationer beträffande implementeringsarbete (och eventuellt även innovation) samt akademiska bakgrund.

- Implementeringsplanens kvalitet inklusive därtill kopplade resurser. Implementeringsplanen ska utvärderas direkt tillsammans med forskningsplanen och sambanden mellan dessa bör noga beaktas.

- *Tvärdisciplinär forskning* bör uppmuntras.

- *Uppföljning och rapporteringsrutiner* som åläggs projektledarna bör förbättras. Rapporteringsformulär, inklusive de ursprungliga projekt- och implementeringsplanerna, tillsammans med redovisning av uppnådda resultat, inklusive länkar till rapporter, vetenskapliga artiklar, konferenser och konferensbidrag, bör göras snabbt tillgängliga via Internet.

Introduction

Formas has requested an evaluation of the research funded through the Formas-BIC collaboration, which has been ongoing since 2003. The purpose of the present report is to provide such an evaluation taking into account 71 projects initiated in the period 2003–2006 and further to evaluate if the current collaboration can be improved.

The present report has been written and the underlying evaluations and analysis undertaken by a committee consisting of:

Professor Henrik Stang, Technical University of Denmark (Chairman)
Professor Alireza Afshari, Danish Building Research Institute, Aalborg University
Professor Christian Koch, Århus University
Professor Niklaus Kohler, University of Karlsruhe
Professor Svend Svendsen, Technical University of Denmark

The evaluation highlights the scientific quality of the projects, the relevance of the scope and research questions as well as the quality and quantity of the output and impact on the construction industry and society as a whole. The added value of the Formas-BIC collaboration has been evaluated through specific considerations of the quality and success of the implementation plans which constitute an integrated part of the project plans submitted as response to the Formas-BIC calls for applications. In this context it is worth noting the four special conditions:

- The projects must be 50 per cent co-financed by participating players in the sector.
- The project description includes an implementation plan and each project has a specific project leader for the implementation.
- The assessment of the project proposals comprises scientific quality as well as relevance to industry.
- The calls for proposals are directed towards specific subject areas.

Since projects considered in this evaluation have all been finished, the amount of material used in the evaluation of each project is substantial and includes:

- The application.
- The implementation plan submitted with the application.
- The self-evaluation form filled out by the project leader – sometimes replaced by or supplemented by mail correspondence.
- Newsletter from BIC describing the project and its main findings in a journalistic format.
- Scientific publications and reports, when available.
- Possibly additional material, in the form of email communication etc.

Each project was reviewed by two reviewers – in a few cases more – according to the thematic area of the project and the competences of the reviewers.

The review of the projects resulted in a numerical evaluation between 1 and 5 (5 indicating highest quality or relevance) in a total of 13 questions. The grade 0 was used to indicate that information had not been provided to allow assessment. Commentaries to each question could be added as well to further substantiate the evaluation.

The 13 questions were arranged in three groups representing (A) the quality of the research, the research environment and the scientific output, (B) relevance of the research questions and quality of communication to stakeholders and finally, (C) benefits for the construction companies involved and society as a whole.

The questions were:

Group A questions

1. The research has been scientifically motivated?
2. The research methods used were appropriate and up-to-date?
3. The project has been led by academically highly qualified people?
4. The scientific output in terms of international peer-reviewed articles has been quantitatively and qualitatively adequate?

5. The research has been adequate visible at international conferences.
6. The research has made use of an adequate degree of obvious opportunities for national and international cooperation?
7. The research has contributed to the renewal of the scientific community by connecting students at different levels (MSc, Lic, Dr)?

Group B questions

1. The research has concerned issues which are important and current?
2. The research has concerned conditions for sustainable development in the construction sector?
3. The research has (for the construction sector) come to the new, and important knowledge in the foreseeable future?
4. The research and its results have been communicated to stakeholders in the construction sector in a satisfactory manner?

Group C questions

1. What benefits have the construction companies involved gained from the project?
2. What benefits has society gained from the project?

The work methodology adopted and the instructions given to the committee to ensure a uniform interpretation of the questions can be found in Appendix A1. The correlation obtained between the two reviewers is shown graphically in Appendix A2.

The evaluation score (1–5 and 0 if no information was provided to allow assessment) was given the following interpretation:

Table 1. Interpretation of evaluation score.

Evaluation score	Evaluation of specific question	Project evaluation
0	No information/not relevant	No information/not relevant
1	Definitely not	Insufficient project
2	Only to a limited extend	Somewhat insufficient project
3	Just to the extend to be expected	Acceptable project
4	Better than expected	Good project
5	Extraordinary	Excellent project

Apart from the 13 questions evaluated numerically, three more questions – the group D questions – were addressed during the evaluation:

Group D questions

1. Are there important questions in the Formas/BIC thematic areas which have not been addressed by the research supported?
2. Has the research and development contributed to development of the research institutions?
3. Which are the most important recommendations for the future?

The numerical evaluations and the commentaries were compiled and analysed both across all the projects and within six thematic areas (see below) to allow for identification of variations between these. Finally conclusions were drawn and recommendations outlined.

An overview of the background material considered in the present evaluation is given in Appendix A1 were general comments on the limitations of the study can also be found.

Background

Out of five calls for applications in total 71 projects were evaluated.

The first call (application deadline 15/9 2003) was directed towards basic and applied research of relevance to the development of the building sector. The call addressed the whole of the construction sector and the built environment, as well as all aspects of service life from planning to design, construction, management, maintenance, renovation and demolition. The following specific themes are highlighted: energy, materials, indoor climate and Information and Communication Technology (ICT).

The second call (application deadline 8/3 2004) had the same overall scope as the first with the additional headings: human health and comfort, environmental impact and resources. The following specific themes were highlighted: Environment and Life Cycle Analysis (LCA), energy use, building processes, ICT and the role of the building owner.

The third call (application deadline 15/8 2005) was an Erabuild call with partners from Finland (The Finnish Funding Agency for Technology and Innovation – Tekes), France (Centre Scientifique et technique du bâtiment – CSTB), Sweden (Formas and BIC) and Austria (Haus der Zukunft) as subpartner. The objective of the call was to support research for the development and use of ICT tools and practices to enhance productivity within the planning, construction and real estate sector and to stimulate establishment of new business concepts. The following themes were mentioned as examples:

- Implementation of ICT and e-commerce
- Information retrieval over the lifetime of structures and components, promoting interoperability in the construction process
- Validation of ICT-tools, evaluation of benefits using various modes of cooperation ICT solutions etc.,
- ICT for visualizing products, services and values during planning, production and use
- ICT for industrialization of construction and for management processes.

The fourth call (application deadline 15/9 2005) was similar overall to the first and second calls. The highlighted areas are materials and resources, indoor climate and building energy, building processes, ICT and the role of the building owner, with special emphasis on the last three issues.

The fifth call (application deadline 17/7 2006) was a joint Erabuild call with participation from Denmark (Danish Enterprise and Construction Authority – EBST), Austria (The Austrian Society for Environment and Technology – OEGUT), Finland (Tekes), France (Plan Urbanisme Construtions Architecture – PUCA) and Sweden (Formas and BIC). In this last call the overall theme was Transformation of the construction sector through industrialization, with the following subthemes: Creating a new industrialized process, meeting user requirements in an industrialized way and tools for increasing the level of industrialisation in the construction sector.

Even though the calls each had their individual characteristics, the overlying themes of sustainability, building processes, industrialization and ICT were quite predominant. It is also noteworthy that even though the calls mentioned basic and applied research, the descriptions of the research themes were strongly application-oriented, which ties in naturally with the overall philosophy of the Formas-BIC collaboration.

The response to the calls was quite good. Altogether 292 applications were received in response to the five calls out of which the 71 projects were funded, resulting in an acceptance rate of 24 %. An overview of the number of applications, the number of projects funded and the total funding can be found in Table 2.

Table 2. Overview of applications and funding in the five Formas-BIC calls.

Formas – BIC call	Number of applications	Number of projects funded	Acceptance rate	Total Funding (SEK)
1 (2003)	89	14	16 %	13 972 000
2 (2004)	148	40	27 %	60 541 000
3 (2005)	6	3	50 %	3 185 000
4 (2005)	36	8	22 %	9 775 000
5 (2006)	13	6	46 %	5 580 000
Total	**292**	**71**	**24 %**	**93 053 .000**

The 71 projects were distributed between 15 organizations and 34 departments or institutes within these organizations. The three biggest players were Lund University (18 projects distributed in 5 departments), Royal Institute of Technology (15 projects distributed in 7 departments) and Chalmers University of Technology (13 projects distributed in 5 departments). A total overview of the distribution of projects on the various institutions and departments can be found in Appendix A3.

Previously, in 2006, an evaluation of the Formas-BIC collaboration was performed by Faugert & Co, studying how the original declaration of intent from 2002 had been implemented and recommending possible changes and continued direction of the collaboration between FORMAS and the stakeholders of the sector. In the report from 2006 the following questions were evaluated:

- Do the project generation and the continued follow-up of ongoing projects work in a satisfactory way from a programme point of view?
- Is there a need to change the joint calls for tenders, including the Erabuild calls?
- Has the mode of working in the collaboration had desired effects as regards the relevance of the projects, its support in the construction sector, the dissemination of results from the projects etc?
- To what extent are the results from the projects communicated to concerned target groups in academia and industry?
- What appropriate and sustainable structures and routines have been created as a result of the collaboration?
- Is the 2003 research strategy for sustainable buildings sufficient and adapted to the international development (globalization of transports, commerce, standards, availability of information etc.)?

The main conclusions of the evaluation in 2006 are as follows:

- The project generation is generally working well, even though the special implementation plans, the project leadership for the implementation and the continued follow-up of on-going projects could do with strengthening.

- The continued collaboration would benefit from a multi-year plan of calls for applications.

- The mode of working in the collaboration has had favourable effects on research. Despite this, the way of financing BIC through taxation on project participants may lead to BIC's limited resources creating a bottleneck when it comes to follow-up activities and the dissemination of results from the projects.

- The results from the projects could be communicated more effectively to target groups outside the projects, and the dissemination of information on a programme level would need to be improved.

- It is too early to tell whether the collaboration has created appropriate and sustainable structures and routines, although the development looks promising. The fragmented structure of the research environments in the sector is an issue that seems not to have been addressed, and may need some sort of strategic approach in order to create critical mass in a few places around the country. The Swedish state should possibly have a clearer role in leading this development.

- The research strategy from 2003 has been a good supporting instrument, and may now need to be updated and made more stringent.

Furthermore, the following recommendations are given:

- ***The continued collaboration with BIC*** – The initiative has been money well spent, and the collaboration has been rewarding for FORMAS as well as for the construction sector. It has become a valuable part of a system for funding construction research. The collaboration should be able to continue and to develop further. This also means that the resources BIC has at its disposal should be analysed.

- ***The management structure*** – a natural step for the continued collaboration would be to complement the existing structure with some sort of programme board. This board should have a balance in the representation from academia and industry in order to hold together the participants and the activities of the programme, and in order to deal with questions of co-funding from

a strategic perspective, selecting subject areas related to the research strategy and also to furnish strategic points of view on the collaboration in Europe and between the Nordic countries.

- ***The calls*** – a multi-year plan should be set up, preferably with calls twice a year for the researchers. FORMAS ought to be prepared to increase its efforts if the players in the construction sector are.

- ***The preparation process*** – has found its forms although some improvements can still be made, especially concerning the guidelines for the committees.

- ***The rules of co-funding*** – should more clearly take into consideration the relevance from the companies' point of view and have an even more flexible design in order to attract companies of different sizes in different parts of the construction sector.

- ***Follow-up and dissemination of results on the programme level*** – this is an important responsibility of the two programme owners and needs to develop and be given sufficient resources for the intentions of the FORMAS – BIC collaboration to prosper.

- ***Collaboration with other players apart from BIC*** – should develop both nationally and on a Nordic level and, amongst others, including Vinnova and the Swedish Energy Agency.

- ***The international cooperation*** – is beneficial in several respects and it is vital that it continue and that FORMAS work to broaden it especially on a Nordic level. In order to increase the benefits from this collaboration, we consider it desirable that funders more clearly focussed on innovation – especially Vinnova – participate. It is also important that the experiences from Erabuild when it comes to working together in different constellations and what different kinds of benefits can be drawn, be noted for future reference when the project finishes.

Analysis, discussion and conclusions

The 71 projects were divided into 6 thematic areas to facilitate analysis across smaller groups and to separate research environments, companies and stakeholders across the construction sector.

The following thematic areas were defined by the scope of the projects:

- Building Technology
- Health and Indoor Climate
- Building Processes
- IT in the Building Sector
- Environmental Quality of Buildings
- Building Energy

Three of the Formas-BIC calls have been of a relatively broad nature, addressing the whole of the construction sector and the built environment as well as all aspects of service life from planning to design, construction, management, maintenance, renovation and demolition with specifically highlighted issues for each call, as described above. Two (Era-build) calls dealt with specific themes: *"Transformation of the Construction Section through Industrialisation"* and *"Managing Information in Construction"*.

As noted above, there is relatively heavy emphasis on sustainability, building processes, industrialization and ICT in all calls, sustainability being an overriding theme which to a certain extent plays a role in all projects. This is reflected by the number of funded projects in each of the thematic areas defined in the present context, as shown in Table 3 building process and ICT projects constituting roughly 35 % of all projects and by three out of the six themes explicitly relating to sustainability:

Table 3: Number of projects in the thematic areas.

Building Technology	13
Health and Indoor Climate	9
Building Processes	17
IT in the Building Sector	8
Environmental Quality of Buildings	13
Building Energy	11
Total	**71**

Overall

The overall evaluation of all projects is presented through graphs showing the average score on each question in the groups A, B and C – representing research quality, research issues and the communication and impact of the results, and benefits for the involved companies and society as a whole, respectively – taken over all projects, across the thematic areas. The results are presented in Figures 1–3. The average is calculated first as the average of the response of the two reviewers (disregarding reviewers with '0' response) and later as an average over all projects disregarding '0' response.

To illustrate the distribution of the overall quality of all projects and the distribution of quality in the A, B, and C areas, respectively, taken over all projects, histograms were produced showing the distribution of the average scores. Average scores taken over all A, B, and C questions were calculated for all projects. Later the overall project score was calculated as the average of the average A, B and C score – with each group of questions weighted equally – for all projects. The distribution of the overall project score over the 71 projects is shown in Figure 4, while the distribution in average A, B, C1 and C2 score over all projects is shown respectively in the Figures 5–8.

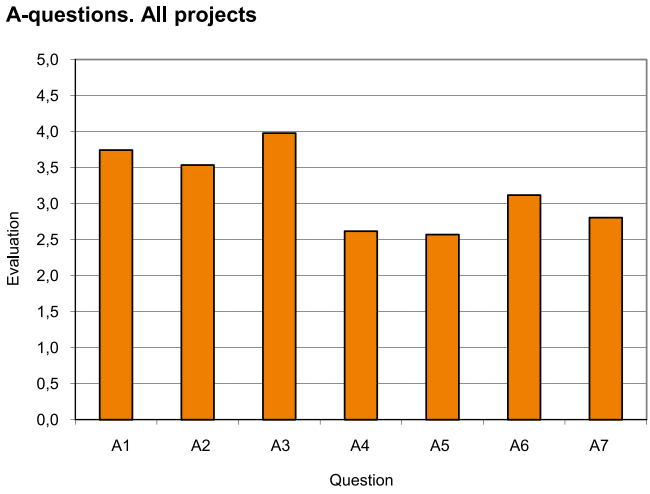


Figure 1. The evaluation of the overall research quality of the projects. An average of the evaluation score is taken over all the projects – across the thematic areas. Level 3 is 'acceptable'.

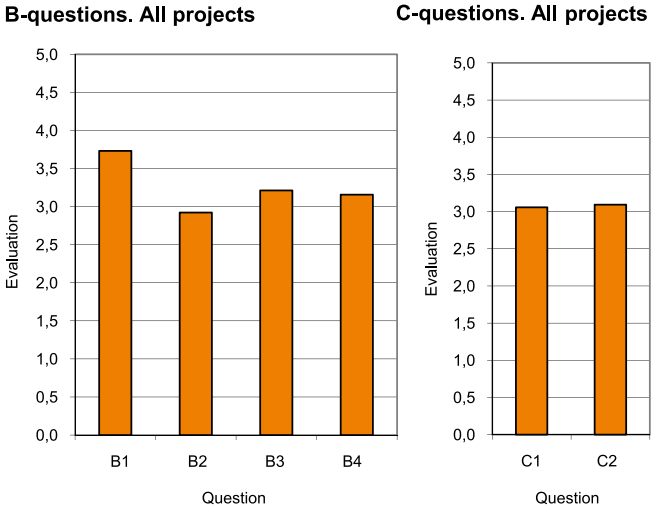


Figure 2. The evaluation of the overall research issues and the communication and impact of the results. Average of the evaluation score is taken over all the projects – across the thematic areas. Level 3 is 'acceptable'. (Left)

Figure 3. The evaluation of the benefits to the companies involved and to society as a whole. An average of the evaluation score is taken over all the projects – across the thematic areas. Level 3 is 'acceptable'. (Right)

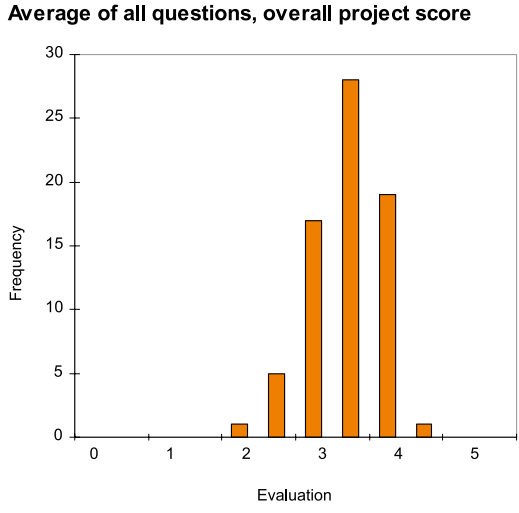


Figure 4. Histogram showing the distribution of the average of all questions for a project – the overall project score. The average overall project score is 3.2, the scores 2, 3 and 4, respectively meaning 'somewhat insufficient project', 'acceptable project' and 'good project'.

Correlation between the average score in A and B questions, A and C questions, B and C questions and C1 and C2 questions are shown in the Figures 9–12 respectively.

To investigate the importance of the size of the project, the total funding for each of the 71 projects is plotted against the overall project score in Figure 13.

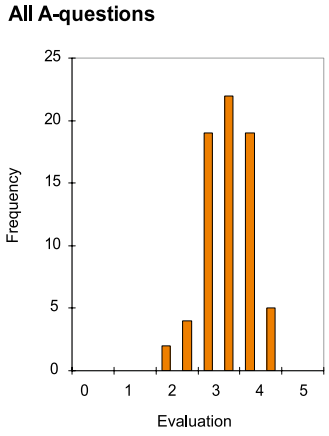


Figure 5. The distribution of evaluations, average of all questions in category A – quality of the research, the research environment and the scientific output. (Left)

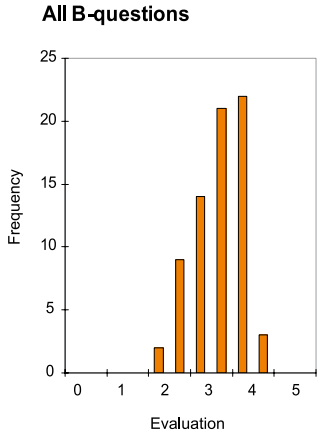


Figure 6. The distribution of evaluations, average of all questions in category B – relevance of the research questions and quality of output. (Right)

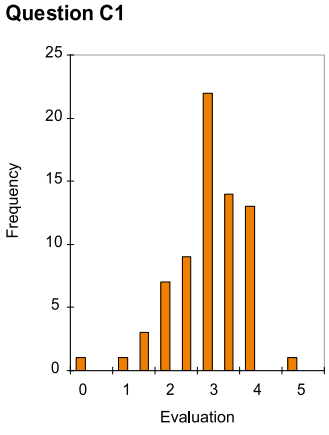


Figure 7. The distribution of evaluations, question C1 – benefits to the construction companies involved. (Left)

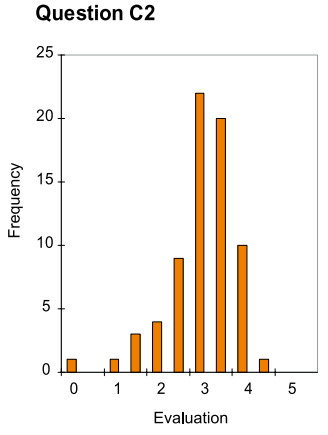
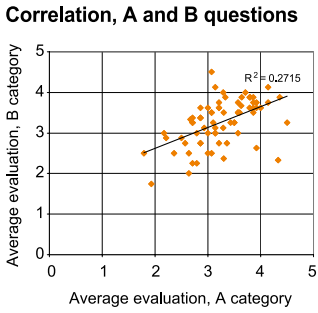


Figure 8. The distribution of evaluations, question C2 – benefits to society as a whole. (Right)



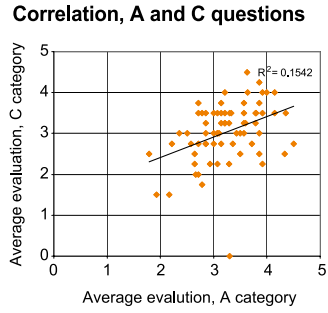
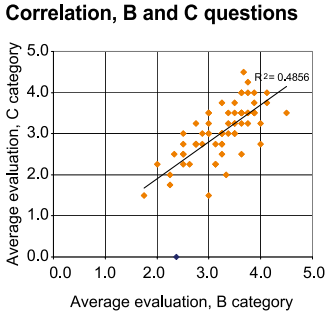


Figure 9. The correlation between average evaluations of all questions in category A and category B for all projects. R^2 = 0.27 (Left)

Figure 10. The correlation between average evaluations of all questions in category A and category C for all projects. R^2 = 0.15 (Right)



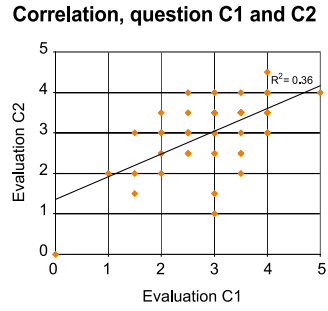


Figure 11. The correlation between average evaluations of all questions in category B and category C for all projects. R^2 = 0.49 (Left)

Figure 12. The correlation between the evaluation of questions C1 and C2 for the 71 projects (note: one point in the graph typically represents several projects). R^2 = 0.36 (Right)

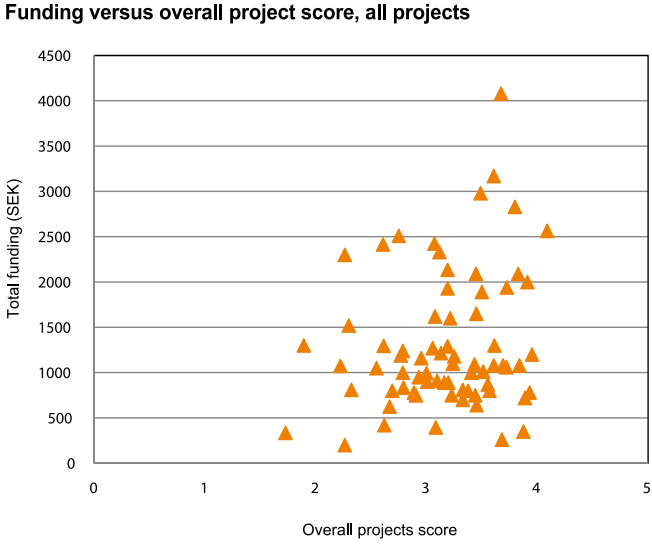


Figure 13. The total funding plotted against the overall project score for all 71 projects.

The scientific production in terms of number of journal papers published and number of Ph.D. students associated in total and for each of the thematic areas is shown in Table 4.

Table 4. Scientific production expressed in terms of number of published journal papers and number of associated Lic. or Doctoral students. Production is furthermore calculated per number of projects.

Theme	Projects	Papers	Papers per project	Ph.D.	Ph.D. per project
Building Technology	13	5	0.4	3	0.2
Health and Indoor Climate	9	9	1.0	3	0.3
Building Processes	17	27	1.6	11	0.6
IT in the Building Sector	8	6	0.8	2	0.3
Env. Quality of Buildings	13	19	1.5	8	0.6
Building Energy	11	14	1.3	8	0.7
Total	**71**	**80**	**1.0**	**32**	**0.5**

Overall it is concluded that the Formas-BIC effort was worthwhile and that the projects funded covered a broad range of relevant and contemporary research issues in the building sector.

The overall project score (based on equal weighting average of the average of the three different classes of questions A, B, and C) is acceptable, the average being 3.2 and the distribution of the score as shown in Figure 4, with only six projects (approx. 10 %) scoring under 3 and a single project being close to insufficient, while twenty are evaluated between good and excellent. This distribution is acceptable from the point of view that risky projects should be allowed to be funded, because such projects typically also have a big potential. There is always much uncertainty related to research projects and especially projects with the dual purpose to produce results relevant both from a scientific and application viewpoint.

The scores on the A questions related to research quality show weaknesses particularly in the area of scientific dissemination, where the score is significantly below the acceptable limit. This is further elaborated on in Table 3, where the scientific production in terms of journal papers published and number of Ph.D.s (lic. and doctoral) involved. The average scientific dissemination amounts to 1.0 paper and 0.5 Ph.D. student per project, which in general is considered on the low side. However, it should be borne in mind that the projects under consideration here are relatively small, in fact the

average project size is a little over 1 million SEK. With that in mind, the average numbers are acceptable – however it should be noted that there are big differences between the various research themes as shown in Table 3. Further it is noted that there seems to be a discrepancy between the project performance (A4, A5, A7) and the potential of the project plans and project groups (A1, A2, and in particular A3). One way to explain this is that the research environments are unfamiliar with the handling of research implementation to the extent required in the Formas-BIC projects and the implementation diverts attention from traditional research dissemination.

When it comes to evaluation of the overall research issues and the communication and impact of the results (B questions) and evaluation of the benefits for the involved companies and society as a whole (C questions), the overall performance of the projects is acceptable. However, it is considered somewhat discouraging that the performance, specifically in implementation (B3, B4, C1), is not evaluated higher – given the specific emphasis on implementation in the project setup and the high emphasis on implementation in the calls and their thematic areas. This concern grows when the distribution of evaluations of the C1 and C2 questions is considered (Figures 7 and 8). In particular, the distribution for the C1 question has an unacceptably long tail below 3. It appears that more than twenty projects did not succeed in making a difference to the companies involved or that the differences made cannot be evaluated at present and/or the tools to make this evaluation are not forthcoming. (In fact one might ask if a commercial company is always interested in revealing whether a specific piece of research in fact has been implemented and has made a difference).

The poor correlation between the project performance in areas A, B and C is interesting – but maybe not surprising. In particular, there is very poor correlation between success in the scientific area and in implementation, Figure 10. This seems to indicate that the link between scientific research and implementation is not trivial and that it is difficult to establish in a single (small) project. Further, it seems questionable to what extent the project management tools to make this happen have been available in the projects at hand. The fact that there is good correlation between performance in the B and C areas is probably due primarily to the nature of the questions and the guidelines laid down for their

evaluation, see Appendix A1, which specifies a correlation between C2 and B1, B3 and B4 in the way that the questions shall be answered.

There is a very weak relation between size and quality of specific projects when all projects are considered. However, it is noteworthy that all projects above 2.5 million SEK had an overall project score better than 3.5.

As noted above, the research themes dealt with in the 71 projects are in line with the overall Formas-BIC research strategies as described in the five calls: building process and ICT projects constituting roughly 35 % of all projects and three out of the six themes explicitly relating to sustainability. Further, it is concluded that all major fields identified by Formas-BIC have been dealt with. However, within the individual thematic areas as defined in the present context, some evaluations point to important areas within the theme which have not been researched or where the results are insufficient.

Measuring the contribution of the projects developing the research institutions by looking at the number of M.Sc. and Ph.D. students (potential new faculty) participating in projects, the result is on the weak side. An average of 0.5 student per project is not particularly high and the variation between different thematic areas is large. As mentioned earlier, one main reason for this is probably the large number of relative small projects, which can only fund a fraction of a full Ph.D. education.

Building Technology

The Building Technology thematic area consisted of thirteen projects covering a broad range of building technological issues with materials technology as the key issue. Other issues include technological aspects of the building process, in particular dampness and other aspects of the early stages of construction, renovation techniques and demonstration projects.

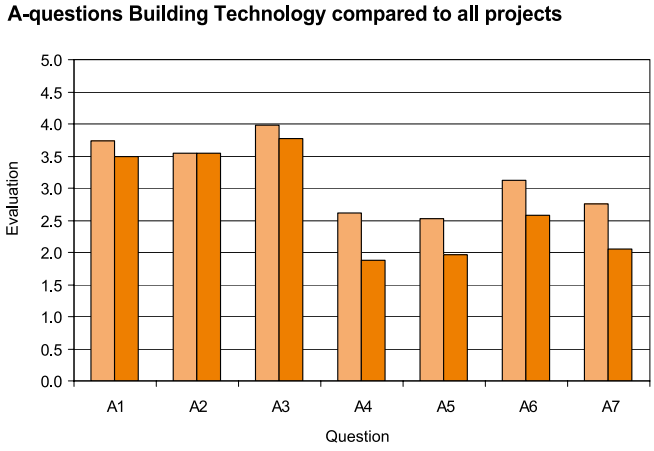


Figure 14. The evaluation of the overall research quality of Building Technology projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Building Technology thematic area and across all thematic areas.

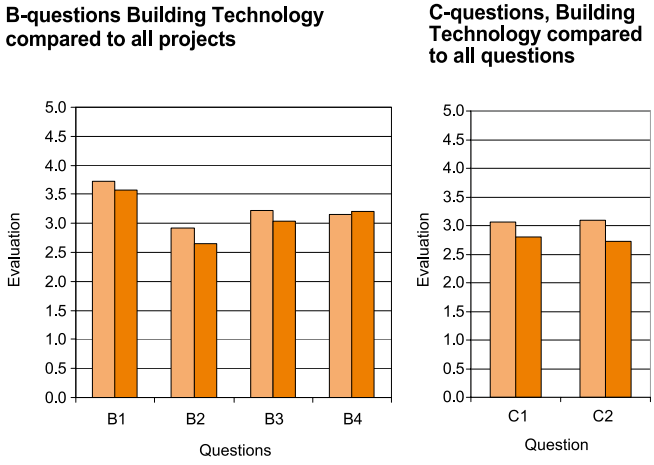


Figure 15. The evaluation of the overall research issues and the communication and impact of Building Technology projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Building Technology thematic area and across all thematic areas. (Left)

Figure 16. The evaluation of the benefits for the involved companies and society as a whole of Building Technology projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Building Technology thematic area and across all thematic areas. (Right)

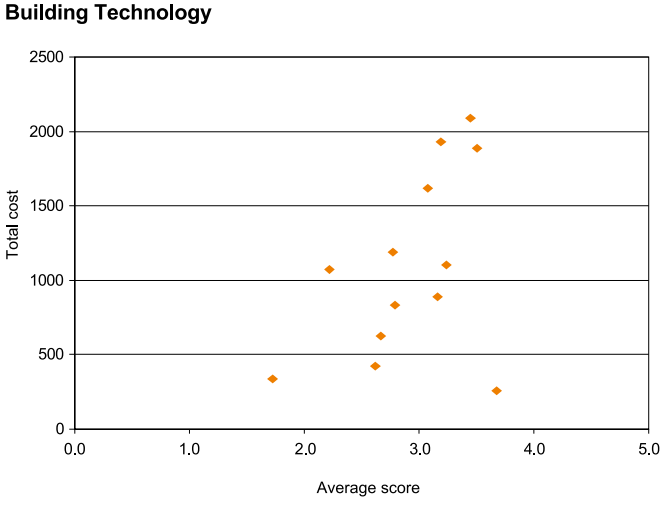


Figure 17. The total cost of the individual Building Technology projects, plotted as functions of average score for the project taken over all questions.

Discussion

The projects in this thematic area represent quite a scattered range of research and development topics with a clear emphasis on traditional materials and construction technologies, except for 2–3 projects dealing with special types of concrete. The absence of research related to novel and innovative technologies including, e.g. smart and advanced materials, novel production techniques, industrialisation and robotics is noteworthy.

Overall, it is concluded that the scientific motivation, and the method applied and the research team competences are of high quality – with a few exceptions, even though the smaller projects tend to be very application-oriented, leaving little room for more general and generic work and results. Much of the research is highly empirical and/or experimentally oriented, which further directs results towards specific, application oriented results rather than generic.

The scientific dissemination is surprisingly weak, with a majority out of thirteen projects reporting one or no scientific journal publications and only a few conference papers. Only five journal papers are reported.. This is significantly less than the average performance in the total group of projects, which is somewhat surprising considering the relatively high scientific quality of the projects descriptions and the relatively high quality of the research groups.

The scientific collaboration and networking seems to be primarily focused on national level while extensive or noteworthy international collaboration is only found in a few projects.

The lasting impact of the projects on the scientific community is limited, at least judging from the number of Ph.D. projects attached to the projects. The involvement – if any – is typically taking place on M.Sc. level. In some cases Ph.D. involvement was foreseen in the application, but in effect M.Sc. students were connected to the project instead. In fact only three projects out of thirteen report involvement of a Ph.D. student. It is reasonable to assume that the relatively small size of the projects plays a role here.

A vast majority of the projects address highly relevant and current issues – relevant not only to the participating companies but also to the building sector in general. Only a few

projects have a very limited scope within the narrow interests of a single stakeholder. The issues addressed in most cases have sustainability relevance either by directly addressing energy efficiency or environmental issues or indirectly by addressing service life issues.

Unlike the scientific dissemination, the communication to stakeholders in general worked well – through either meetings, seminars or technical committees and organizations. This is in line with the practical and empirical orientation of most of the projects. The knowledge generated appears easily communicated and applied by the various stakeholders.

Even though both the relevance and stakeholder dissemination are considered acceptable, the evaluations of the projects in the Building Technology area are slightly below the average of the evaluations of the total population of projects.

The benefits to the companies involved and to society as a whole are acceptable. The benefits are primarily of a 'first to know' and 'general knowledge' or 'new standards or test methods' type, respectively. The benefits are evaluated slightly lower in the Building Technology area compared to the total population of projects.

Conclusions

Overall it seems that there is a tendency to favour practical applicability and knowledge transfer over scientific output, even though the project plans overall are scientifically sound and offer prospects of scientific, generic results. It is likely that this tendency is favoured by the combination of the focus on implementation and the relatively low budgets for the projects.

Health and Indoor Climate

In the thematic area of the Health and Indoor Climate, nine projects were evaluated and four projects had a budget of less than 1 million SEK while the rest were over 1 million SEK, see Figure 21. The projects deal with the relation between health and ventilation system, with focus on filters, investigation of perceived indoor environment in relation to demand-controlled ventilation system for dwellings, the contribution of a solid wood structure to a pleasant indoor climate, development of a model to identify residential buildings with unexpectedly high frequencies of the sick building syndrome

(SBS), risk buildings, study of mycotoxins in buildings with special focus on water damage, upgrading of an existing GC[1]–MS[2]–MS instrument to also include HPLC[3]–MS–MS with electro spray, development of a common national system for environmental classification of buildings, development of a tool that can be used to analyse building service systems in a building, and analysing the operation of the heating, ventilation and air control (HVAC) systems in a hospital.

The projects complement each other in that their specific experience and sufficiency cover a range of expertise needed for research and improvement within indoor climate and health. The width of knowledge and the mix of research, academic and industrial partners are very good. However, the objectives of evaluated projects do not cover the whole spectrum of the health and indoor climate research area. A number of important aspects of indoor environmental quality, such as lighting, acoustics and perceived air quality, are only marginally addressed.

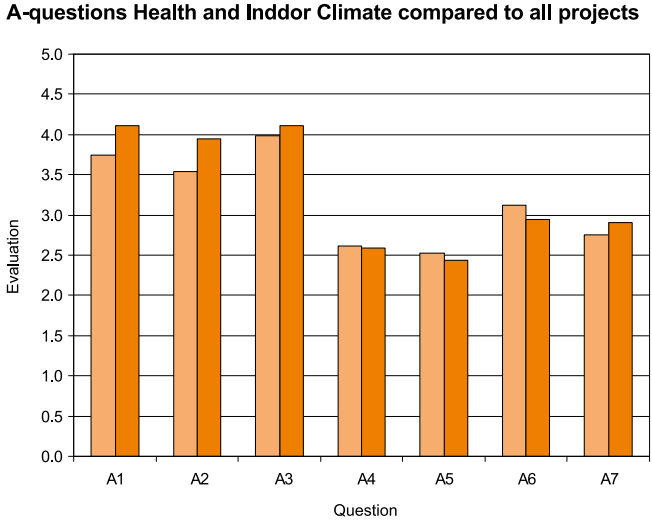


Figure 18. The evaluation of the overall research quality of Health and Indoor Climate projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Health and Indoor Climate thematic area and across all thematic areas.

1 GC – Gas Chromatography

2 MS = Mass Spectronomy

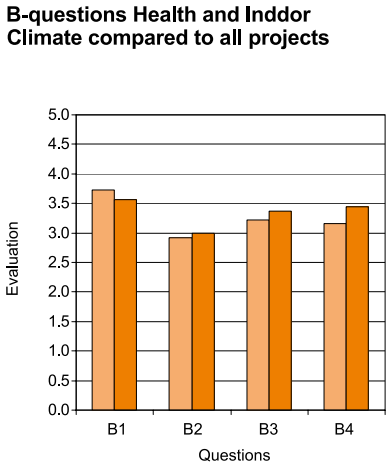
3 HPLC = High Performance Liquid Chromotography

Discussion and conclusions

Overall, the evaluated proposals are good, well-written and with clear methodologies and work plans. The state-of-the-art reports are, in general, comprehensive. The stated objectives of the proposals are realistic and achievable. The proposals showed potential for progress beyond the current state-of – the art relating to the development of technical solutions, tools, methods for improvement of indoor air quality and health in different buildings (See questions A1–A2).

The individual leaders and participants demonstrate qualified expertise and relevant experience with many of them involved in a wide range of national and international projects. The management structure is good, but the procedures for implementation are not clearly defined (See question A3).

The dissemination strategies described in the proposals are clear and well considered, but there is no exploitation plans proposed. It might be suggested that the stakeholders considered as targets for information and training be widened to include building designers including engineers, architects, interior designers, etc. to improve the dissemination of the results. Publishing on the Health and Indoor climate consists of 5 journal articles, 1 report, 14 conference articles, 2 Ph.D and 3 M.Sc. theses and in one case the results of the project was as part of a PhD thesis (See questions A4–A7).



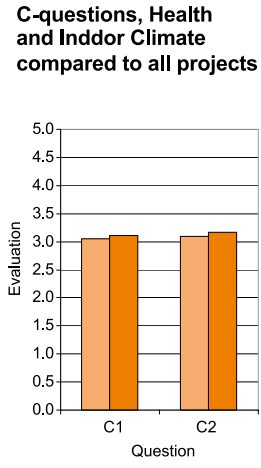
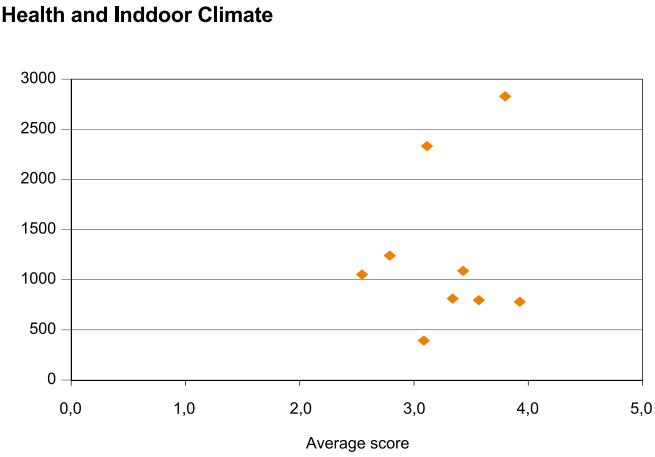


Figure 19. The evaluation of the overall research issues and the communication and impact of Health and Indoor Climate projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Health and Indoor Climate thematic area and across all thematic areas. (Left)

Figure 20. The evaluation of the benefits for the involved companies and society as a whole of Health and Indoor Climate projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Health and Indoor Climate thematic area and across all thematic areas. (Right)

Figure 21. The total cost for the individual Health and Indoor Climate projects plotted as functions of average score for the project taken over all questions.



The projects provide new and necessary knowledge on indoor climate and health effects. The projects have the potential to positively impact on the indoor climate and on the health and well-being of their occupants. There is also the potential for successful product development and resulting dividends. However, it is not clear whether the tools, methods and products developed will be marketed in a way which will succeed in relevant uptake and use by owners, investors or engineers. In all projects, the scientific collaboration and networking seems to be primarily focused on the national level. There was no documentation or report from any projects showing whether international collaboration has been established (see questions B1–B4 and C1–C2).

Building Processes

The seventeen projects evaluated in this group cover a wide range of topics softly clustered around studies of the role of the client, industrialisation, and relations between actors in the sector. But the group also encompasses studies of work environment on the building site and quality issues.

The building process projects relate to 2004, 2005 and 2006 calls, the last of which was an international round within the Erabuild programme. It should be noted that this group does not encompass projects from the 2003 round.

The building process projects are also characteristic in addressing a broader set of interests related to the building industry apart from the companies. This involves facility managers, municipal representatives, occupants, construction workers, site managers, clients' counsellors and others besides.

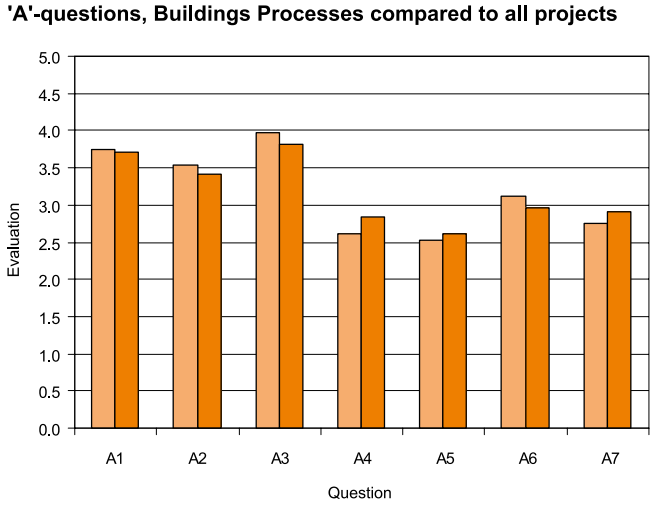


Figure 22. The evaluation of the overall research quality of Building Processes projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Building Processes thematic area and across all thematic areas.

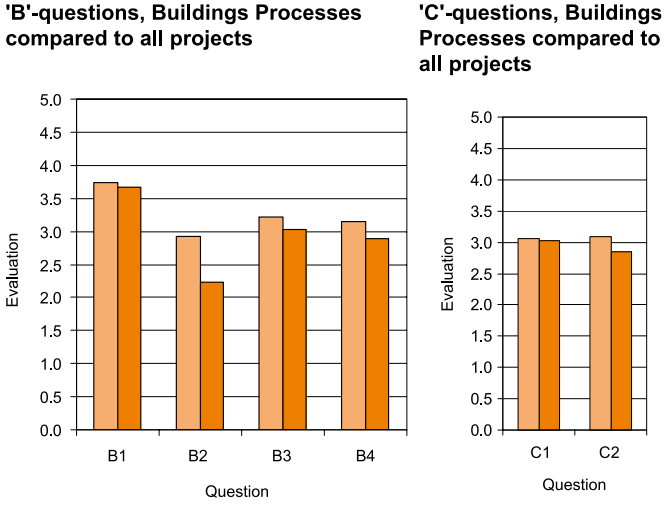


Figure 23. The evaluation of the overall research issues and the communication and impact of Building Processes projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Building Processes thematic area and across all thematic areas. (Left)

Figure 24. The evaluation of the benefits for the involved companies and society as a whole of Building Processes projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Building Processes thematic area and across all thematic areas. (Right)

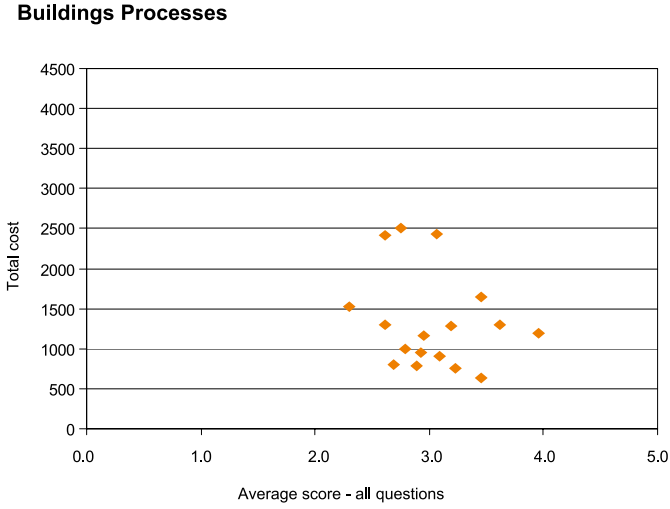


Figure 25. The total cost for the individual Building Processes projects plotted as functions of average score for the project taken over all questions.

Discussion and conclusions

The evaluation of the scientific quality of the projects (A-questions) shows that building process projects are on average with the broader group of projects evaluated here. Only small deviations occur. As the score "3" means a "good project" with the quality at a level that "you least expect" (quotes from the guidelines for the evaluation), it follows that on the issue of scientific quality, building process projects in this Formas –BIC population seen as a whole attain no more than an acceptable level of scientific quality. This over shadows however that a number of excellent projects have been developed within this group.

More specifically, the building process projects are on the same level on issues on the quality of the scientific motivation (question A1), and their visibility at international conferences (question A5). The building process projects deviate *positively* from the rest of the evaluated projects by the production of peer-reviewed articles in international journals (question A4), and the contribution to new Ph.D., M.Sc. and B.Sc. (question A7). The production of peer-reviewed articles amounts to 26, with most from the early projects (2004) and with very uneven distribution, as three projects account for half of the published articles. The number of Ph.D. students associated amounts to 11, fairly evenly distributed over the projects and institutions.

The building process projects deviate *negatively* from the rest of the evaluated projects by their scientific methods (question A2), their management (question A3) and their exploitation of international collaboration.

This weakness is underlined by the fact that three projects were granted under the auspices of the Erabuild collaboration, meaning that international collaboration was obligatory. Two projects arranged collaboration both in and outside Scandinavia, the third only in Scandinavia.

On the issues of the relevance and value of the research, the building process projects score lower on the issue of sustainability. The process research has concerned conditions for sustainable development in the construction sector (question B2), *less* than the other projects.

It is evaluated that the building process projects address relevant and contemporary issues for the construction sector (question B1).

There is a clear concentration of projects at a few larger institutions, here including KTH (5 projects), Chalmers (5 projects), and Luleå (4 projects). At these institutions the projects have contributed to the continuation of research environments in this area.

The building process projects are equal to the average of the Formas-BIC projects being averagely good in terms of benefit for the construction companies (question C1). Whereas the building process projects score lower on the benefits for the society, gained from the project (question C2).

The building process projects involve a broad set of interests in and related to the building sectors. The benefits therefore fall to more than just construction companies as primary target groups. The interest involves specialists in industry, architects, consulting engineers, municipal representatives, building owners, facility managers, site managers, construction workers and the general public.

Societal impacts include more knowledge, requirements and guidelines for future building projects and courses. Also in this group of questions, two or three projects are outstanding. Here they are remarkable in their addressing industrial players and providing direct results for them, and also in their addressing general societal problems such as occupational diseases of construction workers.

There is no correlation between size of the projects, measured in project costs, and the evaluation across the three areas scientific quality (A), relevance for industry and society (B) and implementation (C). It can be noted that there appears to be no correlation between scientific results measured in journal articles and Ph.D. production and the size of funding.

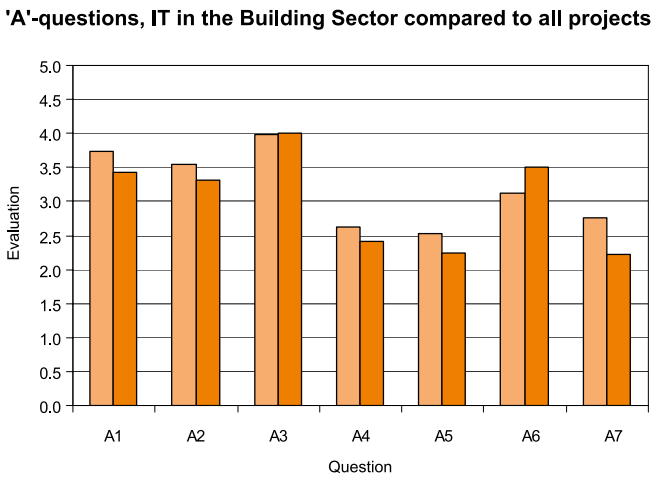
The projects are concentrated on the large Swedish research institutions within building research. The concentration is higher among building process projects than among the Formas-BIC projects as such evaluated here.

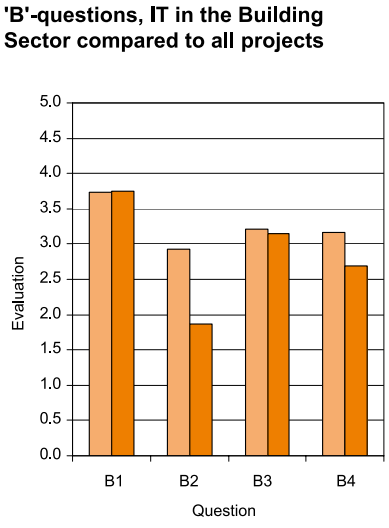
As a group of projects the building process projects does not distinguish themselves clearly from the "averagely good" evaluation that the overall population gets here. The use value for industry and society is limited (as for the remaining projects). Strengthening the link to industry and society was one of the main aims of the Formas-BIC collaboration. It appears that when having to try and span from research to implementation, this is primarily at the expense of the implementation. On the other hand, the research quality is only presently acceptable. The possibility should be considered of letting other bodies than the research institution do the implementation.

IT in the Building Sector

The eight projects of this thematic group cover a quite broad range of issues related to IT. There are both design-oriented and empirically oriented projects. The rather dispersed topics include interoperability, support for building processes (such as supply-chain and site processes), design tools and tools with relation to environmental issues. The projects originate from the whole period evaluated (2003-2006). Three projects come from an Erabuild call on industrialisation of construction.

Figure 26. The evaluation of the overall research quality of IT in the Building Sector projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the IT in the Building Sector thematic area and across all thematic areas.





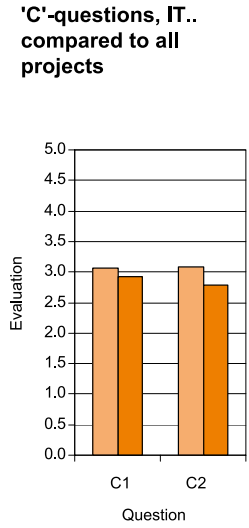


Figure 27. The evaluation of the overall research issues and the communication and impact of IT in the Building Sector projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the IT in the Building Sector thematic area and across all thematic areas. (Left)

Figure 28. The evaluation of the benefits to the companies involved and society as a whole of IT in the Building Sector projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the IT in the Building Sector thematic area and across all thematic areas. (Right)

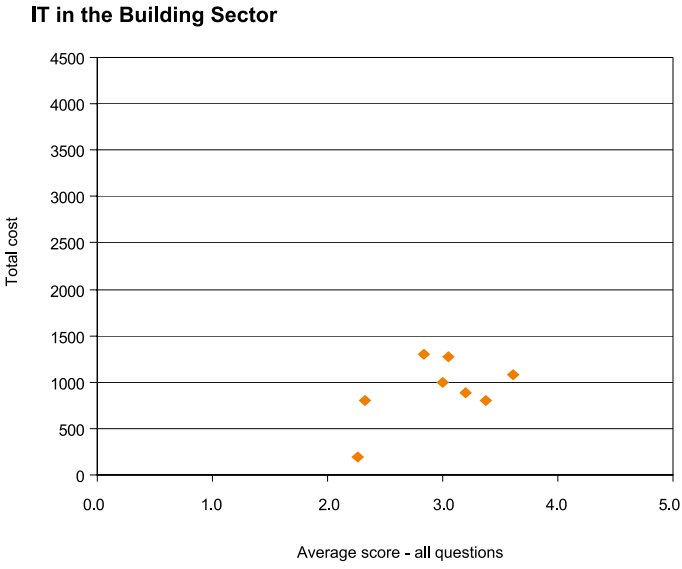


Figure 29. The total cost of the individual IT in the Building Sector projects plotted as functions of average score for the project taken over all questions.

Discussion and conclusions

The evaluation of the scientific quality of the projects (A-questions) shows that the IT projects score lower than the broader group of projects evaluated here, except for one issue, the international dissemination (question A6). Mostly small deviations occur. As the score "3" means a "good project" with the quality at a level that "you least expect" (quotes from the guidelines for the evaluation), it follows that on the issue of scientific quality, IT projects in this evaluation are slightly below this. The inputs (scientific motivation etc.,

questions A1, A2, A3) score better than the outputs, (questions A5, A6, A7, along the general score of all projects) except for A6 which scores clearly better, probably indicating a strong international orientation of IT issues.

There are doubts concerning the competence of some teams or the discrepancy between the competence in the specific field of the proposer (head of an institute) and the researchers. In fact there are no projects with "pure" IT research groups from computer-science departments but mainly experts on specialized IT use from application fields. This is maybe due to the relatively small size of the projects. IT has the smallest and the shortest projects.

The number of Ph.D.'s (2) is among the lowest scores, whereas publications (6) are the second lowest.

On the issues of the relevance and value of the research, the IT projects scores lower on the issue of sustainability. Along with the building process research, the IT Projects have dealt with conditions for sustainable development in the construction sector (question B2), less than the other projects. – There seems to be an opposition amongst the applicants of IT projects to sustainable development at least at the time of application (2003–2006). It is evaluated that the IT-project address relevant and contemporary issues for the construction sector (question B1).

The importance of the subjects is judged rather high. The results are judged in a dissymmetric way, the final judgment is not very concluding. The results are not very well communicated either. In the group C questions it is not clear if the results are more important to society or to the companies.

There is a clear concentration of projects at a few larger institutions, here including Lund University, the Royal Insitute of Technology, Chalmers, and the Luleå University of Technology. At these institutions the projects have contributed to the continuation of research environments in this area.

There is no significant relation between total cost and average score for IT projects, see Figure 29.

Teaching seems not to have profited a lot from the research.

Putting this group of project into a more global and contemporary perspective, it can be remarked that a more structured and efficient application of IT is determined today by the building information model effort, in particular through the Industry Foundation Classes (IFC) and other interoperability models. In Finland this has led to important progress. In Sweden there has been a long awareness of the product-model necessity, but it seems that the research (and in particular the Formas-BIC funded research) cannot really be situated in this general tendency as the funding is too limited. Attempts to work on a particular (firm or branch) level are not promising and cannot produce in a short time a breakthrough on a professional level. Therefore there is a risk of projects often ending up with prototypes that have no future. Such prototypes have been made since more than 10 years, but they are of no real consequence. It could be argued that when funding small and short projects there is a risk of producing neither scientifically interesting results nor advanced publications in refereed journals. Such projects will not be able to solve any practical problems (or the complex relationships between aspects and actors) either, because they are far too small. Maybe the critical mass in this field has not been reached and Formas –Bic should commission larger and more specific IT projects for the building sector and the related research perspectives.

Environmental Quality of Buildings

The group includes thirteen projects. Five projects were related to building evaluation methods and six to sustainable and careful handling of existing buildings. The two subjects are of great importance for a long-term sustainable development of the building stock. They also correspond to the clearly expressed needs (administration, building owners, housing associations) for operational evaluation methods and tools. The objective was to apply such methods to the whole building stock within a period of 3–5 years. The selected groups were active in the field and they cooperated rather well (in particular in the evaluation method). In an international perspective, Sweden was well positioned, the subject had been taken up earlier than in other countries and the proposed methods were considerably more appropriate to the building stock than the internationally dominant Anglo-American methods (LEED and BREAM), which are labels for the real estate industry with a weak relation to the real energy, mass and financial flows of the building life cycle.

Figure 30. The evaluation of the overall research quality of Environmental Quality of Buildings projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Environmental Quality of Buildings thematic area (dark orange) and across all thematic areas (light orange).

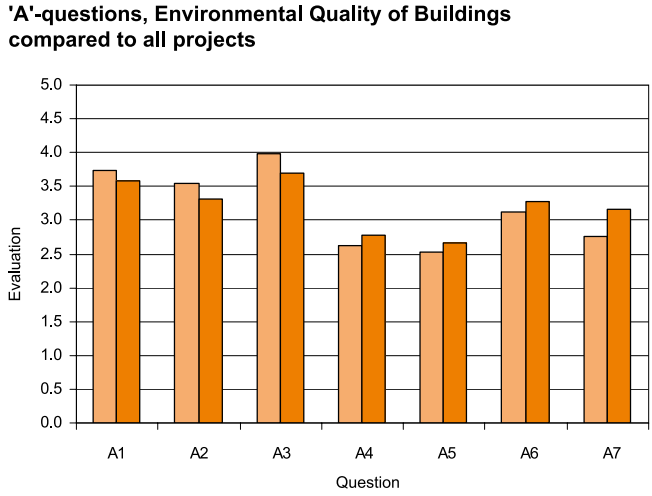
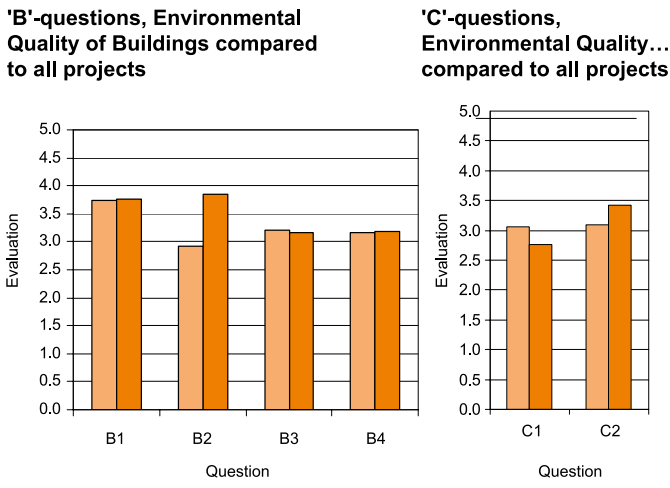


Figure 31. The evaluation of the overall research issues and the communication and impact of Environmental Quality of Buildings projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Environmental Quality of Buildings thematic area and across all thematic areas. (Left)

Figure 32. The evaluation of the benefits for the involved companies and society as a whole of Environmental Quality of Buildings projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Environmental Quality of Buildings thematic area and across all thematic areas. (Right)



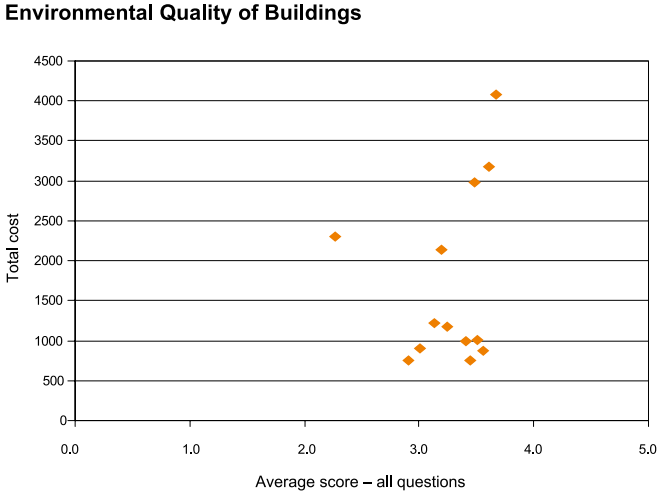


Figure 33. The total cost of the individual Environmental Quality of Buildings projects plotted as functions of average score for the project taken over all questions.

Discussion and conclusions

The score on the A questions is somewhat below the average of all projects, the scores for B and C are slightly higher. The evaluation has been low for some projects because of missing information. The methodological approach and the composition of the teams in both fields (evaluation methods and sustainable careful management) were judged very positively by the reviewers. The publication activity and the Ph.D. level were better than average. There were detailed reports and Ph.D. theses available on Internet. In most projects there was good integration between the academic and practice-oriented partners. The integration of the research and teaching was positively remarked on, in particular in architectural training.

The score on B questions was higher than average, the appreciation quite homogeneous. It was certainly the fact that both the life cycle perspective and the building issue were central, which the reviewers appreciated. As mentioned, these aspects are recognized as important, which was not the case at the moment of application (before 2003). It seems that the expectations carried with the projects in the beginning were very high.

The practical consequences of the projects seem to be lower today than expected. The combination of the projects was maybe not optimal for certain projects that had rather general results because they were not integrated in a cluster of projects. This raises the question of how well a larger group of projects could be coordinated inside the Formas-BIC framework. The diffusion in the construction sector (reports, tools) was well judged. A specific problem was noted for the projects dealing with the sustainable and careful development of the building stock. One very prominent research group at the architecture faculty of KTH was not continued and the group's final reports were hard to find. Being very design oriented, Architectural schools and practising architects often have difficulties in producing research of a quality comparable to other academic disciplines. It is therefore a pity that one of the scientifically prominent groups in this field has ended its activity. The problem of access to publications is a general problem that could also concern other fields.

Concerning the benefit to companies and society (C questions), the answers were in general positive and above average. Quite clearly, the befits were estimated higher to society than to the companies.

Building Energy

The calls for research projects in the Building Energy area include development of energy-saving products and processes in the built environment in general, and one call has a specific focus on savings or replacement of use of electrical energy for heating. The building energy has in general not been focused on in the calls (rather sustainability in general) and no calls explicitly mention specific energy plans.

Most of the research projects are on development of new energy saving products, but some are on development of processes for design of buildings with improved energy performances. Two projects are on the classification or the analysis of the energy performance of existing buildings.

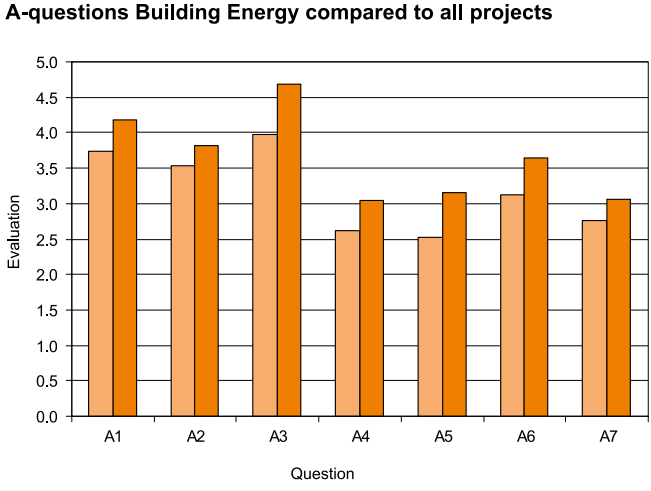


Figure 34. The evaluation of the overall research quality of Building Energy projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Building Energy thematic area and across all thematic areas.

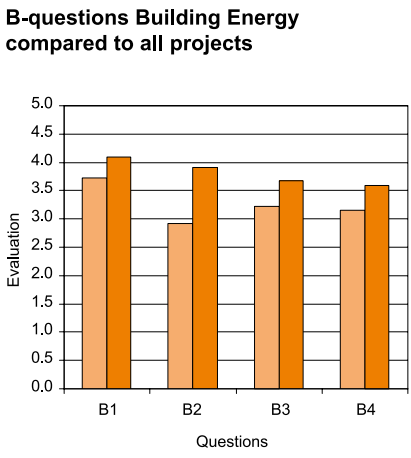
Discussion and conclusions

With regard to scientific motivation, method and competences in the research team, most of the projects are evaluated as very good, with a clear description and references to scientific articles in the area. The projects have in general a very good or acceptable description of the project research method and the research plan. Some of the projects do not have a clearly described research method (see questions A1–A2).

The projects were all managed by academically highly qualified persons – mostly professors specializing in building energy (see question A3)

The scientific reporting in peer-reviewed international journal articles and at international conferences is generally on a relative low level by today's standards. This may have to be seen in relation to the general development in the focus on documentation of results in international research articles over the period since the projects were carried out (see questions A4–5).

The projects have in some cases participated in international cooperation projects, and a number of PhD-projects have been started in relation to the projects, so a certain 'production' of new researchers with a specialization in the area of Building Energy is one very important result of the projects (see question A6–7).



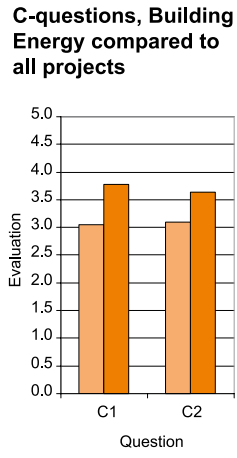


Figure 35. The evaluation of the overall research issues and the communication and impact of Building Energy projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Building Energy thematic area and across all thematic areas. (Left)

Figure 36. The evaluation of the benefits to the companies involved and society as a whole of Building Energy projects (dark orange) compared to the average of all projects (light orange). An average of the evaluation score for each question is taken over all the projects in the Building Energy thematic area and across all thematic areas. (Right)

The projects withal address important problems in relation to energy use in buildings and efforts to strongly reduce it (see question B1).

The projects are contributing to sustainable development by developing and investigating methods and concepts for saving use of fossil fuels for heating houses (see question B2).

The projects have provided new knowledge for the building sector on energy saving in building in many different ways. The dissemination of the knowledge to the building sector

has been effected directly to the participating companies and in general through professional national journal articles. The description of the results in the professional journals is a very good way of disseminating research results to the building sector in general (see questions B3-4).

The benefits to the building sector of the projects are quite high, as the results in some cases have been directly implemented by the participating companies and it is expected that the successful developments will spread to the sector in general (see question C1).

The benefits of the projects to society are mainly related to setting up energy requirements as part of the building code. The research is very relevant for the implementation of the very strong and quick reduction in energy use in buildings which is going to take place in the next decade. With the typical time delays of research implementation in the building sector, the results of the projects are expected to become a benefit for the society right now or in the coming years (see C2).

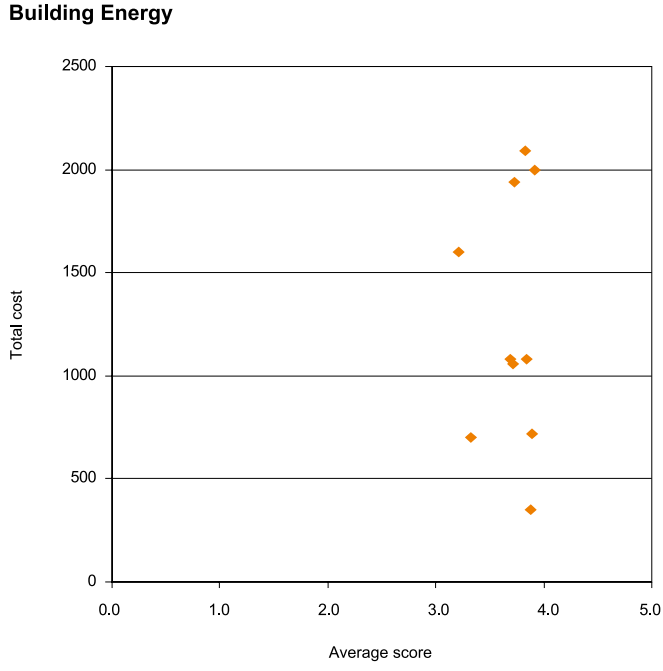
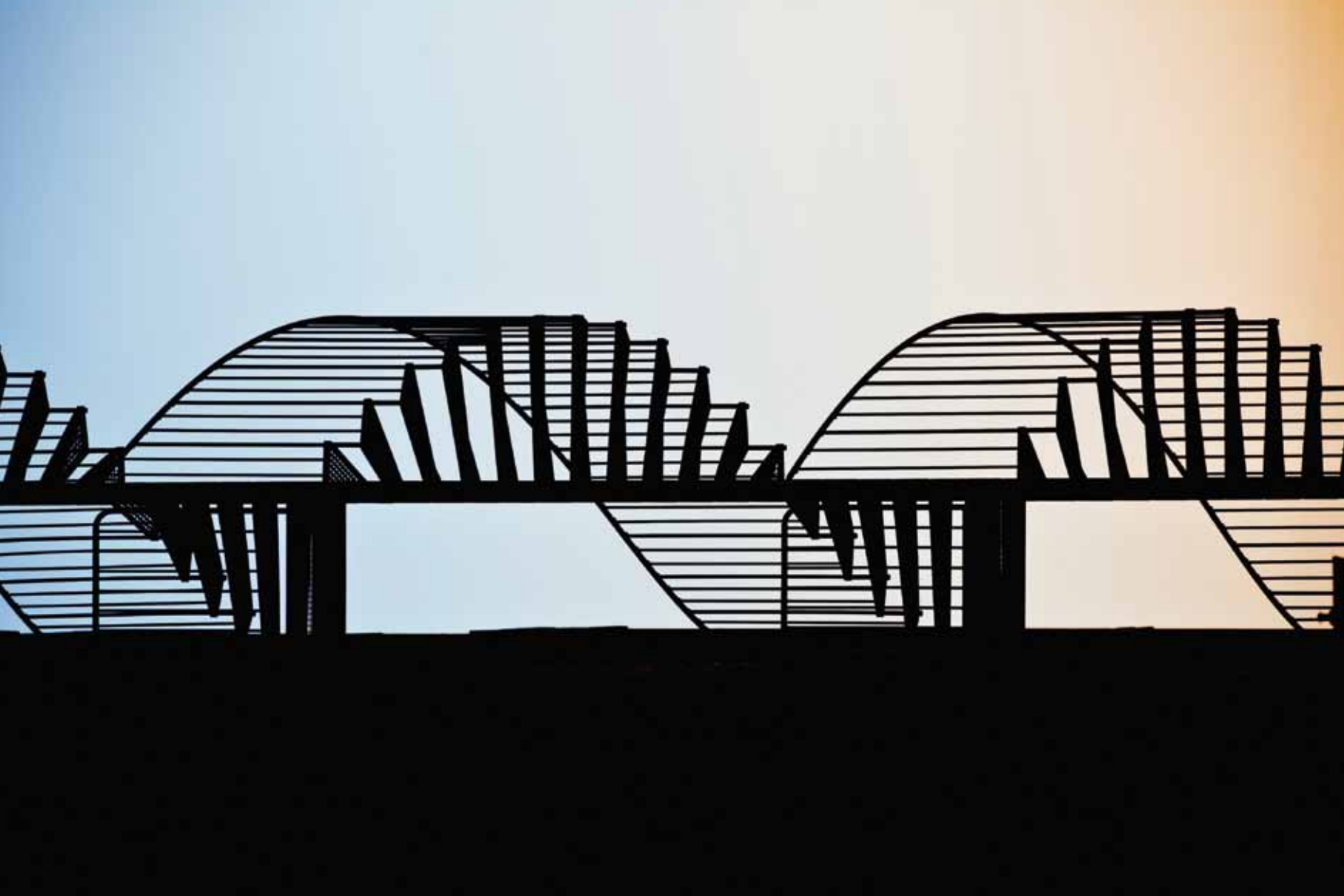


Figure 37. The total cost of the individual Building Energy projects, plotted as functions of average score for the project taken over all questions.

The calls for the energy projects in the evaluated programme period are not organized as part of a long term plan. This may become very relevant in future programmes as a public-private partnership, especially in the energy area, will be needed to successfully implement the national and European energy policy.



Overall conclusions and recommendation

The 71 projects were divided into 6 thematic areas to facilitate analysis across smaller groups and to separate research environments, companies and stakeholders across the construction sector.

In total, 71 projects carried out under the Formas-BIC calls and initiated in the period from 2003 to 2006 have been evaluated.

Overall it is concluded that the Formas-BIC effort has been worthwhile and that the projects funded covered a broad range of relevant and contemporary research issues in the building sector.

Most of the Formas-BIC calls (3) have been of a relatively broad nature, addressing the whole of the construction sector and the built environment as well as all aspects of service life from planning to design, construction, management, maintenance, renovation and demolition, while two (joint Erabuild) calls dealt with specific themes: *"Transformation of the Construction Section through Industrialization"* and *"Managing Information in Construction"*. This is to a certain extent reflected in the number of projects in the various thematic areas as identified and defined in the present work:

- Building Technology
- Health and Indoor Climate
- Building Processes
- IT in the Building Sector
- Environmental Quality of Buildings
- Building Energy

The number of projects in each area is fairly evenly distributed, with a preponderance of 'Building Processes' at seventeen projects and only eight projects in the area of 'IT in the Building Sector'.

In total, the six thematic areas covers current issues in research in the area of the construction sector and the built environment.

In general, the projects in each thematic area are addressing relevant issues, and in general the projects are covering the area well, though it is noted that there are certain current issues in Building Technology and Health and Indoor climate which are not covered. Furthermore, it is noted that in the IT in the Building Sector and the Building Technology areas the projects to some extent have produced relatively poor results of little scientific as well as low practical interest. Overall it is concluded that the research has concerned important and current issues and that no particular main area has been overlooked, apart from the IT area being weakly addressed.

In total, the overall quality of the projects is acceptable (the average project score is 3.2) and only a relatively small number of projects are evaluated as unacceptable, which is an indication of a sound process from call to selection of projects to be funded. Failure of a small number of projects must be expected if high risk projects are also to be funded (as they should be).

The main *strengths* of the projects across the thematic areas are:

- The scientific motivation and quality of the project plans.
- The scientific qualifications of the research groups.
- The relevance of the scope of the research.

The main *weaknesses* of the projects across the thematic areas are:

- The scientific dissemination, ranging from papers in international, scientific journals to involvement and education of M.Sc. and Ph.D. candidates. It is noted that a relatively large number of projects suffer from very poor scientific dissemination. This may have to be seen in relation to the general development in the focus on documentation of results in international research articles over the period since the projects were carried out. It should also be pointed out that there are a number of (larger) projects that deviate positively from this trend.
- The international visibility including participation in and presentation at scientific conferences.
- The international networking and participation of international partners in the projects, even in Erabuild projects.

- Contribution to renewal of the scientific communities and research institutions.

The societal benefits and the benefits gained by the companies involved are on average evaluated acceptable, but too large a number of projects perform unacceptably in the implementation phase (Fig. 7), even though a respectable number of projects performing excellently in this respect have also been identified, including a number of projects in the Building Energy thematic area. Given the emphasis on industrial participation and implementation in the Formas-BIC calls and projects, this result is considered somewhat discouraging. The particular characteristic of the Formas-BIC calls is the direct link between research and implementation. The proposal is accompanied by an implementation plan. In effect, however, it is difficult to gauge the extent to which this implementation has really taken place. There might be a time lag, and the industrial partners generally have other things to think about than looking back at research projects. It should be realized that the attempts at bridging from research to implementation will under normal circumstances involve an iterative process which is demanding both on the research and on the industrial side. This is particularly true in the building sector, where most companies and in particular the SMEs (small and medium sized enterprises) have little or no experience of research and development. Thus the implementation and the iterative process associated with implementation should be considered a separate, nontrivial subtask and the qualification of both research and industrial team should be carefully considered. The idea of a joint venture including implementation during the project is maybe only possible in exceptional cases – at all events, the conditions under which this can happen should be carefully considered. Finally, it should be noted that there seems to be very little – if any – correlation between performance in the scientific, relevance and implementation areas indicating that it is not enough to apply standard evaluation criteria normally applied in research project evaluation.

There seems to be very little correlation between the total average score of a given project and its size (total budget). None the less, the wide scatter of project sizes and the relatively large number of small size projects is of some concern. It seems that very small projects cannot handle complex and multidisciplinary issues. There is a danger of the funding being

too small and constituting only a partial contribution to project-clusters funded by several institutions. This is not an ideal situation and the responsibilities are often unclear in such arrangements. Even though the information concerning the 71 projects has not been complete, it seems that the projects that are large enough to produce Ph.D. candidates have a better level. The Ph.D. candidates as well as the institution are interested in maintaining a high academic level and scientific production is ensured.

The evaluation of the projects leads to the following recommendations for future calls.

- The size of the projects in the calls considered is of some concern, and there are indications that some projects are simply below critical size. The possibility should be considered of establishing a lower limit or a range of acceptable project sizes. This has in particular been identified as an issue in the thematic area of IT in the Building Sector and Building Technology and to some extent within Health and Indoor Climate. Preferably, the projects should be large enough to encompass lic. or doctoral students. Another possibility would be to combine research programmes with graduate schools in three-year programmes. To a large extend such arrangements would ensure also a reasonable scientific production.

- It should be carefully considered how implementation is integrated in research projects in future calls. It appears that when efforts are made to link research to implementation, this is primarily at the expense of the implementation. On the other hand, the research quality of the projects in question is only rated 'acceptable', even though the research environments in general are highly qualified by normal scientific standards. This situation could probably be improved through a shift of focus in the evaluation process for future projects. It is recommended that the following issues be carefully and explicitly evaluated during the evaluation process

    - Previous experience and qualifications of the research partner(s) and project leader in implementation (and possibly innovation) work.
    - Previous experience and qualifications of the industrial partner(s) and implementation leader in implementation (and possibly innovation)

work The academic background of the implementation leader should also be considered to ensure seamless communication between the two environments.

Furthermore the quality of the implementation plan should be evaluated carefully including the resources associated. The implementation plan should be evaluated upfront together with the research plan and the links between the two should be carefully considered.

- Even though the calls investigated seem to cover the current, relevant research issues in the construction sector. Today, it seems that only cross-disciplinary (or trans-disciplinary) research can produce significant new questions and approaches. In cross-disciplinary research the research topic does not come from a discipline or two disciplines (interdisciplinary), it comes from a societal issue (e.g. sustainability) and there is no a priori research plan and methodology. Cross-disciplinary research should therefore be encouraged in future calls.

- A specific problem of all research is the relation between the input (proposal and funding decision) and the output (reports, tools, degrees etc.). In fact most research management models in Europe are largely input-oriented. The proposals are analysed in depth and selected on their intention and method. Once the projects have started there is little control. (This would be too complicated and would need too much specialized manpower). The quantity and quality of the final result are generally judged from an administrative point of view. Several possibilities could improve this situation. Reporting forms including original project and implementation plans together with output reports, including links to reports, conferences and papers, should easily be made available on the Internet. The fact that reports are public constitutes a certain minimal quality control. In Germany, the research applications are reviewed by external experts. Once the project finished, the link to electronic copies of the final report is sent to the reviewers who generally check the results. Poor results are remarked on even if no direct consequences follow.

Appendix

A1. Methodology, sources of information and limitations of the study

The work method adopted by the committee was a combination of individual evaluations of the projects assigned to each member – based on competences – and group meetings during which (i) uniform evaluation and understanding of the evaluation questions was established and (ii) the general outline of the report and the general conclusions were discussed and agreed upon.

One group meeting was dedicated to establishing uniformity in evaluation and understanding of the evaluation questions. The process started with an individual evaluation of the projects assigned. In this process all projects were evaluated by two reviewers. Next the projects with the highest deviation in average score were identified and the evaluations and the underlying criteria were discussed during a one-day meeting. During this meeting individual evaluation criteria were adjusted and it was found necessary to formulate specific instructions for evaluation of the C-questions – see below.

To evaluate question C1, the available material often makes it difficult to answer this question and some sound judgement can be applied to arrive at a conclusion. An acceptable outcome of a project in this aspect – corresponding to grade 3 – could be that the company has gained access to first-hand knowledge or equivalent benefits which possibly enable it to gain a competitive edge at the end of the project or within a reasonable timeframe (1-2 years). This could be the case, e.g. if the company has had an active role as advisor or actively solved work tasks in the project which has had a reasonable outcome. Grade 5 should correspond to establishment of new businesses, spin off companies or equivalent, while grade 1 should correspond to no active company participation and/or no useful results from the project.

To evaluate question C2, again, the available material often makes it difficult to answer this and sound judgement often needs to be applied. Response to this question should to a high degree reflect the response to questions B1, B2, B3 and

B4. Good scores on C2 should depend on good scores on all of these questions (particularly B1, B3, and B4). Normally an acceptable outcome – corresponding to grade 3 – on C2 should require at least high scores on 2 of B1, B2 or B4. However, other factors could influence the score on C2, e.g. that the project has created awareness of issues which could lead to beneficial paradigm or technology changes in society. This guideline obviously links the response on question C2 quite tightly to the response to the questions in group B and indeed in the analysis shown, a relatively strong correlation exist between the evaluation of the individual projects in the group B questions and in C2.

It was found necessary also to highlight the interpretation of the '0' evaluation and the fact that this grade is given when the evaluator finds it impossible to evaluate the specific question either because of insufficient information or if the evaluator finds the question irrelevant. This practice has consequences for the calculation of average grades and questions with a '0' grade were kept out of the calculation of averages. The material available for each project is listed in Table A1.

Table A1. The material available for each project.

Project No	First Name	Last Name	Application	Final Report	BIC-Report	Questionaire	Implementation Plan	Plublication List	Papers, reports	No. of documents in folder
2003-1655	Jesper	Arfvidsson	1	1	1	1				4
2003-1668	Dan	Norbäck	1	1	1					3
2003-1669	Karin	Engvall	1	1	1	1			2	6
2003-1682	Christine	Räisänen	1	1	1	1	1		3	8
2003-1690	Michael	Edén	1	1	1	1			6	10
2003-1709	Jan	Ekstedt	1	1	1		1		3	7
2003-1716	Lars	Jensen	1	1	1					3
2003-1717	Sonja	Vidén	1	1	1				1	4
2003-1721	Susanne	Iwarsson	1	1	1		1		1	5
2003-1726	Anders	Ekholm	1	1	1	1			1	5
2003-1728	Gudni	Jóhannesson	1	1	1	1				4
2003-1729	Lars-Olof	Nilsson	1	1	1	1			3	7
2003-1735	Örjan	Wikforss	1	1	1			1	1	5
2003-1750	Thomas	Olofsson	1	1	1				1	4
2004-130	Örjan	Svane	1	1		1			2	5
2004-133	Mårten	Janz	1	1	1	1	1			5
2004-139	Magnus	Rönn	1	1	1	1	1	1	4	10
2004-151	Annette	Henning	1	1		1			4	7
2004-152	Håkan	Ylinenpää	1	1	1				6	9
2004-157	Ove	Söderström	1	2	1		1			5

2004-158	Michael	Edén	1	2	1	1				5
2004-159	Nils	Svendenius	1	1	1		1			4
2004-166	Per-Erik	Petersson	1							1
2004-167	Karin	Engvall	1	1	1	1	1		1	6
2004-170	Annika	Ekstrand-Tobin	1	2	1	1	1			6
2004-171	Jan	Byfors	1	1	1	1	1		3	8
2004-177	Jesper	Steen	1	2	1	1	1		2	8
2004-183	Stellan	Lundström	1			1	1		2	5
2004-187	Mats	Sandberg	1	1	1	1	1		6	11
2004-189	Björn	Frostell	1	1	1	1	1		7	12
2004-196	Gudni	Jóhannesson	1	1	1	1	1		2	7
2004-203	Sigurdur	Ormarsson	1	2	1	2	1			7
2004-209	Jesper	Arfvidsson	1	1	1	1				4
2004-213	Lars-Olof	Nilsson	1	2	1	1	1		1	7
2004-223	Per	Fahlén	1	1	1	1	1		1	6
2004-224	Mats	Eklund	1	1	1		1		5	9
2004-225	Miklós	Molnár	1	2	1	1	1			6
2004-228	Torbjörn	Lindholm	1	1	1	1				4
2004-231	Johnny	Lindström	1	2	1	1			2	7
2004-233	Lennart	Larsson	1	2	1	1	1		4	10
2004-234	Lennart	Larsson	1	2	1	1				5
2004-235	Clas	Florgård	1	2					2	5
2004-236	Henrikke	Baumann	1	2		1			3	7
2004-240	Mats	Eklund	1	2						3
2004-248	Tor-Göran	Malmström	1	1	1	1	1		3	8
2004-258	Inga	Malmqvist	1	2	1		1		1	6
2004-266	Birger	Ljung	1	1		1			1	4
2004-267	Alexander	Styhre	1	1	1		1		4	8
2004-279	Lars	Jensen	1				1			2
2004-281	Mauritz	Glaumann	1	2		1			4	8
2004-282	Göran	Finnveden	1	1	1	1	1		2	7
2004-283	Lars-Olof	Nilsson	1	2	1	1	1			6
2004-286	John	Sandblad	1	2	1		1		1	6
2004-528	Sonja	Vidén	1	1	1		1			4
2005-2136	Lars-Olof	Nilsson	1	1	1	1			1	5
2005-2138	Anders	Ekholm	1	1	1	1			1	5
2005-2143	Hans	Björnsson	1							1
2005-2177	Ali	Alavizadeh-Farhang	1	1	1				1	4
2005-2183	Gudni	Jóhannesson	1	1	1	1				4
2005-2192	Thomas	Olofsson	1	1	1	1	1		2	7
2005-2196	Bahram	Moshfegh	1	1	1					3
2005-2202	Mats	Sandberg	1	1	1	1			5	9
2005-2208	Per-Erik	Josephson	1	1	1	1				4
2005-2212	Dan	Norbäck	1	1	1				3	6
2005-2219	Jan	Borgbrant	1	1	1	1			1	5
2006-1668	Dan	Engström	1	1	1	1				4
2006-1686	Thomas	Olofsson	1							1
2006-1687	Miklós	Molnár	1	1	1	1				4
2006-1689	Anders	Segerstedt	1	1	1	1			2	6
2006-1691	Anders	Ekholm	1	1	1	1				4
2006-1693	Per-Erik	Josephson	1	1	1	1			2	6
		Total	**71**	**83**	**59**	**48**	**30**	**2**	**113**	**406**

The limitations of the work carried out can be summarized as follows:

There is a significant difference between the amount and quality of the material available for evaluation in the different projects.

In particular, weaknesses were found in the material describing the implementation work. As shown above the implementation plan was only available in 30 out of the 71 projects. This difficulty was – to a certain extent – overcome by the procedures and instructions described above.

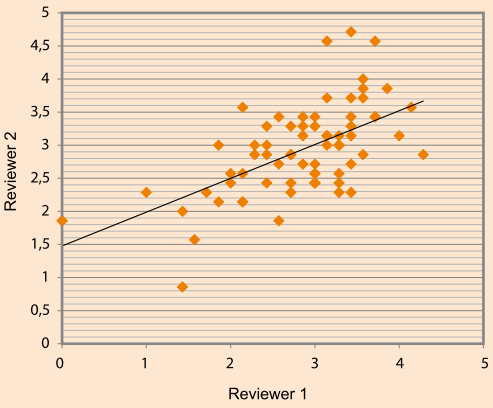
The information on the number of Ph.D. and partially also refereed publications are incomplete for several reasons: the publications/publications were not available at the end of the programme or the Ph.D. was co-financed with other programmes etc.

It was only to a certain extent possible to establish correlation between the two reviewers due – naturally – to the subjective element in all of the evaluations performed. The correlation between reviewers is further discussed in Appendix 2.

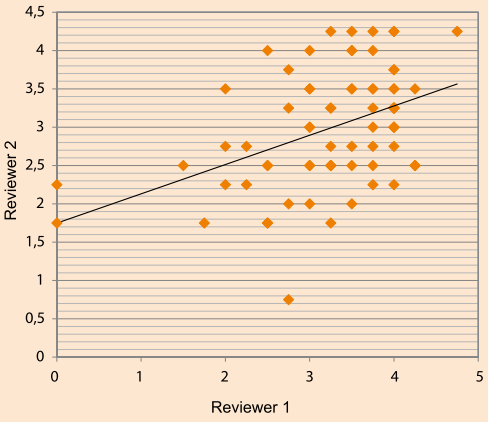
A2. Correlation between reviewers

The x–y representation of the scores of the two reviewers per project overall shows a moderate correlation. This correlation seems to be higher for the 7 A-questions than for the 4 B-questions. For the C question the correlation was significantly lower. This result was obtained after a long discussion of all the results (project by project) and to a certain extent reflects the lack of information on the project performance and output in relation to the C-questions.

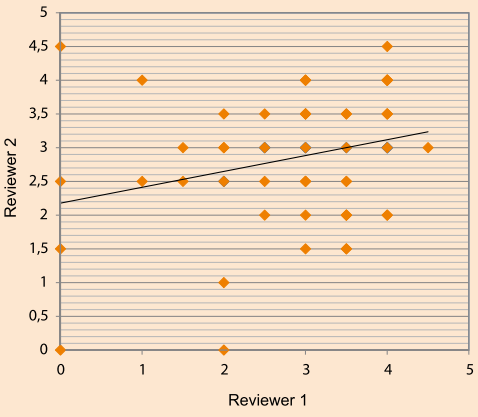
Correlation reviewers, A questions (r=0.61)



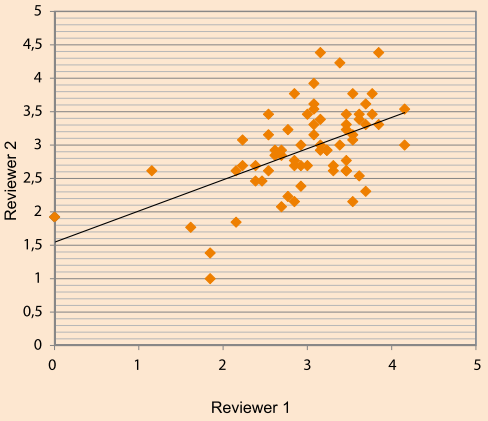
Correlation reviewers, B questions (r=0.43)



Correlation reviewers, C questions (r=0.28)



Correlation reviewers, all questions (r=0.56)



A3 Distribution of projects between universities/organisations and departments

University/Organisation	Department	Number of projects
Uppsala University		1
Uppsala University Hospital	Medical Sciences	3
Swedish Cement and Concrete Research Institute		2
Chalmers University of Technology	Architecture	4
Chalmers University of Technology	Civil and Environmental Engineering	5
Chalmers University of Technology	Applied Information Technology	1
Chalmers University of Technology	Energy and Environment	1
Chalmers University of Technology	Technology Management and Economics	2
Dalarna University	Solar Energy Research Center	1
University of Gävle	Engineering and Sustainable Development	3
Swedish Institute for Quality, SIQ		1
Royal Institute of Technology	School of Architecture	4
Royal Institute of Technology	Civil and Architectural Engineering	5
Royal Institute of Technology	Environmental Strategies Research	1
Royal Institute of Technology	Industrial Engineering and Management	2
Royal Institute of Technology	Real Estate and Construction Management	1
Royal Institute of Technology	Chemical Science and Engineering	1
Royal Institute of Technology	School of Architecture and the Built Environment	1
Linköping University	Management and Engineering	3
Luleå University	Business Administration and Industrial Engineering	2
Luleå University	Civil, Environmental and Natural Resources Engineering	4
Lund University	Astronomy and Theoretical Physics	1
Lund University	Building and Environmental Technology	11
Lund University	Construction Sciences	3
Lund University	Health Sciences	1
Lund University	Laboratory Medicine	2
Malmö University	School of Technology	1
Swedish University of Agricultural Sciences	Urban and Rural Development	1
SP Technical Research Institute of Sweden		1
SP Technical Research Institute of Sweden	Building Technology and Mechanics	1
Umeå University	Applied Physics and Electronics	1

A4 List of projects and their association with the thematic areas.

Project No.	Project title	Building Technology	Health and Indoor Climate	Building Processes	Environmental Quality of Buildings	Building Energy	IT in the Building Sector
2003-1655	Moisture Safety in the Building Process *Fuktsäkerhet i byggprocessen*	1					
2003-1668	A testing system for medico-physiological evaluation of various *ventilation solutions* *Ett testsystem för medicinsk-fysiologisk utvärdering av olika ventilationslösningar)*		1				
2003-1669	Perceived indoor environment and sick building syndrome (SBS) in relation to demand controlled ventilation for dwellings *Bostadsmiljö, komfort och hälsa – brukarreaktioner i flerbostadshus med behovsanpassad ventilation*		1				
2003-1682	Creating understanding for sustainable development in the construction industry. From official directives to environmental strategies in public organisations *Att skapa förståelse för hållbar utveckling i byggsektorn. Från myndighetsdirektiv till miljöstrategier i offentliga organisationer*				1		
2003-1690	Implementing sustainable building. Guidelines and tools for the implementation of demonstration projects. *Att implementera uthålligt byggande. Riktlinjer och verktyg för genomförande av demonstrationsprojekt*	1					
2003-1709	Durable paints for wood *Beständiga färger för trä*	1					
2003-1716	Designing energy-efficient buildings – Calculation program and methodology for all stages of the construction and management process *Utformning av energieffektiva byggnader – Beräkningsprogram och metodik för bygg- och förvaltningsprocessens alla skeden*					1	
2003-1717	Technology for sustainability in the housing estates of the 50s, 60s and 70s *Teknik för hållbarhet i 50–60–70-talens bostadsområden*				1		
2003-1721	Planning of home adjustments – implementation of scientific methodology in municipal activity *Planering av bostadsanpassningar – Tillämpning av vetenskaplig metodik i kommunal verksamhet*				1		
2003-1726	Classification of properties for product classification *Klassifikation av egenskaper för varuklassifikation*						1
2003-1728	Symphony – cost-effective construction of multi-family dwellings *Symfoni – kostnadseffektivt byggande av flerbostadshus*	1					
2003-1729	Measurement of damp in concrete floors with topping concrete *Fuktmätning i betonggolv med pågjutningar*	1					
2003-1735	Project communication with IT *Projektkommunikation med IT*						1
2003-1750	Methods of classifying and evaluating the energy efficiency of buildings. *Metoder att klassificera och utvärdera byggnaders energieffektivitet*					1	

2004-130	The Household, the Dwelling and the Small Neighbourhood – Environmental Management Studied through Situations of Opportunity, Synergies and Stakeholder Co-operation *Hushållen, boendet och det lilla grannskapet – bostadssektorns miljöarbete studerat som nyckelsituationer, samordningsvinster och aktörsmöten*			1			
2004-133	Foamed concrete manufactured with poly-aluminium *Skumbetong tillverkad med poly-aluminium*	1					
2004-139	Quality judgement and quality improvement *Kvalitetsbedömning och kvalitetshöjning*			1			
2004-151	Flexible heating system solutions – information to households and installers *Pellets och sol. Ett bidrag till omställningen från eluppvärmning (PESTO, etapp II)*					1	
2004-152	Cooperation between the actors in the construction process – A way to reach project success? *Etablering av varaktiga relationer i byggprocessen – Ett sätt att stärka konkurrenskraften*			1			
2004-157	Moisture and heat capacity of massive wood constructions to a pleasant indoor climate *Fukt- och värmetekniska egenskaper på massivträkonstruktioner till ett behagligt inomhusklimat*		1				
2004-158	Demonstration projects as an arena for implementing and developing sustainable building *Demonstrationsprojekt som arena för implementering och utveckling av uthålligt byggande*				1		
2004-159	Daylighting Buildings in the 21st Centuary – Energysaving Daylighting Solutions *Dagsljusupplysta byggnader under det tjugoförsta århundradet – Energibesparande dagsljuslösningar*					1	
2004-166	Durability of Concrete with Mineral Additions *Användning av industriella restmaterial och filler vid betongbyggande. Långtidsegenskaper och beständighet. Bic II*	1					
2004-167	Healthy Sustainable Houses – 3H *Hälsomässigt Hållbara Hus – 3H*		1				
2004-170	Quality assurance of indoor environment and energy use *Samordnad kvalitetssäkring av innemiljö och energianvändning*					1	
2004-171	Transition from document-oriented to product-oriented planning and design work – visualisation and product modelling as decision support in the early design phases *Visualisering och produktmodellering som beslutsstöd i tidiga skeden*						1
2004-177	Spatial structures for knowledge sharing – the usefulness of office buildings *Rumsliga strukturer för kunskapsutveckling – kontorsbyggnaders användbarhet*			1			
2004-183	Market research for planning, building and financing of new-build housing *Nytt arbetssätt för kommuner, byggherrar och finansiärer – Marknadsanalyser för planering, byggande och finansiering av nya bostäder*			1			
2004-187	Unconventional conversion of direct electrically heated buildings to district heating *Konvertering från direktel till annat uppvärmningssystem – Ny enkel och billig metod för distribution av värme inom huset*					1	
2004-189	Barriers for implementation of the Environmental Load Profile and other LCA based methods – Implementation studies and development of a user applied screening tool *Barriärer mot implementering av miljöbelastningsprofilen och andra LCA-baserade redskap – Implementeringsstudier och utveckling av ett förenklat screeningsredskap*				1		
2004-196	Termodeck – revisited *Termodeck – ett beprövat koncept med nya förutsättningar*					1	

2004-203	Moisture distortions in wood-based floor structures *Fuktrelaterade deformationer i träbjälklag*	1					
2004-209	Evaluation of causes of energy use and indoor climate in the Bo01-houses *Analys av orsaker till hög energianvändning och upplevd dålig komfort i Bo01-husen*					1	
2004-213	Excess moisture in concrete floors with heating pipes. Part 2 *Byggfukt i betonggolv med ingjutna golvvärmerör, etapp 2*	1					
2004-223	Efficiency of building related pump and fan operation – System solutions, motor technology and control. *Effektivisering av byggnadsrelaterad pump och fläktdrift – Systemlösningar, motorteknik och styrning*					1	
2004-224	Cleaner waste wood flows from the building sector *Renare flöden av träavfall från byggsektorn*				1		
2004-225	Rehabilitation of masonry facades damaged by reinforcement corrosion *Restaurering av murade fasader med korrosionsskador*	1					
2004-228	Classification of buildings. Energy use, us of environmental resources and indoor environment and health *Klassning av miljöanpassade byggnader*				1		
2004-231	Constructing Excellence – systems for construction excellence, measuring and evaluating from on the construction client and end user perspectives *Verksamhetsutveckling för framgångsrikt byggande – mått och mätsystem ur helhetsperspektiv med slutkunden i fokus*			1			
2004-233	Mycotoxins in indoor environments. Prsence, methods of analysis, immunomodulating properties *Mykotoxiner i inomhusmiljöer. Förekomst, bestämningsmetoder, immunmodulerande egenskaper*		1				
2004-234	Mycotoxins in indoor environment. Presence, methods of analysis, immunomodulating properties; Uppgrading of existing mass spectometer. *Mykotoxiner i inomhusmiljöer. Förekomst, bestämningsmetoder, immunmodulerande egenskaper: Uppgradering av befintliga masspektrometer*		1				
2004-235	Assessment of outdoor environment in built-up areas *Miljövärdering av utemiljö i bebyggelse*				1		
2004-236	Environmental improvement potential of existing residential buildings – management*s role and scope of action *Miljöförbättringspotential hos befintliga bostadshus – förvaltningens roll och handlingsutrymme. Environmental improvement potential of existing residential buildings – management*s role and scope of action*				1		
2004-240	Conditions, constraints and opportunities for integrated reuse projects in the Swedish building sector *Villkor, hinder och möjligheter för integrerat återbruk i den svenska byggsektorn*				1		
2004-248	Energy use, us of environmental resources and indoor environment and health *Innemiljökrav för miljöanpassade byggnader – kriterier för klassning*		1				
2004-258	Construction and Design Briefing – Innovative Client's Tool *Innovativa verktyg för byggherrars kravformulering i tidiga skeden*			1			
2004-266	The role of the buildingproprietor – The balance between structure and improvisation *Byggherrerollen – Avvägningen mellan det strukturerade och det improviserade*			1			
2004-267	Site managers in construction projects *Projektledarskap i bygg- och anläggningsprojekt – Förbättrat ledarskap genom coaching*			1			
2004-279	Computer simulation of computer services engineering systems *Datorsimulering av installationstekniska system*		1				
2004-281	Environmental Assessment of Buildings *Miljöstyrning med miljöindikatorer i fastighetsförvaltning*				1		

2004-282	Environmental classification of buildings *Miljöklassning av byggnader*				1		
2004-283	Compatibility between flooring system on concrete *Kompatibilitet hos golvsystem på betong*	1					
2004-286	Closing the loop – Encouraging Post Occupancy Evaluation *Utvärdering av byggnadsprojekt som underlag för programarbete*			1			
2004-528	Techniques for sustainability in housing areas of the 1950s, -60s- and 70s *Teknik för hållbarhet i 50–60–70-talens bostadsområden*				1		
2005-136	ICT for Whole Life Optimization of Residential Buildings *ICT-verktyg för helhetsprojektering av flerbostadshusplattformar*						1
2005-138	Evaluation of benefits of ICT for the industrialization of project and product processes in the construction industry *Undersökning av nyttan av ICT för industrialisering av projekt- och produktprocesser i byggindustrin*						1
2005-143	ISCIS – Integrated Supply Chain Information Systems *Informationssystem för supply chain management i byggföretag*						1
2005-177	Computer-aided modeling, simulation, visualization of movements of Self-compacting concrete in casting process *Datorstödd simulering, modellering och visualisering av rörelse hos självkompakterande betong i gjutprocessen – Bic 4*	1					
2005-183	The air gap-concept: An efficient method for ventilation in building constructions by heated air-gaps in walls and floors at both refurbishment and new production of bath-rooms and kitchens. *Spalt-metoden: Rationell metod för ventilation i byggnads-konstruktioner, med hjälp av uppvärmda luftspalter, i väggar och golv vid renovering och nyproduktion av våtrum och kök – Bic 4*					1	
2005-192	Planning the Healthy Construction Workplace *Planering av den hälsosamma byggarbetsplatsen – Bic 4*			1			
2005-196	Comfort and Indoor Climate Concequences of Structural Energy Rationalization in Hospitals *Komfort- och inomhusmiljökonsekvenser av strukturerad energi-effektivisering för vårdlokaler – Bic 4*		1				
2005-202	Inovative cooling strategy in a school envionment *Innovativ kylstrategi i skolmiljö – Bic 4*					1	
2005-208	Quality development for successful construction and maintenance a pilot study with reduced poor quality costs in focus *Kvalitetsutveckling för framgångsrikt byggande och fastighets-förvaltande – en förstudie med reducerade bristkostnader i fokus – Bic 4*			1			
2005-212	New methods to evaluate technical improvements of damp buildings- with special focus on dampness in the floor construction *Nya metoder för att utvärdera tekniska åtgärder i fuktiga byggnader-med speciellt fokus på fukt i golvkonstruktionen – Bic 4*	1					
2005-219	The client function as a change agent *Byggherrenfunktionen som förändringsagent – Bic 4*			1			
2006-668	Architectural quality, user requirements and mass customization in industrial building systems *Arkitektonisk kvalitet, användarkrav och mass customization i industriella byggsystem – Bic 5*			1			
2006-686	Integration of project specific building information model into industrialised building process, EraBuild ref: SE +358961522072 *Integration av projektspecifika bygginformationsmodeller i en industrialiserad byggprocess, EraBuild – Bic 5*						1
2006-687	Plug&Play Alliance SE+4525322518, SE Cont./WP 5 – Development of economical and business models for analysis of market opportunities for industrial multi-dwelling housing *Plug&Play Alliance SE+4525322518, SE Contrib./WP 5 – Utveckling av förklaringsmodell för karakterisering av det industriella flerbostadsbyggandets utvecklingsmöjligheter – Bic 5*						1

2006-689	Industrial Processes Supported by an Open Virtual Building Environment, referens: SE +468200440 *Industriella processer stödd av en öppen virtuell bygginformations miljö, Bic 5*			1			
2006-691	Developing value and delivering customer value in an industrialised context (SE +46462224163) *Värdeskapande och kundnytta i ett industrialiserat byggande (SE +46462224163) – Bic 5*			1			
2006-693	New industrialisation in supply – balancing project configuration and long term stability through partnerships *Industrialisering i leveranser – balansera projektsammansättning och långsiktig stabilitet genom partnerskap – Bic 5*			1			
	TOTAL	**13**	**9**	**17**	**13**	**11**	**8**

The mission of Formas is to promote and support basic research and needs-driven research in the areas of Environment, Agricultural Sciences and Spatial Planning. The research supported should be of the highest scientific quality and of relevance to the areas of responsibility of the Council. Formas may also fund development projects to a limited extent.

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