

Synthesis report

From Source of Knowledge to Solving Environmental Problems?

Evaluation of 33 Mistra research
programmes implemented and
completed 1996–2011

Stockholm May 2013

Author: Sweco EuroFutures AB

The contents of this synthesis report
are the responsibility of the authors.

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Preface

 This evaluation and impact assessment has been conducted by *Sweco Eurofutures* and principally by Sigrid Hedin, Annelie Helmersdotter Eriksson and Markus Burman. In addition, the following participants also participated in the evaluation team: Charles Edquist, Lund University, Björn Ekelund, Andreas Gyllenhammar and Sofia Klugman, all three colleagues at Sweco. In addition, Niclas Lavesson, from Lund University performed the citation analysis.

The Mistra contacts were Johan Edman, Christopher Folkesson Welch and Fredrik Gunnarsson.

The evaluation team would like to thank all of the Mistra staff and programme participants, specifically for their help in the data collection process but also, more generally, for their willingness to answer questionnaires, participate in interviews and provide us with the necessary documents to complete the task in hand.

Summary

The Swedish Foundation for Strategic Environmental Research, Mistra, began its activities in 1994 and had, by 2011, supported the implementation of around 33 completed research programmes with a total of around 2 billion SEK. The funds were derived from the discontinued ‘wage-earner funds’ programme implying that, indirectly at least, it is tax money that has been used for research purposes.

Due to the origin of the funding the foundation has recognised that it has a particular responsibility to evaluate the outcome of the investments made. The foundation has funded research for almost 20 years. Consequently, there is now a desire on all sides to evaluate the results of this programme undertaken in the form of an *ex-post* evaluation of the effects and impacts of the funded research programmes, implemented and completed no later than 2011. Evaluations have been undertaken on each of the 33 completed research programmes implemented and completed during the period 1996–2011.

The aim of the evaluation is

- ▶ to clarify whether the research programmes have generated the effects that could have been expected when the original programme funding decision was made.
- ▶ to shed light on whether Mistra has invested money in a way that is consistent with the statutes of the foundation.
- ▶ to constitute a basis for the identification of success and risk factors in respect of Mistra’s mode of operation and as regards the practical organisation of the research programmes.

In order to provide a good picture of *whether, how* and *to what extent* completed Mistra research programmes have actually generated the intended effects and results the following questions were in focus as regards the purpose of Mistra:

- ▶ Has the funded research been of strategic importance as regards achieving a good living environment? Has the funded research been of importance in the identification of solutions to crucial environmental problems and in the pursuit of a sustainable development of society?
- ▶ Has the funded research promoted the development of a strong research environment of the highest international standard and has it had a positive impact on Sweden’s future competitiveness?
- ▶ Have the funded programmes taken advantage of opportunities arising to promote industrial applications which may be important for Sweden’s future competitiveness?

The evaluation has also taken into consideration effects other than those expressed in the statutes of the foundation.

The evaluation is based on a deep document analysis designed to reconstruct the programme theory both of Mistra as an organisation and of the individual evaluated research programmes. The studied materials include strategy documents, pro-

gramme proposals, programme plans, evaluations and annual reports as well as the final reports of the programmes themselves.

A series of semi-structured interviews with representatives of Mistra staff, who were employed during the implementation of the studied research programmes, and some members of the Mistra Board have also been undertaken.

In order to achieve a more detailed picture of the programme implementation and its results and impacts, a web-based questionnaire was distributed to those who participated in the research programmes as programme directors, members of the executive committees, programme participants and users of the programme results.

For the programmes *CLIPORE*, *Greenchem*, *MARE*, *Mistra Fuel Cells* and *SUFOR* interviews were also undertaken with programme representatives in order to gain a deeper understanding of the programme implementation as well as of the results and impacts.

Mistra's programme portfolio

Mistra's purpose and mode of operation is, according to the statutes multifaceted. The evaluated programmes have generally sought to address and ultimately to solve highly complex issues. The interdisciplinary mode of operation and the requirement for user involvement were, moreover, viewed as key components in addressing the questions raised by the programme. The programmes have been long-term and comprehensive in terms of the number of participants, even if the number varies between the programmes. The programme portfolio is heterogeneous in its thematic orientation. For instance there are programmes that address climate change, forestry, agriculture, water management and technology development concerning air pollution etc. The scope of thematic orientation has however meant that it has been quite a challenging task to develop general conclusions and recommendations.

Programme results and impacts in the relevant sectors

Despite the varied orientations we can conclude that the programme has contributed to knowledge and competence development. The various results and impacts are presented here based on the nature of their impact in the following sectors, research community, industry, public sector and society as a whole.

Research community: Within the research community the programmes have resulted in a great number of scientific publications. Another concrete result is the increase in educated and qualified researchers. The respondents are however ambiguous as to whether programme participation has been beneficial for individual career development. This can be explained, in part, by the fact that it is predominantly senior researchers that have participated in the programmes. In relation to the research community the undertaken research has continued in research programmes after the finalisation of the Mistra programme to which it was initially attached though often not in such a comprehensive manner as in the Mistra programme. Some programmes have resulted in the establishment of centres of competence or excellence. Some of the researchers have been involved in patenting and in the registration of substances while others have started companies and have used the generated knowledge to sell consultancy services. The programmes have however clearly had an impact on existing courses.

Industry: A number of programmes report patents and the registration of substances as tangible results. Several demonstrators and prototypes have been develo-

ped. Some have already been launched while others are in the pipeline waiting to be launched. The launching of products however often demands additional financing and expertise. The Mistra programmes have, based on the knowledge generated, resulted in the launching of several goods, services and processes. In relation to the impact on companies, existing companies that have participated in the programmes have benefitted in their development. Moreover, new companies have also been established, of which some have expanded rapidly while others have not grown at all. Companies have also benefitted from the newly developed competences. PhD students have gained experience in the programme and have carried the knowledge and perspectives gained into the industrial sector after graduation.

Public sector: In the public sector the knowledge generated in the context of the programme has been used to promote national and international policy development. Some of the evaluated Mistra programmes have contributed to the models and methods subsequently used in the management of natural resources and physical planning. Furthermore, there is a strong connection here also to the development of products (see above) with individual products being tailored specifically for use in the public sector. Industry and the public sector have both benefitted from the competences developed within the Mistra programmes with participating researchers acting as the carriers of new knowledge and perspectives. The Mistra programme has undoubtedly then increased Swedish competitiveness.

Society as a whole: Mistra has not defined the concept of ‘a good living environment’. When programme participants were asked how this concept had been viewed their answers tended to vary significantly between programmes, though they could generally be related to the orientation of the specific programme involved. The programmes have contributed to fulfilling the environmental objectives set. Some objectives are however addressed more successfully than others; these include reduced climate impact, clean air, no eutrophication, natural acidification only and a non-toxic environment.

Mistra’s mode of operation

The interdisciplinary approach and user involvement requirements have resulted in tensions and conflicts in some programmes since the participants display varying interests and perspectives in relation to implementation. In most programmes these tensions have, in general, been successfully managed. In many programmes it was however found to be rather time-consuming to establish a functioning cooperation process that generated synergies. Nevertheless, the interdisciplinary approach and user involvement have contributed to a more successful programme implementation. In relation to the relatively complex uses and mode of operation addressed in Mistra programmes long-term financing is a prerequisite. Moreover, many of the activities would simply not have been undertaken without Mistra financing.

Conclusions

In sum the Mistra research programmes and the foundation’s investments have generated significant results and impacts, some expected others unexpected. Research funding is connected with risk taking and even weak or negative results contribute to the research development. Programmes not expected to produce user friendly results or attain a certain level of quality were terminated. In the relation to Mistra’s purpose (indicated with bold letters below) the following conclusions can be drawn:

Development of strong research environments of the highest international standard which are important for Sweden's future competitiveness: The primary result of the implemented research programmes is knowledge development within various research fields, promoting, albeit indirectly, the solving of environmental problems. This suggests that the programmes have, to a greater extent, fulfilled the requirements of activity paragraph (§3) than of the purpose paragraph (§1). Some programmes have contributed to the development of knowledge in rather novel fields while others have significantly strengthened existing research fields. The most telling example here is of the centres and research environments, which were primarily 'virtual' and which were dismantled when the programme ended. This suggests that the developed research competences were lost.

Contribute to a good living environment and find solutions to important environmental problems while promoting the sustainable development of society: The lack of an operational definition for 'a good living environment' creates the opportunity to include a broad range of activities while remaining challenging in terms of defining results and impacts. All of the programmes have contributed to the promotion of 'a good living environment' since they have each sought to generate solutions to the environmental challenges Sweden increasingly faces. The programme's activities have also been of relevance for the national environmental objectives as well as for sustainable development, since they have contributed to the discovery of solutions to environmental issues as well as ensuring that the knowledge acquired is useful and applied in legislative development, negotiation, management and product development.

Take advantage of opportunities to generate industrial applications: The industrially-orientated programmes have resulted in the creation of industrial applications in the form of products and processes, but also other programmes. The broad application of the developed goods, services or processes across both the private and public sectors also contributes to the development of sustainable development. It should however be noted that the transformation of development knowledge into marketable products is time-consuming and costly.

Other results and impacts include an enhanced understanding of programme development processes and of the perspectives of other actors as well as raised competence levels among those who participated in the evaluated Mistra programmes. In an ever more complex society this insight is a factor of increasing importance in facilitating the seeking of broader solutions and helps to facilitate dialogue with cooperation partners. We also note that deeper cooperation between actors has been witnessed in projects where cooperation has continued after the initial Mistra funding. The programme participants themselves are also potentially carriers of the knowledge and insights produced and they often bring this with them as they take up new positions within the academic world, authorities, companies and other organisations. This offers opportunities for cooperation, approaching challenges and finding solutions.

We should also note the existence of both **risk and success factors** in relation to Mistra's mode of operation, though over time the mode of operation has evolved to some extent. Some participants perceive that the demands on them have been great and that there is risk that this will hamper the opportunities to attain the specific objectives of the programme and in the long run prove detrimental to the overall purposes of Mistra. We can clearly identify tensions here between research and commercialisation interests, but also cross-disciplinary tensions between researchers. This requires a programme management structure that has the ability to manage these challenges. Mistra's role has also influenced programme implementation and Mistra's staff must strike a balance between being a supportive but not a decisive actor, this demands being responsive and possessing a "finger-

tip feeling” in management terms. Based on the 33 evaluated programmes one of the main success factors is that there is a certain amount of flexibility in terms of amendments built into Mistra programmes. This is necessary since the programmes are rather long-term in nature and the conditions influencing the focus of the programme often change during the implementation period. Moreover, long-term financing is a prerequisite if grand and complex issues are to be addressed. We can clearly see a needs-driven knowledge development process at work in the industrially-orientated programmes generating results, products and processes which are of direct use and accelerate the application of the results. For the public sector participation implies access to relevant knowledge that can be used in negotiations, legislative development etc.

Recommendations

Based on our conclusions and analysis the following recommendations, relating to the programme life-cycle, can be made in respect of the future mode of operating and organising the research programmes.

Financing: Mistra should

- ▶ Consider the co-financing of programmes, where possible, to enable larger programmes to be created, promote synergies and avoid duplication. Co-financing also increases the chance that the knowledge generated is disseminated more widely through the networks and dissemination channels of the other financiers.
- ▶ Continue the commitment to the long-term and extensive funding of programmes since this is a prerequisite for the development and establishment of interdisciplinary collaboration and the basis for addressing environmental issues which demand a more holistic contribution or solution. Mistra’s role in the research financing system has been influenced by an increasing level of access to funding for environmental research compared to the mid-1990s. But the foundation still has an important role to play with its novel approach to programme organisation and implementation.
- ▶ Establish a dialogue with the main contractor and other participating higher education institutions and actors in order to establish the prerequisites and enhance the opportunities for the continued financing of a relevant research environment so that the research produced in the programme can continue after the programme is officially concluded. Mistra’s role is not to finance the research forever, but there is clearly a risk that the knowledge and competence is lost if a major effort is not undertaken in order to ensure continued financing.
- ▶ Consider funding of the physical research environment in order to ensure that the generated knowledge and competences are further developed after the finalisation of the programme. Mistra should consider the future safeguarding of the physical research environments that are financed through Mistra programmes since the potential for new or continuing projects and other activities among the Mistra research groups is increasing. Many of the virtual environments created in the context of Mistra programmes have been dismantled after programme is completed. An emphasis on the physical environment could however mean that relevant research environments are not included in the programmes. The potential for international participation and exchange may also be limited. Furthermore, all programmes are not automatically destined to continue.
- ▶ Support opportunities for product commercialisation, application and business development by providing contacts with relevant private and public actors.

- ▶ Consider providing extra funds for commercialisation in order to facilitate product commercialisation and to greater extent ensure that the opportunities to take advantage of industrial applications are taken.

Thematic orientation and initiation of programmes: Mistra should

- ▶ Continue to combine open thematic calls with a more ‘blue sky’ approach which is open to both researchers and users. Both approaches require a dialogue with researchers and experts as well as the users in order to identify the relevant thematic orientation of the calls and programmes. Environmental scanning offers the opportunity to identify ‘cutting-edge’ themes and orientations rather than just responding to already existing needs.
- ▶ Avoid forced mergers between research teams in the development of programme proposals or in implementing programmes since few advantages with this approach have been revealed.
- ▶ Be clear on the types of qualifications required in respect of participating researchers, focusing on both academic and ‘soft’ skills and a genuine will and ability to cooperate and find synergies and create the ‘added-value’ that an interdisciplinary and varied researcher programme participation can imply.

Mode of organisation and operation: Mistra should

- ▶ Apply tools such as environmental scanning, analyses and evaluations in order to increase the chances of “picking and creating winners”.
- ▶ Consider its role in both ensuring that the demands are fulfilled and providing active support to the programme implementation in relation to the creation of “winners”.
- ▶ Ensure the appointment of a suitable programme director who possesses excellent leadership skills, since the management and communication ability of this person is of critical importance for a well-managed programme. Due to the challenging nature of this task, Mistra should also consider employing a dual leadership structure separating the role of the scientific director from that of the administrative director who would be tasked with dealing directly with the stakeholders. Process support should be offered if necessary.
- ▶ Support programmes to help settle the IPR and confidentiality agreements before the programme begins in order to ensure that good ideas are included in programmes and conflicts are avoided. This kind of support could be provided by Mistra by, for instance, offering legal counselling and cooperating with other initiatives and actors addressing the issue. Consider providing greater process support to assist the programme management.
- ▶ Further develop the design of the scientific and user evaluation process. These evaluations have been undertaken before the various phases and comments have been made regarding the timing and content. The timing is important since the results will vary depending on when the evaluation is made. In order to gain greater acceptance from researchers a greater level of consistency in terms of quality must be attained. We have as yet only limited knowledge of how the ongoing programmes have perceived the evaluations. A consistent model increases the trust in the method while increasing the opportunities for comparison. There are good opportunities here for ‘benchmarking’ with other research financiers, such as Formas, the Swedish Foundation for Strategic Research and the Knowledge Foundation among others. Applying the ‘ongoing evaluation’ method as a support mechanism to aid the programme management should also be considered.
- ▶ Consider the routines and instructions given to the programmes in relation to the final reporting, for instance the reporting of programme results and impacts.

Among the evaluated programmes the quality and content of the final reporting varies significantly. In order to increase the opportunities to monitor and compare the programmes we recommend the development of a more coherent final reporting system, for instance the content of the final report in terms of main headings. This increases transparency and the opportunity for comparison.

Finally, we note, in relation to what the evaluation has displayed regarding the evaluated programmes' contribution to solving environmental problems, that Mistra should consider whether it is good enough to create prerequisites such as the research infrastructure, coordination, networks, training etc., rather than aiming to actually solve environmental problems in a more direct way.

Sammanfattning

Mistra, Stiftelsen för miljöstrategisk forskning, etablerades 1994 och har fram till idag finansierat ett 30-tal avslutade forskningsprogram till en kostnad av drygt två miljarder kronor. Mistra är en s.k. löntagarfondsstiftelse, vilket innebär att offentliga medel är ursprunget till stiftelsens kapital. Mot bakgrund av detta samt att verksamheten snart har pågått i två decennier har Mistra låtit genomföra en *ex post*-utvärdering för att undersöka om stiftelsens investeringar har genererat avsedda effekter och på ett sätt som är förenligt med stiftelsens stadgar. Utvärderingen har omfattat 33 forskningsprogram som genomfördes och avslutades under perioden 1996–2011. Syftet med utvärderingen har varit att:

- ▶ Klargöra om forskningsprogrammen har genererat de effekter som förväntades när beslut om tilldelning av medel fattats.
- ▶ Bidra till att klargöra om Mistra har investerat sina medel på ett sätt som är förenligt mer stiftelsens stadgar.
- ▶ Utgöra underlag för arbetet med att identifiera framgångs- och riskfaktorer i Mistras arbetssätt.

För att utvärderingen ska kunna visa om, hur och i vilken omfattning forskningsprogrammets effekter är i linje med Mistras ändamål har utvärderingen sökt svar på följande frågor:

- ▶ Har forskningen varit av strategisk betydelse för att uppnå en god livsmiljö?
Har forskningen haft betydelse för lösandet av viktiga miljöproblem och en miljöanpassad samhällsutveckling?
- ▶ Har forskningen främjat utvecklingen av starka forskningsmiljöer?
- ▶ Har möjligheterna att uppnå industriella tillämpningar tagits till vara?
- ▶ Har forskningen haft betydelse för Sveriges framtida konkurrenskraft?

Utvärderingen har också beaktat andra typer av effekter än de som uttrycks i stiftelsens stadgar.

Utvärderingen grundar sig på omfattande studier av dokument relaterade till Mistra och de individuella programmen, såsom strategidokument, programförslag, programplaner, utvärderingar, årsrapporter samt programmets slutrapporter. Intervjuer har också genomförts med personer som har arbetat vid stiftelsen under de senaste 20 åren samt personer som har suttit i Mistras styrelse under tidsperioden. För att få en bild av programmets genomförande samt resultat och effekter skickades en web-baserad enkät ut till personer som har varit involverade i programmen som programchef, medlem i programstyrelsen, programdeltagare och användare. Vidare har intervjuer genomförts med representanter för fem av de utvärderade programmen – *CLIPORE*, *Greenchem*, *MARE*, *Mistra bränslecellsprogram* och *SUFOR* – för att få en djupare bild av genomförandet samt programmets resultat och effekter.

Mistras programportfölj

Mistras syfte och arbetssätt är mångfald, sett till stadgarna. De utvärderade programmen har ofta haft ambitionen att greppa stora komplexa frågor samt varit lösningsorienterade. Ett tvärvetenskapligt arbetssätt och användarinvolvering har ansetts vara en nödvändighet för att adressera programmets frågeställningar. Programmen har varit långvariga och omfattande sett till antal deltagare, även om antalet deltagare per program varierar. Programportföljen är heterogen beträffande tematisk inriktning. Till exempel återfinns program som har adresserat klimatfrågan, skogs- och jordbruk, vattenvård, teknologisk utveckling rörande rening av luftföroreningar etc. Bredden på programmets inriktning har inneburit att det i viss mån har varit svårt att dra alla program över en kam beträffande slutsatser och rekommendationer.

Programmets resultat och effekter inom relevanta sektorer

Trots olikheten i inriktning kan vi sammanfattningsvis konstatera att programmen har bidragit till utveckling av kunskap samt kompetensökning. Programmets dokumenterade resultat och effekter presenteras i det följande beroende på vilka påverkan de har haft inom relevanta sektorer såsom forskarsamhället, näringsliv, offentlig sektor och samhället som stort.

Forskarsamhället: Inom forskarsamhället har programmen resulterat i ett stort antal vetenskapliga publikationer. Ett annat konkret resultat är utbildade och meriterade forskare. Dock är enkätsvaren något tvetydiga om deltagandet har varit av betydelse för karriärutvecklingen, vilket delvis kan förklaras med att det mestadels har varit relativt seniora forskare som har ingått i programmen. Beträffande forskarsamhället kan vi också konstatera att den forskning som bedrivits i programmen har fortsatt i forskningsprojekt efter att programmet avslutats, dock ofta inte på ett lika övergripande sätt som i Mistraprogrammet. Vissa program har resulterat i etablerande av centrumbildningar. En del av de deltagande forskarna har varit delaktiga i registrering av patent och substanser, och några har startat företag och säljer bland annat konsulttjänster baserat på forskningsresultaten. Avtrycken beträffande påverkan på utbildning är främst att forskningsresultaten har inkluderats i undervisning i redan existerande utbildningsutbud.

Näringsliv: Ett antal program redovisar registrering av patent och substanser som ett resultat. Ett flertal demonstratorer och prototyper har också tagits fram. Marknadslansering av produkter verkar dock i många fall dröja, då fokus hittills har varit på själva produktutvecklingen. Ytterligare kompetens och finansiering kan behövas för en lansering. Mistraprogrammen har emellertid redan resulterat i en palett av lanserade varor, tjänster och processer. Beträffande avtryck på företag har en del befintliga företag som har deltagit i programmen fått hjälp med sin utveckling. Även nya har bildats på grundval av Mistrastödda projekt, av vilka några företag har utvecklats mycket väl, medan andra har förblivit små. Företagen har också kunnat dra nytta av den kompetensuppbyggnad som Mistraprogrammen har bidragit till. Forskarutbildade har till exempel genom den erfarenhet de skaffat sig i programmen fört med sig både ny kunskap och nya perspektiv till näringslivet i sina anställningar efter doktorandtiden.

Offentlig sektor: I offentlig sektor finner vi exempel på att programmen har bidragit till kunskapsunderlag som varit till nytta för att påverka policyutformning, såväl internationell som nationell. Vi ser vidare att Mistraprogrammen har bidragit med modeller och metoder som har påverkat exempelvis naturresursförvaltning samt

samhällsplanering. Dessutom finns en stark koppling till utveckling av produkter (se ovan) som har kommit till användning i offentlig sektor. Liksom för näringslivet har offentlig sektor även kunnat ta del av den kompetensutveckling som Mistra-programmen inneburit. Även här har anställning av deltagande forskare inneburit såväl ny kunskap som nya perspektiv och ökad helhetssyn.

Samhället: Mistra har ingen specificerad definition av vad god livsmiljö avser. När programmen tillfrågas om hur de har sett på denna varierar också svaren stort och relateras till programmens inriktning. Programmen anses ha bidragit till arbetet att uppfylla miljö kvalitetsmålen. Några av målen är mer adresserade än andra, såsom minskad klimatpåverkan, ren luft, ingen övergödning, bara naturlig försurning och giftfri miljö.

Mistras arbetssätt

Det tvärvetenskapliga samarbetet och användarinvolveringen har bitvis resulterat i spänningar i en del program, då deltagarna har haft olika intressen och perspektiv på genomförandet. I de flesta av programmen har det gått att hantera dessa spänningar. I många program har det dock tagit tid att få till fungerande samarbeten som genererar synergier. Men sammantaget anses det tvärvetenskapliga arbetssättet och användarinvolveringen ha bidragit till ett bättre programgenomförande. Baserat på Mistraprogrammens relativt komplexa frågeställningar och arbetssätt anses en långsiktig finansiering vara en förutsättning för genomförandet. Vidare kan konstateras att många av de aktiviteter som genomförts i programmen inte hade ägt rum utan Mistras finansiering.

Slutsatser

Sammanfattningsvis kan konstateras att Mistras forskningsprogram och stiftelsens investeringar har genererat resultat och effekter, somliga förväntade och andra oväntade. I forskningsfinansiering ligger ett risktagande, men även svaga eller till och med negativa resultat kan föra forskningen vidare. De program som inte förväntades leda till användarvänliga resultat eller inte höll förväntad kvalitet förlängdes inte. Relaterat till stiftelsens ändamål (som anges i fetstil nedan) kan följande slutsatser dras:

Främja utvecklingen av starka forskningsmiljöer av högsta internationella klass med betydelse för Sveriges framtida konkurrenskraft: Det främsta resultatet från Mistras genomförda forskningsprogram är kunskapsuppbyggnad inom olika forskningsfält, det vill säga ett indirekt lösande av miljöproblem, vilket talar för att programmen i högre utsträckning levt upp till verksamhetsparagrafen än ändamålsparagrafen i stiftelsens stadgar. Några av programmen har bidragit till utveckling av tämligen nya fält och andra har främst inneburit en förstärkning av befintliga. Det finns exempel på etablering av centra och forskningsmiljöer, merparten har dock varit virtuella miljöer som upphör vid programmets avslut. Med detta finns en risk att förlora uppbyggd kompetens och position.

Stödja forskning av strategisk betydelse för en god livsmiljö och lösandet av viktiga miljöproblem för en miljöanpassad samhällsutveckling: Avsaknaden av definition av en god livsmiljö skapar handlingsmöjligheter då den är bred, men även utmaningar i sökandet av resultat och effekter. På ett eller annat sätt anser sig samtliga program ha bidragit till en god livsmiljö i och med att de sökt lösningar på miljöproblem. Programmens aktiviteter har också haft bäring på de nationella miljö kvalitetsmålen samt på hållbar utveckling, då de har bidragit till att finna lösningar på miljöfrågor samt strävat efter att kunskapen ska komma till

nytta och användas i lagstiftning, förhandlingar, utveckling av praktik likväl som framtagande av produkter.

Möjligheterna att uppnå industriella tillämpningar skall tas till vara: Framför allt de industrinära programmen har resulterat i industriella tillämpningar i form av produkter och processer, men även andra program har resulterat i produkter. En bred användning av de framtagna varorna, tjänsterna eller processerna i såväl privata som offentliga sektor bidrar också till en utveckling mot ett hållbart samhälle. Det kan påpekas att utveckling av kunskap som ska omsättas i utveckling av produkter tar tid och kräver finansieringskällor och kompetens, om exempelvis marknaden.

Övriga resultat och effekter som kan spåras är till exempel en ökad förståelse hos personer som deltagit i de utvärderade Mistraprogrammen för processer och andra aktörers synsätt samt en ökad helhetssyn. I ett alltmer komplext samhälle är denna insikt en tillgång i sökandet efter problemlösningar och för att kunna föra en dialog med samverkanspartners. Vi ser också en ökad samverkan mellan olika aktörer som tar sig uttryck i fortsatta samarbetsprojekt. Programdeltagarna är också bärare av nyvunnen kunskap och insikter och för med sig dessa till nya positioner inom akademi, myndigheter, företag och andra organisationer. Detta för med sig nya möjligheter till samarbete, sätt att se på utmaningar samt att finna lösningar.

Vi ser både **framgångs- och riskfaktorer i Mistras arbetssätt**. Genom åren har arbetssättet delvis förändrats. Somliga har upplevt Mistras krav som många och det finns en risk i att detta kan hämma möjligheterna att nå uppställda mål och i förlängningen Mistras syften. Vi ser framför allt spänningar mellan kommersiella och akademiska intressen, men även mellan olika forskare och discipliner. Detta ställer krav på programmens och projektens ledning samt förmåga att hantera sådana svårigheter. Mistras roll har också visat sig haft inverkan på programgenomförandet. Det är en fin balansgång mellan att som finansiär vara både stödjande och kravställande, vilket kräver en lyhördhet och ”fingertoppskänsla” hos Mistra i hanteringen av program.

Mot bakgrund av de 33 program vi utvärderat ser vi en framgångsfaktor i att kunna vara flexibel och svara på omvärldens förändringar. Detta är av naturliga skäl nödvändigt då programmen oftast är långa och förändringar i omvärlden under dessa år hinner ske. Lång finansiering är en nödvändighet om stora och komplexa frågeställningar ska adresseras.

Vi ser en behovsdriven utveckling av kunskap i de program som haft näringslivet med som användare. Det genererar resultat, produkter och processer som är av direkt användning och påskyndar användningen av resultat. Även för offentliga sektorn innebär deltagandet att relevant kunskap kommer dem till del som kan användas för politiska förhandlingar, lagstiftning etc.

Rekommendationer

Mot bakgrund av ovan angivna utvärderingsresultat ser vi att Mistra kan arbeta vidare med följande frågor; det är förslag som i mångt och mycket följer ett programs livscykel:

Finansiering: Mistra bör

- ▶ Överväga en ökad samfinansiering av program, då detta ger ökade möjligheter till större satsningar och synergier, samt se till att överlappningar undviks. Dessutom möjliggör en samfinansiering att utvecklad kunskap får en bredare spridning genom tillgången till andra finansiärers spridningskanaler och nätverk.

- ▶ Fortsätta med den långsiktiga och omfattande finansieringen av forskningsprogram då detta är en förutsättning för utveckling och etablerande av tvärvetenskapliga samarbeten och för att nå mer helhetsinriktade bidrag till lösningar på miljörelaterade problem. Mistras roll i forskningsfinansieringssystemet har visserligen påverkats av en ökad tillgång till andra forskningsmedel för miljöforskningsändmål jämfört med mitten av 1990-talet. Men stiftelsen har fortfarande en viktig roll att fylla med sin speciella organisation, sina bidrag till finansieringen och genomförande av program.
- ▶ Etablera och föra en aktiv dialog med programvärd och andra lärosäten och aktörer som är involverade i programgenomförande för att öka möjligheterna för en fortsatt finansiering av relevanta forskningsmiljöer och att den forskning som har etablerats av programmet har möjligheter att fortsätta efter programslut. Mistras roll är inte att finansiera forskningen "för evigt", men det finns en risk att uppbyggd kunskap och kompetens går förlorad om inte större insatser görs för att säkerställa en fortsatt finansiering.
- ▶ Överväga finansiering av fysiska forskningsmiljöer, då detta tenderar att ge ökade möjligheter för utveckling när det gäller fortsättning och upprätthållande av den kunskap som skapats inom programmen. Mistra bör således överväga att i en framtida strategi säkerställa att fysiska miljöer finns och tar del av finansieringen, då detta ger högre chanser för fortsatta projekt och insatser av forskargruppen. Det har också visat sig att många av de virtuella miljöerna som programmen har baserat sig på har upphört vid programmets avslut. Å andra sidan kan en tonvikt på fysiska miljöer innebära att relevanta forskningsmiljöer inte inkluderas i programmen. Möjligheter för internationell medverkan och utbyte begränsas också. Det kanske inte är så att alla program ska eller ens bör leva vidare.
- ▶ Tillhandahålla kontakter med relevanta offentliga och/eller privata aktörer för att ge så goda förutsättningar som möjligt för en fortsatt produkt- och affärsutveckling av de resultat som programmen kommit fram till.
- ▶ Överväga att ge extra stöd och/eller finansiering för att underlätta en kommersialisering av produkter för att se till att möjligheter till industriell utveckling i högre utsträckning kan tillvaratas.

Tematisk inriktning och skapandet av program: Mistra bör

- ▶ Fortsätta att både göra öppna tematiska utlysningar och vara öppen för förslag från forskare och användare. Detta nås genom att föra en dialog med forskare och experter för att ringa in och bestämma relevanta tematiska inriktningar på utlysningar och program. Med god omvärldsbevakning ges dessutom möjligheterna att identifiera teman och inriktningar som ligger i yttersta framkant snarare än att svara på behov inom redan befintliga områden.
- ▶ Undvika påtvingande sammanslagningar av forskargrupper och ansökningar eftersom Swecos utvärdering inte har funnit några övertygande fördelar med sådana.
- ▶ Vara tydlig med att deltagande i ett program inte bara kräver den "rätta" vetenskapliga kompetensen utan även en vilja och förmåga att samarbeta för att finna synergier och skapa det mervärde som ett programdeltagande från olika discipliner och forskarperspektiv kan medföra.

Arbetsätt och organisation: Mistra bör

- ▶ Använda sig av verktyg som omvärldsbevakning, analyser och utvärderingar för att öka chanserna att både "välja ut och skapa vinnare".

- ▶ Säkerställa att krav uppfylls samt stödja programmet i genomförandet. Den sistnämnda handlar till stor del om att stödja, vara bollplank samt att bidra med erfarenheter när så behövs.
- ▶ Nogsamt informera programvärden om betydelsen av att välja en lämplig programchef, då programchefens kompetens och skicklighet – såväl vetenskaplig som lednings- och kommunikationsmässig – inte nog kan understrykas för ett väl fungerande programgenomförande. Uppgiften är inte lätt. Mistra bör överväga om det är till gagn för programmen med ett ledarpar, d.v.s. en vetenskaplig ledare och en mer användarorienterad ledare. Det bör finnas processtöd eller beredskap till stöd för ledningen när så krävs.
- ▶ Säkerställa att ägandet av de immateriella rättigheterna vid programmets start är fastställda för att säkra att goda idéer inkluderas i programmen samt för att undvika konflikter. Konkret handlar det exempelvis om att erbjuda juridisk rådgivning och se till att samarbeta med andra initiativ och aktörer kring denna fråga.
- ▶ Se över designen för och genomförandet av de vetenskapliga och nyttoutvärderingarna. De utvärderingar som har utförts inför programmens olika faser har kommenterats av flera deltagare, både gällande timing samt utförande. Timingen är viktig då resultaten kan bli olika beroende på när utvärderingarna görs. Ännu mer betydelsefullt är att utförandet blir acceptabelt, vilket speciellt gäller nyttoutvärderingarna som varit föremål för skiftande kvalitet. Vi har liten kännedom om hur pågående program uppfattar dessa. En konsistent modell väcker ökad tillit till metoden och ökar möjligheterna till jämförbarhet. Här finns möjligheten att genomföra en ”benchmark” med andra forskningsfinansierare, till exempel Formas, Stiftelsen för strategisk forskning, KK-stiftelsen m fl. Även möjligheterna att tillämpa pågående utvärdering som ansats och som stöd till programledningen för att genomföra programmet bör övervägas.
- ▶ Se över sina rutiner och instruktioner till programmen beträffande slutrapportering, till exempel redovisning av programmets resultat och effekter. Bland de forskningsprogram som ingått i utvärderingen skiljer sig slutrapporteringen vida åt i kvalitet och innehåll. För att öka möjligheter att följa upp och i viss mån jämföra program rekommenderar vi att ett tydligare slutrapporteringssystem skapas, exempelvis vad slutrapporteringen bör innehålla rörande huvudrubriker samt informationen under dessa. Detta ökar transparens såväl som jämförbarhet.

Avslutningsvis ser vi, mot bakgrund av vad utvärderingen belyst i fråga om de genomförda forskningsprogrammets bidrag till att lösa miljöproblem, en möjlig diskussion inom Mistra beträffande vägvalet: ska miljöproblem adresseras på ett direkt sätt eller ”räcker” det att tillhandahålla förutsättningar i form av vetenskaplig infrastruktur, samverkan, nätverk, utbildning, ny och utvecklad kunskap etc.?

1. Introduction

1.1 Background

The Swedish Foundation for Strategic Environmental Research, Mistra, is a research financier that supports research of strategic importance in solving key environmental problems and contributing to Sweden's competitiveness with a focus on the creation of a good living environment and sustainable development. The foundation began its activities in 1994 and had, by 2011, supported the implementation of around 30 completed research programmes with a total of around 2 billion SEK. The funds were derived from the discontinued 'wage-earner funds' programme implying that, indirectly at least, it is tax money that has been used for research purposes.

Due to the origin of the funding the foundation has recognised that it has a particular responsibility to evaluate the outcome of the investments made. As noted above, the foundation has funded research for almost 20 years. Consequently, there is now a desire on all sides to evaluate the results of this programme undertaken in the form of an *ex-post* evaluation of the effects and impacts of the funded research programmes, implemented and completed no later than 2011.

1.2 The aim of the evaluation and delimitations

The aim of the following then is to explore the effects of completed Mistra research programmes and thus to evaluate the investments made by the foundation. The evaluation is tasked with providing a good picture of *whether, how and to what extent* completed Mistra research programmes have actually generated the intended effects and results.

In addition, their unintended effects and results need also to be investigated. More concretely, the following questions are to be addressed in the evaluation:

- ▶ Firstly, the evaluation is to clarify whether the research programmes have generated the effects that could have been expected when the original programme funding decision was made.
- ▶ Furthermore, the evaluation is to shed light on whether Mistra has invested money in a way that is consistent with the statutes of the foundation.
- ▶ Finally, the evaluation is to constitute a basis for the identification of success and risk factors in respect of Mistra's mode of operation and as regards the practical organisation of the research programmes.

Effects and impact are thus to be related to the statutes of the foundation and especially to the paragraphs identifying the purpose (§1) and activities (§3) of the foundation. To summarise, the first paragraph expresses what the foundation is to achieve while the third paragraph specifies how the objectives are to be attained.

The emphasis of the evaluation is above all on the question of purpose, though processes as well as the mode of operation, the organisational culture within Mistra

and the programmes themselves are all important to understand in order to be able to identify successes and risk factors of relevance in relation to both the output and the impact of the programmes.

The following questions were in focus as regards the purpose of Mistra:

- ▶ Has the funded research been of strategic importance as regards achieving a good living environment? Has the funded research been of importance in the identification of solutions to crucial environmental problems and in the pursuit of a sustainable development of society?
- ▶ Has the funded research promoted the development of strong research environment of the highest international standard positively impacting on Sweden's future competitiveness?
- ▶ Have the funded programmes taken advantage of opportunities arising to promote industrial applications which may be important for Sweden's future competitiveness?

1.3 Target groups of the evaluation

The main target group of the evaluation is above all the management of the foundation including the board. The aim is that the results contribute to the development of the future activities and mode of operation of the foundation.

The results are also of interest and relevance for other actors such as private and public decision-makers as well as the research community, including other research financiers, and above all to the financing of research related to environmental issues.

1.4 Delimitation of the evaluation

The results of the evaluation are reported in this synthesis report. The report includes a synthesis of the evaluations undertaken on each of the 33 completed research programmes (see text box below). The evaluation reports for each research programme may be found in a separate report *Mistra's funding – a 20 year journey*. During the period 1996–2011 Mistra also funded *Ways Ahead – Paths to sustainable development (UTVÄGAR – Vägar till uthållig utveckling – beteenden, organisationer, strukturer)*¹, *ProEnviro*² and *Idéstöd*³. The aims, orientation and mode of organisation in respect of these support schemes are rather different to the other programmes evaluated here.

¹ *Ways Ahead* (1996–2001) was a research programme within the humanities and social sciences which, in addition to Mistra funding also had a number of other financiers such as; The Swedish Foundation for Strategic Research (*Stiftelsen för strategisk forskning*), the Swedish Environmental Protection Agency (*Naturvårdsverket*), the Swedish Waste Research Council (*Avfallsforskningsrådet*), National Board for Industrial and Technical Development (*Närings- och teknikutvecklingsverket*), Swedish Council for Building Research (*Bygghälsningsrådet*), Forskningsrådsnämnden, Humanities and Social Research Council (*Humanistisk-samhällsvetenskapliga forskningsrådet*), Communication Research Board (*Kommunikationsforskningsberedningen*) and The Swedish Council for Forestry and Agricultural Research (*Skogs- och jordbrukets forskningsråd*).

² *ProEnviro* (2007–2010) was a rather independent research programme orientated towards small and medium-sized enterprises working with environmental adopted product development. A prerequisite for receiving funding from this programme was that the participating companies had to be closely involved with either higher education institutions or research institutes. This programme was run in conjunction with the Swedish Foundation for Strategic Research.

³ A separate study is being undertaken in respect of *Idéstöd* and will be ready in 2013. *Idéstöd* (2002–2008) was established in order to attract researchers with especially innovative ideas. The research was to be novel with the project form providing an alternative to traditional large scale programmes, with fewer demands placed on organisation, management and reporting. In all, around 30 projects covering a broad thematic scope were financed.

TABLE 1. Evaluated Mistra programmes in alphabetical order.

Acronym	Full English name	Swedish name (if applicable)
ASTA	International and national abatement strategies for trans-boundary air pollution	Åtgärdsstrategier för gränsöverskridande luftföroreningar
Biosignal	Pheromones and kairomones to control pest insects	Doftämnen mot skadeinsekter
Black Liquor Gasification		Svartlutsförgasning
ByggMISTRA	Sustainable building	Kretsloppsanpassat byggande
CLIPORE	Mistras climate policy research programme	
COLDREM	Soil remediation in a cold climate	Marksanering i ett kallt klimat
DOM	Domestication of micro-organisms for non-conventional applications	Domesticering av mikroorganismer
FjällMISTRA	Sustainable management in the mountain region	Uthållig utveckling i fjällregionen
FOOD 21	Sustainable food production	MAT 21 – uthållig livsmedelsproduktion
Greenchem	Speciality Chemicals from Renewable Resources	Specialkemikalier från förnyelsebara råvaror
HagmarksMISTRA	Management of semi-natural grasslands – economics and ecology	Skötsel av ängs- och hagmarker – ekonomi och ekologi
Heureka	Environmental decision support models for forest land	Miljöinriktade beslutsstödsmodeller för skogsbruket
KAM	The ecocyclic pulp mill	Kretsloppsanpassad massafabrik
LUSTRA	Land use strategies to reduce greenhouse gas emissions	Markanvändningsstrategier för minskade nettoutsläpp av växthusgaser
MAaF	Microbial antagonism against fungi	Mikrobiell antagonism mot svampar
MARE	Marine Research on Eutrophication – a Scientific Base for Cost-Effective Measures for the Baltic Sea	Kostnadseffektiva åtgärder mot eutrofiering av Östersjön - ett beslutstödssystem
Marine Paint		Åtgärder mot påväxt på båtar
MASE	Microbial Activity for a Sound Environment	Mikrobiell aktivitet för en sund miljö
MiMi	Mitigating the environmental impact of mining waste	Åtgärder mot miljöproblem från gruvavfall
Mistra Fuel cells in a sustainable society		Mistras bränslecellsprogram
NewS	New strategy for risk management of chemicals	Ny strategi för riskhantering av kemikalier
PERSEA	Plasma-enhanced reaction systems for environment applications	Plasmaförstärkta reaktionssystem för miljööändamål
ProEnviro	Programme for product realization with a focus on reducing environmental impact	Forskningsprogram för miljöanpassad produktframtagning
RESE	Remote sensing for the environment	Fjärranalys för miljön
Soundscape support to health		Ljudlandskap för bättre hälsa

Acronym	Full English name	Swedish name (if applicable)
SUCOZOMA	Sustainable coastal zone management	Bärkraftig förvaltning av kustresurser
SUFOR	Sustainable forestry in southern Sweden	Uthålligt skogsbruk i södra Sverige
SWECLIM	Swedish regional climate modelling programme	Svenskt regionalt klimatmodelleringsprogram
TransportMistra		
URBAN WATER	Sustainable urban water management	Urbana VA-system
VASTRA	Water management research programme	Vattenstrategiska forskningsprogrammet
Ways ahead	Paths to sustainable development	UTVÄGAR - Vägar till uthållig utveckling - beteenden, organisationer, strukturer
ÅSC	Ångström Solar Centre	Ångström Solenergicentrum

1.5 Reporting of the evaluation and disposition of the synthesis report

The synthesis report strives to present a comparative overview of the main conclusions and recommendations that may be drawn from the individual programme evaluations and includes the following sections:

In the following chapter we briefly address how the study of impacts may be performed while, in addition, outlining the approach that has been used in this evaluation. Furthermore, the applied methods are also presented.

In chapter 3 we introduce the programme theory of Mistra programmes, including a presentation of Mistra's statues and how these have been interpreted and applied in Mistra's mode of selecting, organising and operating research programmes. This chapter also provides an overview of the evaluated programmes, which are presented in the context of a 'programme portfolio analysis'.

The evaluation results are presented in chapter 4. In this chapter the documented results and impacts in relevant sectors, namely the research community, industry, the public sector and society as a whole, are presented.

Chapter 5 reports on how the programme design, including programme management, inter-disciplinary cooperation, the involvement of users, different types of cooperation (including international) etc., has been perceived and how it has functioned in the programme and, in addition, outlining in what way programme design has potentially been important for the results and impacts of the evaluated programmes.

The report concludes with a chapter presenting the main conclusions and recommendations.

2. How to study impact and applied methods

In the following chapter we discuss how the study of impacts may be performed and present the approach that was applied in this evaluation. Furthermore, the applied methods are also introduced.

Interest in, and demand for, the assessment of the impact of public research investments have increased sharply in recent decades. The main explanation for this is that research undertaken at universities is primarily funded with public money. Since the early 1990s the universities were also given the explicit task of disseminating the results to society (in Sweden this is known as “the third task”). This had the effect of increasing the demand for research that is of benefit to society.

Various methods can be used to study research impacts and these methods have been developed extensively over time. The most common approaches include bibliometric analysis, patent analysis and experimental or quasi-experimental designs etc. Some of these methods are however rather difficult to apply since they require substantial planning and resources, such as control groups, pre- and post-tests etc. Another approach to investigating research impacts is cost-benefit analysis while the study of different ways to investigate the “additionality” of research support, such as input, output, behavioural and cognitive capacity⁴ can also be useful here.

To summarise then, the approaches used to gauging research impacts and outputs has evolved and broadened in recent decades. For instance new information, instruments, technologies, networks, commercial spin-offs and patents, the dissemination and sharing of new and expensive equipment etc., are now all routinely included in evaluating the outcome of research funding. For instance the perspective on how research results and knowledge are interlaced with a variety of different actors like users, public, media etc., has become ever more important. The term “embedded value” is used to describe this.⁵

The point of departure in the following evaluation is to look at research results from a rather broad perspective and to pay particular attention to the primary factors in the programme’s context.

2.1 Impact evaluation and assessment – a challenging task

Impact evaluations and assessments present a challenging task for several reasons. One is the difficulties involved in proving the causality between an intervention and apparent impact. To be able to determine whether an apparent impact in environment, society etc., is caused by a specific intervention, isolation would be necessary in order to prove that the chain of events that have occurred was due to the studied intervention. This is a highly complex task, indeed one that is extremely difficult to

⁴ Georghoiu, L., 2002, Assessment of the Socio-economic Impact of Framework Programme.

⁵ Deiacco, E., & Johansson, M., 2007, Att få kunskap använd.

pull off as, in most cases, the impact of the specific intervention is difficult to isolate from the multitude of other factors that may have influenced the object. In addition, it is well known that impacts can be weakened or strengthened by both external and internal influences. Part of this can be dealt with when the programme theory or intervention logic is constructed for an intervention, more or less explicitly and consciously assumed by the programme makers. However, changes and events in the surroundings will take place during the implementation of an intervention, for instance a research programme, which could not be anticipated in the design phase of the programme. This calls for a discussion prior to an impact evaluation on concepts in focus, at what level, expected impact, which foreseeable possible side effects are likely to occur etc.

To summarise, the following measuring challenges must be considered when conducting impact evaluations:

- ▶ The difficulty of demonstrating the cause and effect relations between an intervention and an impact.
- ▶ Time perspective, a significant amount of time may elapse between the activity actually being performed and the impact appearing.
- ▶ The impact sustainability also varies for several reasons.

2.2 Framework of analysis

The following evaluation has a primarily summative character, although the lessons learned are identified in order to enable adjustments and possible improvements regarding the future organisation and operation of Mistra programmes. The point of departure is that effects can be both short-term, which imply that they occur shortly after or even during the implementation of the intervention, or long-term, implying that they occur a long time – often years – after the implementation. We have, in this study, used a tailor-made model for the analysis in which the foundation consists of so called *contribution analysis*⁶, including:

- ▶ An investigation or reconstruction of programme theory.
- ▶ An impact assessment at different levels.
- ▶ An identification of the internal and external factors affecting the situation.

Illustrated below (figure 1) is an overview of outcomes and impacts relating to intervention and the problems it was set out to address.

The point of departure in *Contribution Analysis* is that all conducted interventions or programmes affect society and actors in some way or another. The question is how, at what level and whether it took place as intended. It is important then to dismantle the programme theory (or *theory of change*) of an intervention. The investigation and analysis of the overall Mistra programme theory in general and of the evaluated research programmes in particular thus played an important role in the initial phase of this evaluation. The programme theory is, simply put, the mode of the programme, how it is initially thought to work, explicitly or sometimes implicitly. For Mistra, the statues (see the following chapter) and how they have been practiced, for instance that the scientific quality and potential use have been emphasised for selecting and funding programmes, are important element of Mistra's overall programme theory.

⁶ The method is developed by Euréval (Centre for European Expertise and Evaluation) and which is used for assessing causal questions and inferring causality in programme evaluations. It offers an approach designed to reduce uncertainty about the contribution the intervention is making to the observed results through an increased understanding of why the observed results have occurred (or not) and the roles played by the intervention and other internal and external factors.

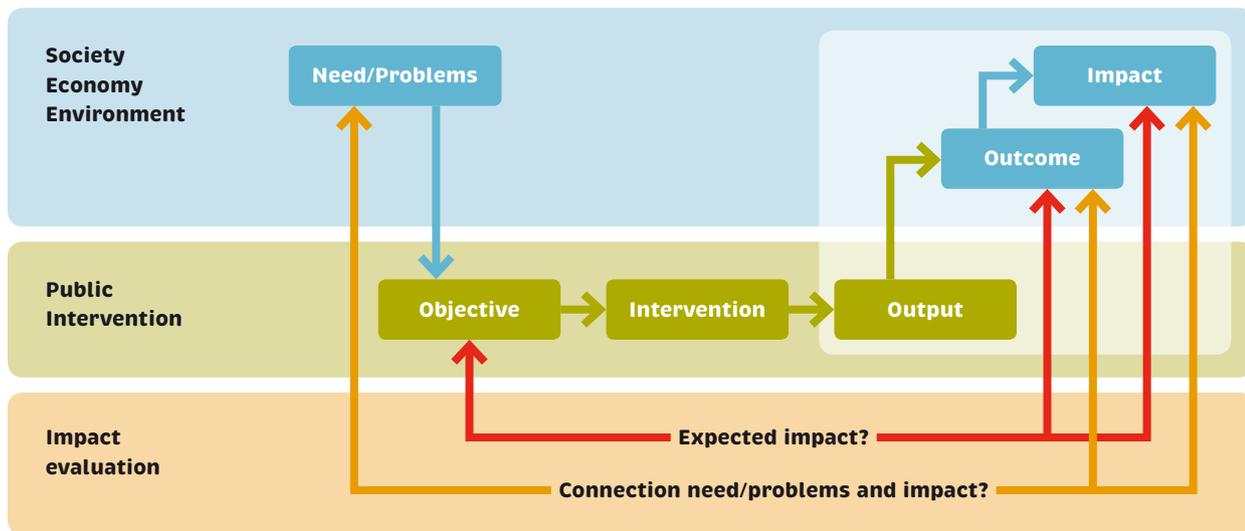


FIGURE 1. Impact in relation to identified needs/problems.

SOURCE: ADAPTED FROM 1999.

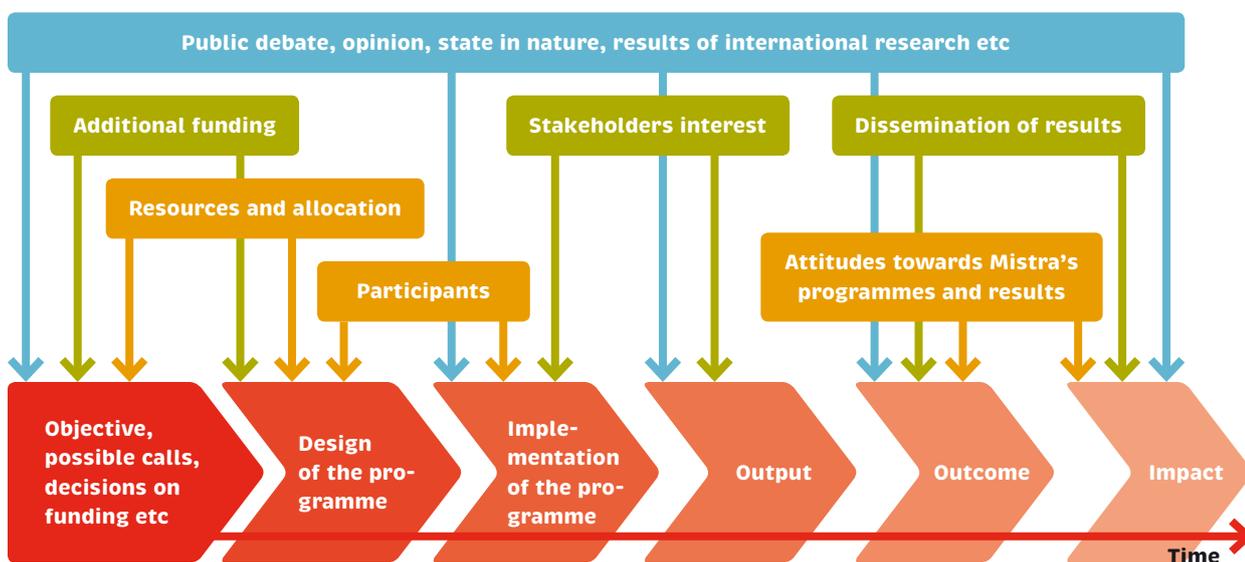
Outcomes and impacts might arise on different levels. Concerning research programmes the levels may be that of an individual researcher, a research environment, perhaps the university, a research field in Sweden, the whole society etc. *Contribution Analysis* as method indicates the influential explanatory factors in events and effects. Influential factors can be both internal to the programme and/or external in terms of the context.

The *internal* influencing factors might be connected to the initiation of a research call, the encouragement of researchers to submit calls, assessment and financial approval including assessment criteria, the formulation of the objectives in the programme, timing of work phases, the allocation of the programme's resources to the involved actors and different phases and stages, cultural issues, the specific design of programmes and projects etc.

The *external* influencing factors may include access to, or the absence of other activities and funding, in the same or overlapping areas, international research, public debate, other actors' reliance on, and attitudes towards, Mistra programmes' outcomes and context as well as nature and environmental occurrences, etc.

The influencing factors, both internal and external, can either support or hamper the appearance of results and effects depending on how they work and when. The factors also, potentially, have a variable influence across the different phases (see figure 2).

FIGURE 2. Examples of influential internal and external factors.



Some of the most pertinent factors are exemplified in figure 2. It must however be stressed here that the development of a research programme is seldom linear in nature as the idealised situation in figure 2 would suggest. Nevertheless, this is a simple of illustrating the chain of activities and their potential impacts. The length of time that elapses between the application being made and the final outcome – and beyond that any additional impact – makes it important to emphasise the difficulty of identifying clear causality between activities and impacts, especially in the information-based, globalised world that exists in relation to cross-border environmental issues.

2.3 Methods and materials

The focus of the evaluation is 33 completed research programmes. In order to investigate the interpretation of Mistra's purpose, as well as identifying how Mistra's mode of operating and organising the programmes (the programme theory) has changed over the last 20 years, several sources have been consulted. The use of different sources and methods has also been important in establishing as complete a picture of the implementation, as well as the results and impacts, of the evaluated Mistra programmes as possible.

Firstly, documents related to the foundation have been scrutinised in order to investigate the Mistra foundation programme theory. As stated above the analysis of the programme theory is important since it helps to establish how a specific activity or measure is intended to work. In the case of this evaluation we have both reconstructed the programme theory of Mistra as an organisation and the individual evaluated research programme.

The programme theory may to some extent be revealed by consulting documents. The main sources here have primarily been overviews showing the financial allocation to the programmes, including allocations to the participating actors. In addition, annual reports, operational strategies as well as evaluations and analyses have also been used. For instance, the evaluations and reviews undertaken by the *Vetenskapliga Akademierna*⁷ represent an important source of knowledge and experience in providing a picture of Mistra's objectives and activities. Also the evaluation performed after Mistra first 10 years⁸ and studies such as *I den absoluta frontlinjen*, have been used as background material in identifying the programme theory and the context within which Mistra has been acting over the last 20 years.

In addition to the written sources, we have also undertaken a series of semi-structured interviews with three former CEOs of the foundation (group interview face-to-face) as well as other representatives of Mistra staff⁹ (group interview face-to-face), who were employed during the implementation of the studied research programmes. Furthermore, some members of the Mistra Board (individual interviews, around half of which were performed face-to-face and the others by phone) have been consulted in order to determine how the board worked in relation to the statutes and how, as a supplement to the minutes we have studied, funding decisions were reached. See reference list (chapter 7) for more information about the studied documents and interviews undertaken, all of which were used to establish the Mistra foundation programme theory.

In order to establish the programme theory for and the results and impact of the completed research programmes we have studied numerous programme-related documents, such as programme proposals, scientific and user reviews of the pro-

7 The Royal Swedish Academy of Sciences, the Royal Swedish Academy of Engineering Sciences and the Royal Swedish Academy of Agriculture and Forestry.

8 Mistra, 2003, Learning from Mistra's first ten years. An Evaluation of the Foundation for Strategic Environmental Research by an international committee.

9 During the years in question Mistra's staff complement has, on average, consisted of a CEO, 3–4 programme directors and 1–2 additional administrative staff.

gramme proposals, minutes from the Mistra board meetings related to the approval of the programme as well as the annual and final reports of the programmes. The document study was also undertaken in order to generate an input into the process of creating relevant questions to pose in the questionnaire and interviews with programme representatives.

It must however be noted that the quality of the documentation in respect of the various programmes varies markedly. Regarding, for instance, information about the implementation and output of the programme, the annual and final reports vary in terms of content and details specified. This may to some extent at least be explained by the fact that the character of the programmes varies. In addition, guidelines for the common reporting of programme activities and outputs seem to have been lacking.

In order to achieve a more detailed picture of how the programme had contributed to achieving Mistra's purposes and objectives as well as those of the individual programmes, a web-based questionnaire was distributed to all those who participated in the research programmes. Four different kinds of participants were identified; people who have had served as programme directors, members of the executive committees, programme participants and users of the programme results. Four slightly different versions of the questionnaire (see annex 2) were distributed to the respondents, who had been identified with the assistance of the programme directors.

Briefly, the questionnaire included questions about the background of the respondents, programme implementation in terms of activities and the fulfilment of objectives (see annex 2). The operationalisation of the Mistra statutes was achieved by grouping the content of *Article 1* (see below) into three headings:

- ▶ *Good living environment and finding solutions to important environmental problems while promoting the sustainable development of society.*
Under this heading we have above all investigated how a good living environment has been defined in the programme and how the programme has made a contribution to achieving this. We also asked a question in the questionnaire relating to which environmental objectives the programme has contributed to.
- ▶ *Development of strong research environments of the highest international class.*
Here we have studied whether the programmes have resulted in publications (articles in scientific journals as well as PhD / licentiate theses), development of research environments, and non-commercial spin-offs such as centres of competence, new research projects, development of education or courses as well as career development.
- ▶ *Take advantage of opportunities to promote industrial applications and their importance for Sweden's future competitiveness.*
Here we have scrutinised whether the programmes have resulted in patents, demonstrators/prototypes, commercial spin-offs such as the development of new or existing companies, commercialisation of products (goods and services) and processes.

But in order to also be able to capture unintended results and impacts we also included a series of open-ended questions focusing on results and impacts. The questionnaire also included questions about the general perception of the programme's results and impacts. Furthermore, we also investigated Mistra's programme mode of organisation and operation by posing specific questions about programme management and organisation including questions specifically related to Mistra's role, the application of the interdisciplinary approach and user involvement. A major challenge in evaluating the Mistra programmes is that they are each often rather different in character. Despite the different character of the programmes however all respondents were asked to answer the same kinds of questions.

An additional challenge, in relation to the length of time that has elapsed, difficulties were inevitably encountered in reaching all of the people who had participated in the programmes – primarily due to the lack of a centralised register of updated contact information.

Due to the different characters of the programmes, the number of respondents per programme also (see table 2) varied significantly. The aim has thus been to have respondents from all programmes representing the categories programme directors, members of the executive board and programme participants. This has been achieved with few exceptions (see further information about the non-response rate below).

In addition to the first e-mail including the link to the web-based questionnaire, two reminders were distributed to those respondents who had not answered the questionnaire when the deadline initially expired. After the second reminder respondents belonging to those programmes with a poor response rate were contacted by telephone. In total, the response rate was 52 per cent with 369 of the 709 individuals originally sent the questionnaire responding. See table 2 for the response rate for each programme.

The response rate also varies according to the categories of respondents. Responses from three of the programme directors are however lacking. The response rate declines with the distance from the programme management. We can see that the response rate for programme participants, the members of the executive committee and users decrease in that order. This may to some extent be explained by how involved a respondent has been in the programme.

Another explanation for the response rate pattern is the elapsed time since the programme was finalised. Here we suspect that interest in responding to the questionnaire simply decreases after some years.

The finalisation date may also influence how much the respondent can recall of the implementation of the programme and also how engaged the person is in responding to the questions. Moreover, those who have participated in the programme some years ago may also have difficulties in judging the impact of the continued development of activities that were initiated and performed in the Mistra programme, since these have been developed in other projects and not are recalled as being based on an output from the Mistra programme.

The non-response analysis further points to the level of engagement: the further away from active involvement the less likely is a respondent to answer. Another factor is the working climate within the programme. Here we can observe that there are satisfied and clearly dissatisfied respondents. When having strong opinions both categories seem more likely to answer. There are also however many respondents who are “neutral”. Being engaged in new research or other similar work is also mentioned as a factor affecting response, i.e. not having the time or the desire to look back and review old work.

In addition to the document studies and web-based questionnaire five of the 33 evaluated programmes were selected for deeper investigation: *CLIPORE*, *Greenchem*, *MARE*, *Mistra Fuel Cells* and *SUFOR*. Several criteria, discussed with and approved by Mistra, were related to the selection of these programmes (see annex 1). For these programmes interviews were also undertaken with programme representatives in order to achieve a deeper understanding of the implementation as well as the results and impacts of the programmes.

2.3.1 Citation analysis

In order to investigate how the generated knowledge disseminated through the publication of scientific articles has been applied; a very limited bibliometric and citation analysis of ten articles per programme was produced. The ten articles analysed were initially identified by the programme directors who were asked to deliver a list of the ten most relevant articles that could be connected to programme.

TABLE 2. Response rate questionnaire

Programme	Selection per programme	Number of responses (self selected programme inheritance)	Response rate
ASTA – International and national abatement strategies for transboundary air pollution	20	10	50%
Biosignal – Pheromones and kairomones to control pest insects	13	8	62%
Black Liquor Gasification	20	10	50%
ByggMISTRA – Sustainable building	17	13	76%
CLIPORE – Mistras climate policy research programme	50	19	38%
COLDREM – Soil remediation in a cold climate	10	5	50%
DOM – Domestication of micro-organisms for non-conventional applications	24	16	67%
FjällMISTRA – Sustainable management in the mountain region	15	9	60%
FOOD 21 – Sustainable food production	22	12	55%
Mistra Fuel cells in a sustainable society	51	18	35%
Greenchem – Speciality Chemicals from Renewable Resources	46	16	35%
HagmarksMISTRA – Management of semi-natural grasslands – economics and ecology	25	13	52%
Heureka – Environmental decision support models for forest land	72	36	50%
KAM – The ecocyclic pulp mill	17	12	71%
LUSTRA – Land use strategies to reduce greenhouse gas emissions	14	6	43%
MARE – Marine Research on Eutrophication – a Scientific Base for Cost-Effective Measures for the Baltic Sea	25	11	44%
Marine Paint	17	8	47%
MASE/MAaf – Microbial Activity for a Sound Environment	25	11	44%
MiMi – Mitigating the environmental impact of mining waste	29	22	76%
NewS – New strategy for risk management of chemicals	16	8	50%
PERSEA – Plasma-enhanced reaction systems for environment applications	8	5	63%
ProEnviro – Programme for product realization with a focus on reducing environmental impact	18	7	39%
RESE – Remote sensing for the environment	13	6	46%
Soundscape support to health	13	9	69%
SUCOZOMA – Sustainable coastal zone management	27	12	44%
SUFOR – Sustainable forestry in southern Sweden	16	15	94%
SWECLIM – Swedish regional climate modeling programme	23	12	52%
TransportMistra	22	13	59%
URBAN WATER – Sustainable urban water management	19	12	63%
VASTRA – Water management research programme	23	11	48%
Ways Ahead – Paths to sustainable development	31	12	39%
ÅSC – Ångström Solar Centre	11	7	64%

Unfortunately, not all programmes¹⁰ have been able to deliver this selection despite numerous reminders. In order to apply the same selection procedure, we chose not to let an expert define articles or make a random selection for the programmes unable to deliver the requested list. Consequently, gaps remain for some programmes in this aspect. See annex 5 for more information on, and the results of, the citation analysis.

¹⁰ Lists are lacking from *ByggMISTRA*, *COLDREM*, *FjällMISTRA*, *NewS*, *ProEnviro*, *RESE*, *SUFOR*, *VASTRA* and *Ways Ahead*.

3. Mistra Background - the programme theory and programme portfolio

In this chapter we introduce the Mistra foundation programme theory including a presentation of Mistra's statutes and how these have been interpreted and applied in Mistra's mode of selecting, organising and operating research programmes. This chapter also provides an overview of the evaluated programmes, which is presented in the programme portfolio analysis.

3.1 Programme theory

3.1.1 Mistra's purpose and activities according to the statutes

The point of departure for the evaluation has been the statutes of the foundation. The purpose of the foundation is specified in the first article of the statutes. (see table 3).

The activities of the foundation are defined in the third article of the statutes (see table 4).

Based on the interviews¹¹ we get the impression that the formulation of the statutes was a rather rapid process. Since it was also expected to be rather difficult to amend the statutes once the foundation was founded, they were written in a rather general way. A number of analyses of this issue were however made before the purpose and mode of operation were settled. According to the first Annual Report (1994) the objective of Mistra was to "pose a challenge to the Swedish research community". In conclusion, and based on work undertaken on the environmental research field in Sweden, the following *weaknesses* were identified:

- ▶ Lack of interdisciplinary research
- ▶ Fragmentation of the research effort into small and short-term projects
- ▶ Imbalance between identification and solution of problems

The conclusion was consequently to:

- ▼ "Give priority to multi-disciplinary solution-oriented programmes of importance for Sweden's future competitiveness and with networks involving academic institutions and industry".

In a strategy document from 1997 (*Miljöstrategisk forskning*) it is also confirmed that environmental strategic research is perceived as research which is performed from a long-term perspective and is aimed at solving important environmental problems. Previous studies also state that Mistra has identified its role as an environment policy actor rather than research policy actor. This implies that research is seen as a means to achieve environmental objectives. It is confirmed in studies that

¹¹ Interviews with CEO and members of the Mistra Board.

TABLE 3. Article 1 Mistra's statutes

Article 1. The purpose of the Foundation, whose name shall be the Foundation for Strategic Environmental Research, is to fund research of strategic importance for a good living environment. The Foundation shall promote the development of strong research environments of the highest international class with importance for Sweden's future competitiveness. The research shall be of importance for finding solutions to important environmental problems and for a sustainable development of society. Opportunities for achieving industrial applications shall be taken advantage of.

TABLE 4. Article 3 Mistra's statutes

Article 3. The activities of the Foundation shall be built up gradually based on the Foundation's own independent judgements and the special nature that shall distinguish the activities according to what is said below. The research activities may range from pure basic research to applied research, and, not least, areas in between.

The Foundation shall be distinguished by the special nature of its activities as described below:

- ▶ Concentration of efforts so that research centres or research areas with international impact can be established.
 - ▶ Projects and programmes that span the boundaries between disciplines.
 - ▶ Establishment of networks or more permanent forms of collaboration nationally and internationally, including the establishment of an international researcher exchange programme.
 - ▶ Promotion of training and recruitment of researchers.
 - ▶ Research centres or research areas in close association with universities and colleges.
 - ▶ Collaboration between universities and colleges on the one hand and industry on the other hand when it comes to research within fields that are of particular interest to industry.
 - ▶ Mobility of researchers both across international borders and between universities/colleges institutes and companies.
 - ▶ The activities of the Foundation may eventually entail that the Foundation's endowment is used up.
-

the Mistra way of designing the programmes was novel and constituted an alternative approach to the "traditional" approach entailing mono-disciplined small projects in environment research¹².

3.1.2 Mistra's development over the last 20 years

Mistra's focus and activities have remained more or less the same over the last 20 years. Based on the document analysis and the interviews it is clear that the purpose has not been defined in more concrete terms. The rather vague definition of 'good living environment' may indeed be seen as one way of ensuring that the possibility to address new environmental issues that would appear could be retained, since important environmental issues to some extent are time and context dependent.

It may be noted that when Mistra was founded, the focus and mode of working implying problem solution, while an interdisciplinary approach and user involvement in long-term programmes was considered to be rather challenging. Today this kind of content can generally be found as a primary condition of receiving funding

¹² Sörlin, S. (ed.), 2005, I den absoluta frontlinjen.

from other research financiers such as Formas, the Swedish Research Council, and VINNOVA, both of which were established in 2001.

Moreover, we should also note that the so called “third task” of the higher education institutions has only really begun to be emphasised the last decade, which may have enhanced the level of user involvement in the Mistra programme. That the focus of Mistra is influenced by the surrounding society may also be seen after the environmental objectives were adopted by the Swedish parliament in 1999. The annual report in 2000 addresses these, and during the 2000s, the programmes were also categorised according to these.

After some years of research programme implementation it became evident that the application of the research results was to be crucial in order to be considered as a successful Mistra programme. In the Annual Report for 1999 it is stated:

▼ *”For Mistra supported research, this cannot be regarded as successful until the results have been implemented in practice.”*

In 2000, it was also stated that the aim of the programme is to ensure that “practice” gets access to the latest scientific knowledge, both in terms of facts and understanding. The role of Mistra is also to ensure that the programme enables the researchers to encounter the problem formulation of the practice.

In the early 2000s, the finalisation of research programmes also appeared on the agenda. In connection with the finalisation of programmes, it is concluded that, despite the stated ambition of Mistra, it is not easy to have come so far that the research results have started to be applied. The expression “death valley” is now introduced to describe the rather challenging task of ensuring that the generated knowledge is applied in practice. As a means of creating a bridge that can help the results to be transferred over this death valley and thus ensuring the application of the research results, a so called “*staffettväxling*” (*concluding period*) is introduced and tested in some programmes, for instance in the *NewS* and *FOOD 21* programmes.

It is also rather interesting to follow the development of Mistra by looking at the brand expressions or slogans that have been routinely applied by the organisation. The first brand expression we have found is from 2002 – “Mistra is a source of knowledge” (*Mistra är en källa till kunskap*) – which may be connected to the programmes now which are starting to contribute to knowledge development. By 2003, however Mistra already had a new brand expression, which was “Research with user value for sustainable development” (*Forskning med användarvärde för hållbar utveckling*).

Based on re-assessments and the finalisation of several programmes lessons are beginning now to be learned. It can for instance now be concluded that more social and behaviour scientists are to be engaged in the future. Problems during the implementation of the programmes have also been observed, such as geographically dispersed programme implying that participants are located in different institutions across Sweden. A tension between merits and user value may also be seen. Difficulties regarding intellectual property rights (IPR) have also been observed and here the “teacher exemption¹³” issue is mentioned as a particular challenge.

In 2004, the *Vision for 2020* was presented arguing that important environmental problems are solved in research cooperation between higher education institutions, Swedish industry, politics, public management and NGOs. The vision is also to support several internationally competitive interdisciplinary research environments, which in dialogue with the users contribute to a sustainable society. The competitiveness of Swedish industry has increased through the adoption of several new environmental products and services.

In 2004, it is also noted that the approach to implementing large scale programmes is to be supplemented with a number of minor activities and investments.

¹³ In Sweden teachers, researchers and doctoral students own the right to their own patentable inventions even if they are made during working hours. However, teachers, researchers and doctoral students may agree to give up this right.

In the same year Mistra also began to apply a more proactive approach in terms of calls. It estimated that two-thirds of the financing decisions are to be approved after the publications of thematic competitive calls and one-third within specific prioritised areas. New priorities are also introduced. These may be related to the environmental objectives, since they are defined to be climate impact, a non-toxic environment, reduced eutrophication, marine environment, sustainable management of renewable natural resources and sustainable urban development. It is also noted that these priorities have been discussed with the Swedish Environmental Protection Agency.

No major amendments were made in the following years. In 2008, however, a new brand expression was launched, when it is stated that “Mistra invests in research that solves environmental problems” (*Mistra investerar i forskning som löser miljöproblem*), this may be seen as the foundation being able to observe the results and effects of the invested money or more as an ambition. The latter may be confirmed, since a new strategy for the coming six years was also introduced in 2008. The vision is that Mistra is to be the leading initiator of research that prevents and solves essential environmental problems. Above all, more efficient energy use and transport solutions, non-toxic and resource-efficient cycles, sustainable production, consumption and the management of land, water and the built environment are to be addressed. It is also stressed that policy development including policy innovations, where technology and science are connected with social science will be an important approach in the years to come.

3.1.3 Mode of operation and organisation of Mistra programmes

Despite minor revisions, the Mistra programme life cycle and design, including mode of initiation, operating and organisation, has more or less stayed constant. Characterising the initiation of the evaluated Mistra programmes during almost the whole of its first decade, no directed calls were published. Instead the programme proposals were developed by researchers, sometimes in dialogue with Mistra, and submitted for assessment. Only three out of the 33 evaluated programmes, *Greenchem*, *TransportMistra* and *CLIPORE*, are the result of specific thematic calls, which today are the most common procedure for initiating Mistra programmes.

The approval for research programme funding is made by the Mistra Board. In a programme proposal the programme presents the research question and formulates explicit objectives, which however, may be modified during the progress of the programme. Furthermore, the demand for the adoption of a more interdisciplinary approach is now clear and the programme was to be orientated towards finding solutions and new ways of thinking. There was also a strong recommendation to involve users from the beginning in the programme in order to identify the problem and objectives. Eventually the need for an active communication strategy was also recognised.

The submitted programme proposals were reviewed by both a scientific panel (peer-review) and from a user perspective. The design and quality of the user evaluation has however varied substantially over the years. In the beginning, this review was based on representations made by different actors, for instance companies, authorities etc. Then the review was organised by the programme itself and finally a special investigator was appointed and made responsible for collecting opinions about the programme proposals from relevant actors as well as for compiling a review report. Modifications were also often recommended by scientific and user evaluations conducted after the first phase.

Both the user and scientific reviews were presented to the Mistra board. For a period of time the programmes also had the opportunity to present the programme proposal to the Board. In the minutes it is often noted that the Mistra Board, based on the reviews, demanded revisions and clarifications to the programme proposals in order to approve the funding (see programme reports). During the opera-

tion of the programme annual reports and yearly programme plans were also to be submitted to Mistra. Financing was only given for one phase at the time, implying 3–4 years, but there was an option for additional funding for at least one further phase. In terms of research funding, this was perceived as long-term financing. The financing was also considered to be large-scale, since it allowed for the participation of a great number of participants. But in order to receive funding for an additional phase, it was necessary to demonstrate but a positive set of results in terms of the evaluations undertaken during the implementation of the first phase and that the new programmes proposal had positive reviews.

A specific characteristic of a Mistra programme is their organisation. From the start Mistra demanded a strong programme management and the organisation based on a “business model”. This implies that Mistra makes an agreement with a *main contractor*, which is responsible for the implementation of the programme. In addition, the programme is to have a programme management team consisting of a *programme manager/director (programchef)*, who is formally appointed by the main contractor and is, ideally, not to be an active researcher in the programme. Instead, their role is to manage the programme and ensure that the various projects are working in line with, and contributing to, the overarching programme objectives. The programme manager function is to be a part-time position. A *programme executive committee (programstyrelse)* consisting of representatives of relevant users and researchers and with a Mistra staff member as an observer is also to oversee the implementation of the programme though they do have the mandate to make prioritisation in terms of programme focus. According to the interviews with Mistra staff, the members of the executive committee of the programme sometimes have a different perspective than researchers on the problem of identification, which of course has been something of an issue at times. This is also confirmed in the evaluations of some of the programmes.

Below the management level we have the various projects that are performed in the programme. The projects focus on the defined tasks or activities required to achieve the programme’s objectives. In the Mistra Annual Report from 1997, it is stated that the programmes are to contribute to the creation of synthesis (communicated in an understandable way) and synergy between the projects, “implying that the value of the programme is greater than the sum of the projects” and to contribute to solving a problem.

In addition to those instances mentioned above, some programmes have also developed additional reference groups and councils in order to ensure scientific quality and user involvement.

This way of organising the programme was to contribute to a better implementation record and to ensure that the research did not become “more of the same”. Basically this was a good way to ensure that the projects of the programme were integrated, and that the objectives were met.

3.2 Programme portfolio

The initiation of programmes was rather rapid. By 1997, 16 programmes had been approved and started (see table 5). By the end of 2011, 33 programmes had been finalised. The first of the evaluated Mistra programmes began their implementation phase in 1996. The last start-date of the studied Mistra programmes in this evaluation was *TransportMistra*, which commenced in 2006.

During the first year of operation Mistra received a lot of programme proposals. However, many of the proposals did not fit the “Mistra model”, including problem solving, interdisciplinary cooperation and user involvement, and were thus rejected. Some proposals were revised while others learned that Mistra demanded specific requirements and did not re-submit a revised proposal.

TABLE 5. Overview of evaluated programme and time line

Program	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ByggMISTRA																
KAM																
MAaF ¹⁴ /MASE																
SWECLIM																
SUFOR																
ÅSC																
VASTRA																
Biosignal																
Ways Ahead																
COLDREM																
MiMi																
SUCOZOMA																
FOOD 21																
Mistra Fuel Cells																
RESE																
FjällMISTRA																
URBAN WATER																
MARE																
NewS																
ASTA																
LUSTRA																
Soundscape support to health																
HagmarksMISTRA																
Heureka																
Greenchem																
PERSEA																
Marine Paint																
DOM																
Black Liquor Gasification																
CLIPORE																
TransportMistra																
ProEnviro																

¹⁴ Since the MAaf (1996–2003) and MASE (2004–2011) programmes are so interrelated we have chosen to report the results of the programmes together.

It should also be noted here that a specific development in respect of environmental research funding influenced Mistra's programme portfolio. When research financing from the Swedish Environmental Protection Agency was minimised in 1997, financing from Mistra was allocated to programmes and projects that would otherwise probably have been financed by the Swedish Environmental Protection Agency. For instance the programmes *ASTA*, *NewS* and *COLDREM* are programmes that may have qualified in this regard.

3.2.1 Thematic division of the programme portfolio

One way to understand and analyse the Mistra programme portfolio is to establish a thematic division of the implemented programmes. It is however clear from the various overviews of the programmes produced in relation to the annual reports that this thematic division has not been evident in practice and has varied markedly over the years. An explanation given for this in one of the early reports is that:

▼ “... it is rather the way of conducting the research than the choice of problem that makes the portfolio exciting.”

However, in the same report it is noted that that the future portfolio is to address future threats and possibilities within the environment and sustainable development areas. In interviews, the thematic focus of the Mistra programmes was to be major environmental issues and these issues are considered to be the same today as 20 years ago, for instance climate change, clean air and water, etc.

The evaluation, *The first ten years Mistra*, summarising Mistra's first ten years also concludes that Mistra is working in the right direction and is impressed both by the mode of research organisation and the broad focus of the portfolio.

The heterogeneous character of the Mistra programme portfolio has to some extent presented a constant challenge to the effective pursuit of this evaluation. It has, for instance, been difficult to categorise the different programme portfolios. This may also be seen in regards to Mistra's varying approaches to categorising the programmes. In the Annual Report for 1998, the first thematic division of the programmes is presented and this is also applied in 1999, the themes are *Agricultural industry and natural resources*, *Construction and infrastructure*, *Production of goods and hazardous waste*, *Chemicals – reduced dependence and improved risk management*, and *Scientific support for international conventions and Support programme*. Since then the programmes have been sorted under different headings. A new thematic division (*Commercial activities*, *International political negotiations* and *Decision-making for management of natural resources*) was presented in 2000 and was utilised until 2003. In 2004 a slightly newer thematic division was presented (*Environmental adopted products, processes and services*, *International environmental negotiations*, *Management and use of natural resources*, *Environment in the society*) while in 2005, an entirely new division connected to environmental objectives can be observed¹⁵. Already in 2006, the division inspired by the environmental objectives is replaced by the one used in 2004, albeit slightly modified, in (*Environmental adopted business development*, *International environmental negotiations Management and use of natural resources* and *Environment in the society*). For the years 2008–2010 only two categories are used (*Environmental driven business development* and *Knowledge for public management and policy*).

Consequently, we can conclude that it is not easy to group the evaluated programmes into different “thematic clusters”. While there are some programmes that can be clearly defined in accordance with a cluster others overlap more than one cluster and yet others are not easy to fit into any cluster. We have therefore focused on viewing patterns among all the programmes which means that one and

¹⁵ Reduced climate impact, Non-toxic environment, No eutrophication with focus on the marine environment, Sustainable use of renewable natural resources and Sustainable urban development.

the same programme can occur in different parts of our analysis or in different categorisations.

3.2.2 Financing and participating organisations

In annex 4 an overview of the 33 evaluated programmes that had been financed by Mistra is provided. On average, programme last around eight years and two phases. Two programmes, *ByggMISTRA* and *TransportMistra*, were terminated after one phase.

The main contractors for these projects have primarily been universities and higher education institutions. In some cases the main contractor has also been changed between the first and second phase. Among the higher education based contractors it may be observed that none of those institutions established from the 1990s and onwards have held such a position. The Swedish Agricultural University (SLU) (8) is the most frequent main contractor, followed by Göteborg University (3), Chalmers University of Technology (3), Lund University (2), the Royal Institute of Technology (2), Uppsala University (2), Linköping University (1), Luleå University of Technology (1), Stockholm University (1) and Umeå University (1).

Among the research institutes the Swedish Environmental Research Institute (IVL) AB has been the main contractor for two programmes and the *Swedish Pulp and Paper Research Institute (STFI-Skogsindustrins Tekniska Forskningsinstitut)*¹⁶ one. In some rare cases public authorities have been the main contractor, the Swedish Meteorological and Hydrological Institute (SMHI) and *Lantmäteriet*¹⁷. Some programmes have also started companies that have run the management of the programme (*BLG-programmet AB* and *MASE Laboratorier AB*). A private company, *Trivector*, was the main contractor for one programme.

Most of the programmes have had participants from at least 2–3 organisations in addition to the main contractor. But in general terms the main contractor has received most of the financing. Most of the participating actors represent the natural science or engineering disciplines with rather limited participation rates from social science and the humanities. It is difficult to estimate exactly how many people have been involved in the Mistra programmes. The number of people involved per programme varies significantly from one of the smallest one, *PERSEA*, with around ten people involved to *Hereuka* with more than 70 people.

In total, Mistra has financed the programme to the tune of just over 2 billion SEK. On average individual programmes have received funding of around 8 million SEK per year from Mistra.

Some of the programmes have involved co-financing from other actors. Other public financiers have been extensively involved in providing additional funding for the implementation of some programmes. One such example here is *Heureka*, where the Swedish Agricultural University has allocated additional funding. Another is *ÅSC*, which was financed 50:50 by Mistra and the Swedish Energy Agency. Regarding for instance *Black Liquor Gasification*, the Swedish Energy Agency, funded the pilot gasification plant. Private co-financing however predominates in the industrially-orientated programmes, such as *Mistra Fuel Cells*, *KAM*, *MAaf/ASE*, but also in those programmes orientated towards the management of natural resources, such as *FOOD 21*, *SUFOR* and *Heureka*.

In addition to direct funding, users from the private and public sector have also contributed with so-called *in-kind financing* as regards implementing some of the programmes. *Greenchem* and *Mistra Fuel Cells* have been told by Mistra to report these in-kind contributions. However, for *PERSEA*, the in-kind contribution has been important but not reported back to Mistra since this was not required in the original agreement. Moreover, the likelihood is that the in-kind contribution in

¹⁶ In 2003, STFI was merged with *Institutet för förpackningsforskning*, *Packforsk*, and STFI-Packforsk AB was founded. In 2009, the name was changed to *Innventia AB*.

¹⁷ *Lantmäteriet* maps the country, demarcate boundaries and secures ownership of Sweden's real property.

the other Mistra programmes is also significant. The resources spent in the programme, for instance related to manpower, are thus higher than those formally reported.

In terms of financing around 60 per cent of the programme financing is allocated to staff cost on average and around 20–25 per cent is overhead cost implying that around 15–20 per cent of the financing is spent on other expenses according to the financial reporting provided by Mistra.

4. Evaluation results

In the following section we present the main documented results and impacts of the Mistra programmes on an aggregated level. We illustrate some of the findings by using examples from a number of programmes. More specific information about the individual research programmes may be found in the programme reports. The various results and impacts are presented here based on the nature of their impact in the following sectors:

- ▶ Research community
- ▶ Industry
- ▶ Public sector
- ▶ Society as a whole

However, as may be seen below, some results affect many sectors and many are also interrelated. The division has nevertheless functioned well as a means to sorting through the rather extensive volume of information that is presented in the programme reports. The reporting structure of the results and impacts is also related to how we have tried to operationalise the purpose of the Mistra foundation as it is defined in the statutes. This may be measured, such as by means of PhD students or publications as well as by other relevant output and impacts. We have also reported on more intangible results and impacts, which we have observed during the evaluation. Examples here include the contribution to policies, input to political processes and facilitating dialogue etc.

4.1 Overall assessment of performed activities and main outputs and impacts

In general, the respondents are satisfied with the implementation of the programme. But of course this varies between programmes and between the different categories of the individual programmes. We can however also conclude that most of the programmes claim to have succeeded in undertaking their planned activities and achieving their defined objectives. Many of the programmes also perceive that they have contributed to finding solutions to the identified research problems as well as to making progress in the research field.

There are examples of programmes where developments have taken another direction than that originally planned. Sometimes this has been influenced by external factors. Concrete examples here include the *DOM*, when the financial crisis in 2008 demanded a prolongation of the programme. Also the *Mistra Fuel Cells* programme had to terminate the battery project when that industry relocated away from Sweden. These factors were rather difficult to foresee when the programme started. It is also clear that the rising level of interest in climate issues has also affected the development of Mistra programmes. Here we conclude that a kind of ‘momentum’ exists where, for instance, the *SWECLIM*-programme managed to time the delivery of their results perfectly. The results of this programme were developed further in a follow-up

project and it is also claimed that they constituted an important base element in the decision to establish the Rossby-centre.

The results and impacts of all of the programmes have had an impact in some way or another on each of the sectors mentioned above. Above all, the programmes have contributed to knowledge development. Here many examples are provided in the documentation of the programmes as well as by the respondents to the questionnaire and interviews. This may be seen in terms of enhanced knowledge and understanding of the issue in focus. The enhanced knowledge developed in the programme is also considered to have contributed to finding a solution to defined problems. We also see the development of knowledge in rather novel fields, such as *Greenchem* and *SWECLIM*.

Another common result and to some extent also common effect is enhanced competence among the people who have participated in the programmes, including formal and informal skills, as well as an increased insight and understanding of the research issue and environmental problem in focus. This aspect has been difficult to measure and has above all been revealed in the comments provided in the questionnaire or during the interviews with programme participants. The extent and other aspects of this may be followed-up more thoroughly in a follow-up study.

It is however clear that these new competences have been of use for the organisations concerned. For instance the researchers participating in the more industrially-orientated programmes have often been recruited by the participating industry, either to full time positions or to part-time positions in order to allow for continued academic research. We also see that the public sector has employed a number of researchers who have worked in those programmes orientated towards the management of natural resources.

Another common result is that many programmes have promoted increasing cooperation between disciplines, users (private and public sector) and researchers. This also relates to the point mentioned above, since it has implied the development of experience and a better understanding of needs and cooperation possibilities. This can be confirmed to the extent that the cooperation has continued in joint research projects, networks etc.

4.2 Research community

In this section we mainly address how the programmes have contributed to the development of strong research environments of the highest international class with importance for Sweden's future competitiveness. We would like to stress that we have only provided a few examples here from across the various programmes. For extensive descriptions of the contributions from each programme reference should be made to the programmes reports.

4.2.1 Publications

The generated knowledge has been disseminated through the publication of articles in scientific journals. Based on a limited citation analysis we may also conclude that the articles that have been published have been cited, the number of citations however vary. But we may conclude that some of the programmes, for instance *SWECLIM*, addressing the rather hot topic of climate adaptation and mitigation, scores rather well in contrast to the more technically-orientated programmes, where we may suspect that the research field is more limited. See Annex 5 for further information about the citation analysis exercise.

A number of popular scientific publications also emerged as a result of the programmes. This was in line with programme demands to be orientated towards users. The dissemination of the results has also been undertaken in many different ways, although traditional channels such as publications (both scientific and popular), conferences and research network or research cooperation partners,

predominate. The respondents representing the user category state that they have gained closer contact with research – if they did not already have this prior to their participation in the programmes.

We can also however conclude that for some of the programmes few PhD and licentiate theses were reported. There are however significant differences between the programmes in this respect with some programmes stating that they are simply not orientated towards the inclusion of PhD students but instead are primarily designed for senior researchers.

We can then draw the conclusion that some of the Mistra programmes have demanded senior researcher level participation due to the rather complex issues these programmes address. In addition, the mode of organising and operating the programmes, including user involvement and the use of an interdisciplinary approach, may require the particular expertise of senior researchers.

This implies that it has been difficult to undertake PhD work in some of the programmes. Furthermore as pointed out by many, incentives for interdisciplinary research may contradict the requirements for an academic qualification since the academic merit system rewards depth *within* each discipline and not crossing between them.¹⁸

Regarding PhD students, the length of the programme may not hamper participation since on average programme lasts for 8 years and a PhD study demands around 4–5 years. We can however, only speculate as to whether PhD students have opted for more traditional research projects in order to ensure an academic career. This may be further investigated in a specific study focusing on PhD students, who have participated, or are currently participating in Mistra programmes.

4.2.2 Towards more entrepreneurial researchers

It is also clear that researchers have been quite active in terms of getting patents. Intellectual property rights have also been an issue generating conflict in some programmes since the question of ownership was not settled before the programme started.

In some programmes the researchers have decided to centralise the patents developed in the programme in a common company. In the long run this may increase their opportunity to earn money. However, in order to ensure that patents are further developed specific strategies for this need to be developed. The question here is whether the researchers will prioritise these activities or whether the patents would be better off belonging to other actors.

We also see examples of researchers who have used the generated knowledge to sell consultancy services. Some researchers have also started their own businesses. For instance a researcher who participated in this programme has further developed a tool originally developed in the *Heureka* programme. This tool is now applied in the analyses performed in connection with the provision of consultancy services. Also in relation to *MiMi*, participants state that they are using the developed knowledge in consultancy work. In the case of *URBAN WATER* the company *Urban Water Management AB* has been established and is developing the knowledge originally developed in the project further. Moreover, several of the participating researchers are engaged in the company.

4.2.3 Research environments

Although there are exceptions, programmes or parts of programmes and/or projects are considered to have been of high scientific quality. This is also confirmed in the scientific reviews that have been undertaken of the programmes before the programme began and further phases were approved. The application of peer-reviews of the programmes is highly appreciated by the respondents particularly as a means of ensuring the scientific quality of the financed research.

¹⁸ See for instance Sörlin, S., 2005, *I den absoluta frontlinjen*

Most of the Mistra programmes have contributed to the development of strong research environments. Assessments from scientific panels point to enhancing existing environments and networking among researchers, primarily nationally, in this respect. One example of the successful strengthening of Swedish research within a particular field is *CLIPORE* which has enhanced national climate research, which would not have been likely without the Mistra programme. *PERSEA* is another example where Swedish research was developed in applied non-thermic atmosphere plasma.

Some of the programmes also managed to create an atmosphere of creativity. This creativity combined with the notion of attractiveness expressed by the users, has seen some of the programmes draw international attention to both the research and the researchers, creating a platform for individual researchers as well as research environments to participate in new research projects and equipping them with a good international reputation (see also section on new research projects below).

It seems that few physical environments have been created for implementing the programmes. Instead most have been organised in some kind of virtual organisation where the programme has had a common objective to which different disciplines and departments have contributed.

One major challenge in terms of virtual cooperation is how to unite different elements of the project team and how to integrate both projects and individuals. The mechanisms used for uniting the programme have for instance included organising regular programme meetings and having researchers locate their workplace in the other departments. In addition however a few explicitly new physical environments have been created. Consequently, it is difficult to maintain cooperation after the finalisation of the programme particularly where this has simply not been strong enough to be continued.

We can clearly see that there is, to some extent at least, a stronger development in this respect as regards programmes with a physical concentration. Physical closeness is still a crucial factor in the maintenance of close cooperation as is developing a new research environment. In terms of the development of a robust and sustainable research environment both “bricks and brains” are important in creating a synergy around the research undertaken. Long physical distances does not improve the chances of remaining and continued development, on the contrary, the networking continues to be *ad hoc*.

The Mistra programmes have both facilitated and contributed to the contacts between different disciplines. Sometimes, as for instance in *FOOD 21*, *CLIPORE* etc., it has worked out very well. In other cases however it has caused frustration affecting cooperation.

The interdisciplinary approach has contributed in several ways to the bolstering of contacts between different disciplines. Unfortunately this has not occurred so much between researchers orientated towards basic research or in relation to those orientated towards applied research within the same discipline.

4.2.4 Education

For 21 of 33 programmes it is explicitly indicated that the programmes have had an influence on the type of education provided by universities. Above all it is indicated that the programmes have had an impact on existing courses.

The influence on existing courses may be related to the practice of research-based education, ensuring that new research findings are included in the education and that teaching at universities is undertaken by active researchers.

We observe very few totally new education programmes or courses. Possible explanations here are that it is difficult to develop totally new courses and create interdisciplinary courses within traditional disciplines. In a comment on the programme *Soundscape support to health*, it is for instance noted that the performed

research did not fit the curriculum of the psychology programme. Interdisciplinary courses may also present a challenge since they do not belong to a specific department. However, the two programmes addressing climate change, *SWECLIM* and *CLIPORE*, provide examples of new courses being run which may be explained by the fact that the theme received increasing attention during programme implementation and thus that the demand for this kind of education also increased.

4.2.5 New research projects

The knowledge generated and developed in the programmes is further developed in continued research programmes. Most respondents claim that the research has continued in new projects – a natural development regarding research. Project continuations have generally been financed by research financiers other than Mistra, predominantly national-based though the EU is also mentioned frequently as a source of support. For some programmes, for instance *Greenchem*, *MARE* and *CLIPORE*, the respondents state that thanks to the research findings in the Mistra programme they are now an attractive cooperation partner for international research actors and are thus more likely to become involved in large research programmes.

In some cases parts of the programme have continued in new Mistra funded programmes. One such example here is *CLIPORE* in which a part of the research team has continued in the now ongoing Mistra Indigo project. Other examples include *Biosignal*, which partly continued and was expanded in PlantComMistra, *FjällMISTRA* (Mistra Future Forests), *NewS* (Mistra Pharma) and *SWECLIM* (Mistra Swecia).

In sum, research performed in Mistra programmes has been further developed without Mistra support, but this has been done for the most part in smaller projects and not in comprehensive programmes, implying that the synergies obtained in Mistra programmes may not have been further developed. Cooperation between disciplines and organisations has been developed thanks to the Mistra programme but after the finalisation of the programme most researchers have returned to their 'old ways' of working since the financing opportunities are available for this. To some extent the mode of operation and organisation of the programme which is, in the main, the financing of virtual environments, may explain why this type of cooperation breaks down when the programme comes to an end.

4.2.6 Non-commercial spin-off

In relation to non-commercial spin-offs we clearly see the establishment of networks. We can also observe that some Mistra programmes have provided the basis for the establishment of centres of competence or excellence. Examples here include the establishment of the *Rosby Centre* by the Swedish Meteorological and Hydrological Institute, which may be related to the *SWECLIM* programme. Furthermore, results from *MAaf*, *MASE* and above *DOM* can also be connected to the *Centre for Biological Control* at the Swedish Agricultural University. The *MARE* programme has also been of importance for the Baltic Nest Institute. We also see examples where Mistra programmes have contributed to the establishment or further development of networks of cooperation between private and public actors. Examples here include the foundation *Georange* and *Bergkraft*, a research and network-orientated project focusing on the development of mining, can be related to *MiMi* as well as the *Swedish Gasification Centre* hosted by the Luleå University of Technology but with the involvement of industry is connected to the *Black Liquor Gasification* programme.

Some programmes, for instance *Mistra Fuel Cells*, do also mention that they have tried hard to receive financing for a centre of excellence in order to continue the comprehensive research, but there are a few possibilities for this type of financing in Sweden. This implies that there is a risk in seeking to develop research competence further in this way when research findings cannot be further developed.

Programme	Example of centres
SWECLIM	Rosby Centre
CLIPORE	Centre for Science and Technology Policy Research vid Colorado University Climate Science and Policy Research Centre (CSPR), Linköping University RFF's Centre for Climate and Electricity Policy
COLDREM	Northern Sweden Soil Remediation Center
MASE, MAaf, DOM	Centre for Biological Control
KAM	Chalmers Energy Initiative
MARE	Baltic Nest Institute
MiMi	Bergkraft and Georange
Black Liquor Gasification	Swedish Gasification Centre
ÅSC	Centre for Molecular Devices

TABLE 6. Examples of research centres that Mistra programmes have had a direct or indirect impact on.

4.2.7 Career development

It is hard to judge whether participation in a Mistra programme is beneficial for an individual's career development. A little bit more than half of the respondents representing the programme participants agree completely or to a high degree with the statement that participation in the programme has been of direct benefit for their future careers while the share of programme directors who agree with this statement is even greater. Most of the programme directors, who came from industry rather than the tertiary education sector, nevertheless held a PhD. Some, however, seem to have remained in the academy after the finalisation of the programme.

Some of the Mistra programmes have fostered PhD students. However, in some programmes, for instance *CLIPORE*, *DOM*, *MASE* and *PERSEA*, it is mainly senior researchers who have participated. These programmes have not resulted in the production of PhD and licentiate theses (see sections above addressing publications). In the following programmes, however, the fostering of PhD students was particularly stressed as an important result; *ByggMISTRA*, *FjällMISTRA*, *Greenchem*, *Mistra Fuel Cells*, *NewS* and *SUCOZOMA*.

A further question arising here is whether a Mistra programme demands, due to the demand for interdisciplinary approach and user involvement, senior researcher involvement. To some extent this is verified by the fact that around 20 per cent of the respondents are now retired. As also noted previously, the complex issues and broad research questions addressed in many of the evaluated Mistra programmes often require senior researchers, preferably with an interest in broad and cross-bordering solutions as well as researches with a network, in order to be able to compile a successful application. Moreover, the researcher should be experienced in and willing to collaborate without concern for any potential impact this may have on their own career.

The question may thus have been interpreted as of benefit for the *scientific* career. The Swedish academic system has so far rewarded publications and deeper knowledge and results within each discipline. This may be difficult to gain in an inter-disciplinarian Mistra-programme compared to more focused research projects. Participating in a Mistra programme might, however, be rewarding in other ways, for instance allowing an engagement in societal development, contribution to finding solutions to problems, having research results applied, widening the research scope, (see also sections below), but not for an academic career. For instance, the notion of user involvement has implied that PhD students have been prepared and then recruited into both the private and public sectors, carrying with them knowledge and 'know how' useful for society and industry. As we have seen

in other evaluations, this mobility is important in ensuring the full usage of results and knowledge. Regarding the Mistra programmes themselves many of the PhD candidates employed also bring with them a holistic view on issues as well as problem solving.

4.2.8 Sweden's future competitiveness

The concept of future competitiveness can be understood in at least two ways. Either it is interpreted as enhanced possibilities for the industry in terms of the development of new goods, services or processes, which may be launched on the market thus contributing to increased opportunities for export, attracting capital and investments etc. The concept could also be interpreted as relating to an ameliorated knowledge base, i.e. attracting more 'high profile' researchers, the creation of a better equipped research community etc.

The latter interpretation is the one most expressed by the participants. The programmes that have contributed to the international recognition of Swedish research for instance include, *Greenchem*, *KAM*, *CLIPORE*, *MARE* and to some extent also *Soundscape support to health*, which was viewed as the first comprehensive research programme with a novel focus.

4.3 Industry

On the question of results and impacts related to Mistra's industrial purpose we have chosen primarily to present how opportunities to promote industrial applications have been taken advantage of in the programmes. Here the focus is on judging whether the developed knowledge has been transformed into concrete products (goods and services) and/or processes. When the statutes of Mistra were formulated in 1994, the focus of this formulation seems to have been on industry and commercialisation. This approach has however now been widened, implying that in terms of research and innovation, the application of innovation in the public sector is now also important. This development may best be seen in relation to the evaluated Mistra programmes (see section addressing the public sector).

In general terms, we may conclude that some programmes have taken advantage of the available opportunities to promote industrial applications. This does however clearly take time. We would like to stress that due to the limitations of space we can only provide a few examples from the different programmes below. For extensive descriptions of the contributions from each programme we refer readers to the programme reports.

4.3.1 Registration of patents and substances

At least 12 of the 33 programmes have resulted in the registration of patents, either during the programme or after its finalisation. Registration according to certain directives of substances is reported by seven programmes. The registration of patents and substances may above all be seen in those programmes that focused on commercial activities, but also in some programmes not explicitly orientated towards industrial applications, such as *SUCOZOMA*.

Regarding patents and IPR (intellectual property rights) issues we also see that this issue has caused problems in some programmes. This may be related to specific Swedish conditions in terms of the so called 'teacher exemption' noted previously. Problems related to IPR have primarily been encountered in those programmes focused on commercial activities.

In some programmes the participating companies have themselves contributed to settling the IPR issues. The *Mistra Fuel Cells* is one of Mistra's first industrial programmes and here it seems that the patent issues worked rather well, since the competence and experiences of the major companies participating in the programme were used from the outset to settle issues related to IPR. Greater problems

can be detected in respect of Ångström *Solar Center* and *Greenchem*. Mistra policy here has been to try to settle these agreements before the programmes began. That problems occurred in *Greenchem* is rather surprising since the programme began in 2003¹⁹. But of course this could relate to the fact that new actors from academic and industrial sides became involved at this point bringing with them rather different traditions and experiences in respect of IPR.

A further challenge to patenting in Mistra programmes is that any attempt to apply for and exercise a patent may run contrary to the tradition of the making public the research results. In addition, patents have not been generally been viewed as meritorious in terms of academic careers, something which is probably unlikely to change in the foreseeable future. In some cases patents are also irrelevant since the development process is so rapid. In effect there is simply little or no time for the patenting process to run its course. It must also be noted here that there are different rationales to patenting, one of which is, for instance, to block the development prospects of competitors, or, in addition, to collect a patent portfolio which may be sold or used for trading.

The registration of substances has emerged as a specific activity in some programmes, primarily in *MASE* and *DOM* as well as in *Biosignal*. This process is stated to be very time and resource demanding in terms of bureaucracy and expenses. The programmes have also tried to make public decision-makers (see section on public sector) aware of their experiences in this regard, since this is an example of that the application of research results, which may be of benefit for the environment and which can easily be hampered by the period of time it takes to have products approved e.g. by the public authorities in Brussels.

4.3.2 Development of demonstrator and prototypes

The development of demonstrators and prototypes is normal practice within Mistra-programmes. These have often been designed for both commercial and public use (see also the section addressing impacts on the public sector). In 24 programmes it is indicated that they have developed concrete demonstrators/prototypes. We have already noted previously that the development of products based on the knowledge generated in Mistra programmes has proven to be very time-consuming. It can also be noted that few products and processes have thus far reached the market launch stage, however, many are just about there. For *Greenchem* it is stated that the various products that have emerged from the programme are still in the development phase and the process economy represents something of a 'bottleneck' when it comes to not being able to launch the products. Another example relates more to external factors. For the *Black Liquor Gasification programme* it is noted that the technology is ready to be commercialised and licensed. However, due to the current recession the development of the first full scale demonstration establishment has been suspended.

Sometimes the knowledge and products developed in the Mistra programmes have not been able to be absorbed by the private sector. This may be related to the discrepancy between the needs and research provided and the fact that the timing may simply have been wrong. This seems to have been the case of the *ByggMISTRA*.

4.3.3 Commercial spin-offs - new companies and the development of existing companies

We can also conclude that 17 of the 33 programmes have generated some kind of commercial spin-offs, for instance that companies have been started or that already existing companies have been further developed. An example of the latter is *Greenchem*, where the existing companies have been involved and influenced the research orientation and also benefitted from the research undertaken.

¹⁹ Here a challenge was that the academics wanted to retain generic process patents while industry wanted to get the product patents.

TABLE 7. Some examples of the demonstrators and prototypes developed: based on results from Mistra programmes.

SOURCE: QUESTIONNAIRE

Programme	Example of products
Biosignal	Field trial
ByggMISTRA	Eco-building
Black Liquor Gasification	Chemrec's gasification establishment in Piteå
COLDREM	Electro-migration cell
DOM	Biological control formulations
Greenchem	Tenside for drug formulation
KAM	Technique for cleaning cadium, LignoBoost process
MiMi	Demonstration establishment
Mistra Fuel Cells	Production methods and fuel cell stack
PERSEA	Plasma conversion cell
ProEnviro	Industrial heater
SUCOZOMA	Pontoon trap for salmon fishing
ÅSC	Solar cells, smart windows

The new companies are mostly established as small companies for regulating the IPR and without any or at most only a few employees. Examples found here include, for instance, *Greenchem* (Intenz (IPR), *Biosignal* (Pheronet), *DOM* (CaptiFel, DOM-EXPLORE) as well as *NewS* (Onco Targeting). Some have also been reconstructed or have been liquidated.

Some of the new companies that have been developed more extensively and where results from Mistra programmes have been of importance are *Solibro AB* and *Chromogenics AB* in the case of ÅSC and the VOLVO Power cell in the *Mistra Fuel Cells* programme.

We can also conclude that the knowledge has been used by existing companies, for instance *MAaf/MASE* (*BioAgri AB*). Here it may be seen that if the results have been developed together with a firm the use seems to have been more rapid than in the other cases. One such example here is that of the *KAM* programme, which resulted in the company *LignoBoost AB* now owned by METSO. As regards the *Black Liquor Gasification* programme the participating companies have also continued with product development. Furthermore, the *Marine Paint* programme has been working closely together with the company *Itech*, which existed before the programme started, but it is stated that the company has been able to develop thanks to the programme. For some programmes we also get an illustration of how companies evolve. In the context of the programme *MAaf* the company *Agrivir* was created but was later liquidated, due to the lack of financing.

4.3.4 Launching of products and processes²⁰

A standard definition of an innovation is that this is a new or substantially improved good, product or service which has been *launched* on the market. However, in the case of Mistra programmes the market is clearly also the public, in the

²⁰ In the report *När staten spelat roll, lärdomar av Vinnovas Effektstudier* (2011) Vinnova observes that they have made a difference in identifying new needs-oriented disciplines in dialogue with the surroundings. Neither research (which rewards excellence) nor industry (which honours the knowledge that support today's business) can do this on their own. A 'bottom-up' perspective is required to identify new areas and programmes to scale up promising areas. It takes time before new knowledge is visible in terms of measurable or discernible impacts; it is not unusual that this equates to a time lag of 10–20 years. The size of programmes is often unimportant; rather, what is in focus is how the research is conducted together with industry and the public sector. The study also points to the impact of dependence on public funding and particularly when and how the government has affected development – therefore time is a significant factor in impact assessments.

sense that the products or processes developed are applied but that no economic compensation is given (see section below). Few programmes with the aim of developing concrete products and processes have succeeded in reaching the commercialisation stage.

It takes time to develop products. Research findings alone are not enough, other kinds of competences are also required, for instance related to marketing and design, as well as additional resources, such as venture capital. Although conditions for entrepreneurship have improved, primarily considering issues related to rules and markets, challenges remain concerning growth and young entrepreneurship.²¹ Here we may also identify a gap in terms of public financing for research and product development. The question of the balance between public money for financing research and private interest to finance product development and commercialisation has also been discussed in the programmes.

As many other actors, for instance the Knowledge Foundation (KKS), have argued, improving competence levels and the availability of research are prerequisites for the growth and development of Swedish industry.²² It is also now clearly understood that the performance gap between innovative and non-innovative exporters increases with accessibility (of the former) to external knowledge.²³

Many respondents claimed that there are products or processes in the pipeline, we have also received many examples of products and processes which have been launched. Examples of launched products and processes, which may be connected to the evaluated Mistra programmes, are provided in table 8. It is rather interesting that programmes that have not been viewed as industrial or commercial may also be found here. It may also be the case that a new product or process has been used as an input factor in respect of another process and/or product.

We can also see some examples of product development that directly affect the public sector, industry (understood as companies) and, in the long run, society as a whole. Such an example is *Heureka's* software for better forestry management which is currently in use and with more sustainable management should have the potential to enhance the competitiveness of the forestry sector over time.

4.3.5 Employment of staff

For industry, the Mistra programmes have also implied that the PhD researchers, who have been fostered in the programme, have either been employed by companies or that the cooperation has continued after the finalisation of the programme. *URBAN WATER* is one such example where PhD candidates now are employed in sewage and water companies. The employment of such people may also be viewed as a result of the *Mistra Fuel Cells* programme. In this sense, the Mistra programmes have provided the business sector with an enhanced level of competence among their staff component. The participation of private sector companies in the programme is also mentioned in relation to the development of staff competence levels in some programmes.

Others, like *FOOD 21*, saw the introduction of a much changed mind set including the introduction of a holistic view on the whole food production chain, from farming to industry and consumers. Values in relation to this holistic perspective were integrated into food research.

4.3.6 Sweden's future competitiveness

Based on the evaluation results we can conclude that the implementation of the Mistra programmes have been of importance in the development of the industry.

²¹ Napier, G. (et al), 2012, Nordic Growth Entrepreneurship Review 2012, Nordic innovation report 2012:25.

²² <http://www.naringsbloggen.se/innovation/gastbloggare/tillgangen-till-forskning-och-kompetensforsorjning-en-odesfraga/>, accessed on 10 February 2013.

²³ Löf, H. & Nabavi, P., 2013, Learning and Productivity of Swedish Exporting Firms: The importance of Innovation Efforts and the Geography of Innovation, Royal Institute of Technology, CESIS (Centre of Excellence for Science and Innovation Studies).

Programme	Example of products and processes that have been launched
Black Liquor Gasification	Goods: Black liquor gasifier, Biometanol fuel
	Process: Complete process for fuel production
DOM	Processes: Cultivation and formulation of microorganisms products for companies
	Goods: Lantmännen BioAgri has launched a product that stimulate the growth of vegetables
Heureka	Goods: System Skogsägarplan, the software Heureka-system
	Service: Consultancy service among several companies, for instance forest analysis and planning, education and assignment in relation to the developed software
	Process: Planning process
KAM	Goods: Sulphate lignin
	Process: The LignoBoost-process
MAaF / MASE	Goods: Cedomon, Cerall, Cedress, Amase, Rotstop, Feedtech 3000 (ensilage)
Marine Paint	Goods: Medetomidine for control of barnacles
MiMi	Service: Environmental forecasts
Mistras Fuel Cells	Goods: Fuel cells, mobile charger, APU (Auxiliary Power Unit) for trucks
	Service: Consultancy services
	Process: New testing methods
NewS	Service: Evaluation of persistence of chemicals
PERSEA	Process: NOx conversion
ProEnviro	Goods: Industrial heater
	Service: Software for the transport of chemicals
	Process: A production line for solar cells
SUFOR	Service: Consultancy services in relation to forest management
URBAN WATER	Goods/service: Software URWARE and SEWSYS, planning support for sustainable water and sewage systems, system analyses and multi-criteria analyses (decision support-system for investments in water and sewage systems)
	Process: Several tools and methods for water and sewage management
ÅSC	Goods: Thin film solar cells and smart windows
	Process: Technology for production of smart windows

TABLE 8. Examples of some products that have been launched and may be related to Mistra findings.

SOURCE: QUESTIONNAIRE

The industry has benefitted from the competence and knowledge developed and also in concrete terms we see that in some cases the industry has received direct help to develop products and processes which, in the long run, may feed into improved competitiveness. It does however take time to have a real impact and also to ensure that increases in turnover, exports, the number of employees etc., are directly related to the Mistra programmes as, of course, a multitude of other factors can also influence this development.

4.4 Public sector

Some of the programmes in Mistra have addressed the management of natural resources. In these programmes the aim has been to develop knowledge that may be of use for public actors at the national, regional and local levels. Here we may also find the results from programmes, aimed at supporting public actors, in international negotiations. In this section then we present some examples of the contri-

butions made by Mistra programmes to the public sector. We would however also like to stress that due to limitations on space we can only provide a few examples from the various programmes. For extensive descriptions of the contributions from each programme we refer readers to the programme reports.

4.4.1 Legislative development, international conventions and support schemes

Some of the evaluated Mistra programmes have resulted in new legislation and the development of guidelines for management of natural resources, as for instance with *CLIPORE*. Knowledge developed in the context of the Mistra programme has also been used in the development of international conventions. In relation to knowledge being used in international negotiations the *ASTA* and *CLIPORE* programmes may be specifically cited here. The results of the *ASTA* programme have been used to support international negotiations related to conventions aiming at the reduction of the air pollution. Results from *CLIPORE* have been used in the climate negotiation processes where, for instance, the research results influenced EU policy on trade with emission rights. Results from *NewS* have also been used to developing the EU directive REACH. Moreover, *MARE* results have been used by HELCOM and the development of the Baltic Sea Action Plan.

We can also see that some of the findings from the Mistra programmes have influenced environmental objectives, for instance the *FjällMISTRA* results influenced revision of the environmental objective *A Magnificent Mountain Landscape*. Results from *HagmarksMISTRA* clearly also influenced the evaluation and revision of the EU rural support programme.

4.4.2 Development of competence

The Mistra programmes have also contributed to the creation of enhanced competence levels among the staff employed in the public sector since they have, for instance, been included in the programmes as users. We can also see that some of the researchers, fostered in the programmes, are now employed in the public sector. Examples here include *FjällMISTRA* which has produced several PhDs as well as *SUCOZOMA* and *SUFOR*. To some extent also *URBAN WATER*, where PhDs now are employed in sewage and water companies, also fits this pattern.

4.4.3 Demonstrators, product development and change of practice

We can however also find examples of products that have been developed in the Mistra programmes, being applied by the public sector, mostly without any economic compensation. We can also identify several demonstrators that have been ‘up scaled’ into products and processes and which have then been applied to public management, for instance the monitoring and management of natural resources. A concrete example of a product that has been developed and launched but where usage has been on a ‘free of charge’ basis is the climate modelling tool developed by *SWECLIM*.

Above all, programmes orientated towards providing support to the public sector can be seen here. This confirms the perspective of looking at the notion of ‘industrial application’ as something more than just commercial development. However, it must also be stressed that some of the products may also be commercialised on the private market. It may also be the case that some of the products are further developed by the private companies and sold to actors in the public as well in the private sector.

We can also conclude that some of the programme results have also influenced the practice of public management. This is of course related to the use of new tools and processes. Examples here for instance include the *SUCOZOMA* programme, where a process for sustainable coastal and sea management has been elaborated. Methods have also been developed for the management of fisheries and for reducing

Programme	Example of products and processes
CLIPORE	Adaptation Atlas
	Consultancy service for international NGOs and negotiation secretariat
	Powerinvest (tool)
Heureka	Heureka System
MARE	Web based support tool for decision-making, NEST
RESE	Monitoring of algae at sea
Soundscape support to health	Instrument for measuring the soundscape, which was tested by a Swedish municipality A renovated and restructured housing area
SUFOR	FORSAFE, a simulation model
SWECLIM	Regional climate scenarios
	Analyses of climate adaptation for Country Administrative Boards, municipalities, and the power industry.
URBAN WATER	URWARE, membrane for water cleaning,
VASTRA	Models and DSS

TABLE 9. Examples of prototypes and products used in the public sector.

eutrophication. In the *SUFOR* programme we should also acknowledge the development of a process that has encouraged long-term management in forestry, including for instance modelling of varied forest-related processes, which may be of use for both public and private forest owners. The programme also states that information and knowledge about how biological diversity may be preserved in a cost-effective way in forestry is an important output and something which may influence the overall approach to management.

Another programme which may have changed public sector practices is *TransportMistra*. In this programme new knowledge was used to develop a support tool for decision-making related to the so-called *Stockholmsförsöket*, implying the implementation of a vehicle-related congestion charge. Knowledge developed in this programme was also used in physical planning in terms of housing planning, energy use of transports and CO² emissions. The *SWECLIM* results are also stated to be applicable to the purposes of physical planning, for instance the planning of the “Nya Slussen”. In addition, the programme *Soundscape support to health* has contributed to the development of an international standard in relation to noise.

We can also find evidence that *FjällMISTRA* has changed previous practice, for instance through the knowledge it has generated in the programme about grouse hunting and mountain fishing which has significantly influenced the management of the County Administrative Board. The work performed in the *NewS* programme also implied a clarification in terms of how the ‘precautionary principle’ may be applied in connection with chemical control.

4.4.4 Sweden’s future competitiveness

One way of understanding competitiveness might be the strengthening of Sweden’s position in the international arena, both in terms of negotiations and policymaking. To conclude, the Swedish public sector has been helped by the research produced in the *Mistra* programmes and translated into the *Mistra* statues; this may imply an increasing level of future competitiveness in terms of improved and more efficient public management.

This development may also be of benefit for the development of Sweden’s recognition as a role model in certain areas. A country’s ability to achieve political objectives, promote trade, attract investments and visitors, as well as participate in the

exchange of talent and creativity largely depends on how it is perceived. Competence, values and experiences are all factors which help to build a positive perception which can enhance the impact of Sweden's international policies, for Swedish companies to do business and in relation to the dissemination of Swedish culture more generally. It also becomes easier for Sweden to take part in international cooperation and dialogue with other countries and discuss future opportunities and challenges if this can be done from a solid competence base.

In respect of the public sector it is generally the case that governmental agencies are involved in programmes for the exchange of 'know-how' and experience with other countries. Well tested management approaches, technology solutions or adopting policies underpinned by research from Mistra funded programmes are all good ways to strengthen Sweden's future competitiveness. Examples of programmes contributing to this include *RESE* (Still arranged seminar *Fjärranalysdagarna* attracting central government agencies among others), *SWECLIM* (methods for practical climate adaptation), *COLDREM* (methods of remediation in cold climate), *Heureka* (planning and management system in forestry) etc.

4.5 Society

Finally, what impact have the evaluated programmes had on society? For society as a whole the results and impacts related to the relevant purpose of Mistra may be related to the development of a good living environment and finding solutions to important environmental problems and the general move towards the sustainable development of society. The definition of a good living environment has been understood broadly by Mistra and often differs significantly between the various evaluated Mistra programmes. In general terms, all programmes consider that they have contributed to the development of a good living environment though often in quite varied ways. For extensive descriptions of the contributions made by each programme we refer readers to the programme reports.

In respect of the general understanding of a good living environment programmes directly related to health issues are generally not in view. Instead, it seems that Mistra has addressed question relating to the broader factors that may influence human health and well-being. We can also see that in many of the programmes a good living environment is not only meant to be for human beings but also for animals and plants.

In Sweden the Environmental Objectives stipulate the overall goal of Swedish environmental policy and were adopted by the Swedish parliament in 1999 and slightly amended in 2005.²⁴ The objectives define the direction of the changes in society that need to occur within one generation if the country's environmental quality objectives are to be achieved. In this context it must be stressed that Mistra is an independent research foundation. But since that funding was based on tax money and a sound use of the financing of public benefit we decided to use the environmental objectives as one of the best ways of illustrating the contributions various Mistra-programmes have already made towards contributing to these objectives.

The environmental objectives may be seen as the most highly prioritised without themselves being viewed as environmental challenges to be addressed primarily by public actors. Development cannot however be influenced without the involvement of private actors. We can also see here that Mistra has used the objectives as a reference point for their programmes, for instance they were used for categorising the programmes in 2005.

²⁴ <http://www.miljomal.nu/sv/Environmental-Objectives-Portal/Undre-meny/About-the-Environmental-Objectives/>, accessed on 13 December 2012.

- 1 Reduced Climate Impact
- 2 Clean Air
- 3 Natural Acidification Only
- 4 A Non-Toxic Environment
- 5 A Protective Ozone Layer
- 6 A Safe Radiation Environment
- 7 Zero Eutrofication
- 8 Flourishing Lakes and Streams
- 9 Good Quality Groundwater
- 10 A balanced Marine Environment, Flourishing Costal Areas and Archipelagos
- 11 Thriving Wetlands
- 12 Sustainable Forests and Protection of Endangered Species
- 13 A Varied Agricultural Landscape
- 14 A Magnificent Mountain Landscape
- 15 A Good Built Environment
- 16 A Rich Diversity of Plant and Animal Life

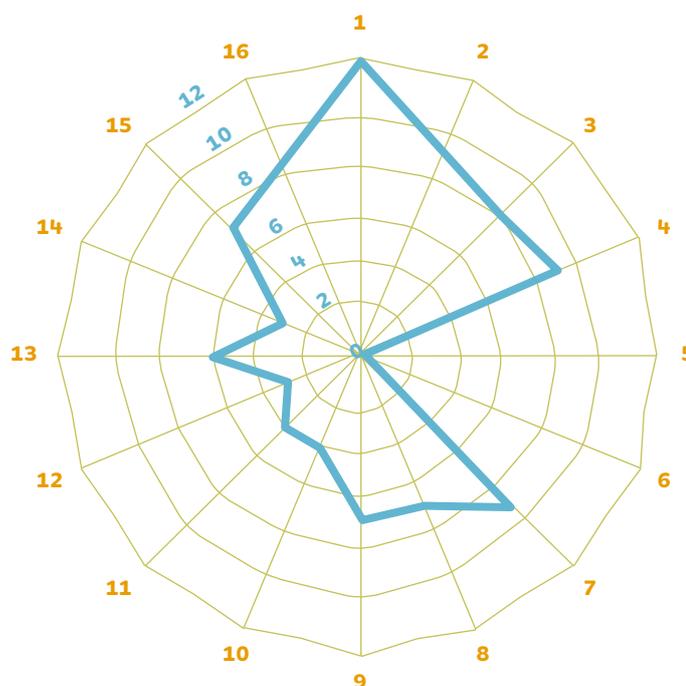


FIGURE 3. Number of programmes addressing environmental objectives according to the survey.

SOURCE: QUESTIONNAIRE

The environmental objectives²⁵ to which most programmes state that they have contributed are *reduced climate impact, clean air, natural acidification only, a non-toxic environment, zero eutrophication and a rich diversity of plant and animal life.*

Concrete examples of the rather comprehensive impact on an environmental system may be seen in the *FjällMISTRA* programme, which has addressed conflict management in relation to natural resources in mountain areas as well as *SUCOZOMA*, which has addressed integrated coastal zone management. One such concrete result in this programme has for instance been an increase in our knowledge levels relating to the economic importance of a better environment in coastal zones.

4.5.1 Sweden's future competitiveness

The contribution to the development of a more sustainable society in general terms may also be regarded as a means of enhancing Sweden's future competitiveness. The body of research produced, including knowledge development and the development of products, processes and new practices contributes to the establishment of a more robust society. The insights produced within the context of the *Mistra* programmes imply, in terms of cooperating to better address environmental problems that it could have an impact on future research projects undertaken either by the current programme participants or in other projects undertaken by the users themselves.

²⁵ According to the in-depth evaluation presented in 2012 only two (A Protective Ozone Layer and A Safe Radiation Environment) of the 16 objectives are assessed to be achieved until 2020. (Naturvårdsverket, 2012, Steg på vägen – Fördjupad utvärdering av miljömålen 2012. Naturvårdsverket rapport 6500).

5. Mode of organisation and operation

In this section we briefly address the role that, for instance, the programme design, programme management, interdisciplinary approach, user involvement, different types of cooperation etc., plays in the results and impacts of the evaluated programmes.

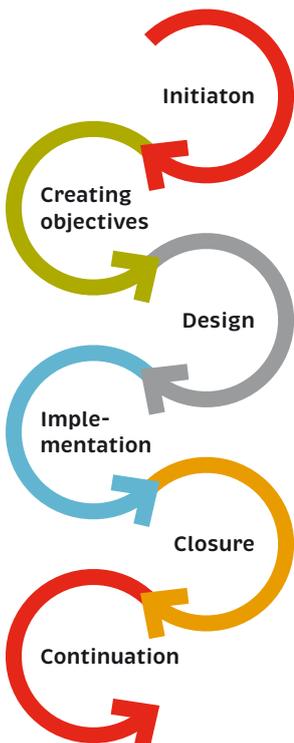
5.1 The programme life cycle - from initiation to finalisation

The programme life cycle has usually followed the same steps, however with some differences, as illustrated in the figure 4.

Only three of the evaluated programmes, *CLIPORE*, *Greenchem* and *Transport-Mistra*, were initiated based on an open thematic call. Mistra has, since the beginning of the 2000s however, initiated most of the new programmes based on open thematic calls.

For some programmes like *CLIPORE* and *SUFOR* 'forced marriages' effectively took place which resulted in some conflicts and frustration among participants at the beginning of the programme. For some of the programmes like *CLIPORE* and *SUFOR* this was solved and by project closure the collaboration worked fine with

FIGURE 4. Programme life cycle



The INITIATION of the programmes has sometimes been encouraged by Mistra; while on other occasions the initiative has come from the researchers themselves. Few of the evaluated programmes have been initiated based on open thematic calls.

The OBJECTIVES were mostly created by researchers by means of developing programme proposals. These objectives have sometimes been revised after the conducted assessments.

The DESIGN of the programme, including organisation and work plan, has generally been based on what Mistra stipulates (see section 3.1).

The IMPLEMENTATION of the programme has usually been undertaken in two phases (3-4 years per phase) with a renewed approval for funding after the first phase.

The CLOSURE of the programme occurs after a synthesis phase and results in a final or closure conference.

CONTINUATION (optional): For some programmes, new research proposals were developed and were subsequently granted funding.

participants generally expressing their satisfaction. In others the existing ‘knots’ do not seem to have been resolved.

Prior to the objective and design phases and for a short period of time only, Mistra has allowed seed money to be used to develop a programme idea into a full programme proposal and extend the partnership, for instance in relation to the fuller involvement of users. Sometimes this step was extensive and it was often conducted in consultation with Mistra. This is understandable in the light of the programme history when the initiation of programmes was very much based either on an idea from researchers or from Mistra.

It is clear that, in relation to the overall objective, Mistra was generally rather inflexible in managing this system. The rewriting of the programme proposal was often necessary. Whether design, working mode and staffing were successful or not depends, from our perspective, on how the programme thereafter was managed. But in, for instance, the deeper study of the *Mistra Fuel Cells* programme, the programme management recall that the first proposal that was submitted to Mistra, was more like a number of projects compiled into a single folder, but encouraged by Mistra. Moreover, the extensive consultation round with the users was undertaken during the planning phase, and this really improved the programme proposal and implied that a ‘programme’ had been created.

5.1.1 Mistra’s management including evaluations

In general terms, Mistra’s management is considered to have been sound by the respondents. The programme participants and members of the executive committee are however a little more sceptical than the programme directors. Our interpretation for this is that researchers were, at least not at that time, often used to this kind of management from research funders and in addition were rather distanced from Mistra in many programmes. The opinions of the executive board members may be related to both attitudes towards funders’ participation in research programmes and on how collaboration with Mistra’s programme officer *de facto* worked.

We can note that there are also some critical comments regarding Mistra’s role and how the management tasks have been performed. In general terms, respondents representing programmes, which were terminated after the first phase, are rather more critical towards Mistra’s management. It is suggested in this context that the evaluations have misinterpreted the programme’s aim and results and that the Mistra board has, as such, been misinformed in the decision-making process. Also for other programmes, some respondents noted that Mistra representatives have not fully understood the research and to some extent have also sought to micro-managed the programme. There are, on the other hand, many examples cited where Mistra’s management has contributed to the better organisation and implementation of the programme. For instance Mistra has assisted in managing conflicts that have emerged in relation to some programmes.

During the implementation of the programme Mistra participated (and continues to do so) as an additional member of the executive committee. This means both that the programme director and board have had contact with Mistra and, *vice versa*, that Mistra has had some input into the development of the programme concerned. Yearly dialogue meetings between Mistra and the programme management did also take place. Many representatives of the programmes perceive this involvement to be perfectly acceptable. Some respondents, moreover, underline that when advice were sought Mistra responded accordingly. Others felt micro-managed and perceived the funder’s management to be both too wide ranging and too detailed (see below, in the section on Mistra’s management).

The second, or concluding, phase focused on the synthesis work. In the deeper investigation of some programmes, it is revealed that in the finalisation phase rather activity have been undertaken in some programmes in order to ensure further

financing for the whole programme. Here, Mistra is said to have assisted in this work by, for instance, providing contacts with other possible financiers.

It is also clear that respondents from some programme would have appreciated more steering from Mistra while other programmes wanted less. Mistra confirmed that if a programme organisation is functioning as planned Mistra's involvement in the management of the programme is not required.

From a scientific as well as a user perspective the evaluations are generally appreciated by the respondents. However comments have been made that they are conducted too often and sometimes too soon after the start of a programme (mid-term evaluation). This has been stressful, especially since the first phase of the programme focused on establishing a working collaboration between the various actors involved. It has been noted previously that in relation to the character of a Mistra programme, including a rather complex way of working encompassing interdisciplinary aspects as well as user involvement, the establishment of a functioning modus of collaboration takes time. The peer-review process is regarded as an important element in the approval of the programme's proposals since it is a good way to guarantee that the programme has an acceptable scientific quality, something that is necessary for the financing of research and in receiving legitimacy for researchers to apply for, and participate in, Mistra programmes.

Regarding programme reporting, the available yearly documentation for the individual programmes has been good. But it can nevertheless be seen that the standard of final reporting and documentation for the evaluated programmes varies often quite significantly. This may, in part, be explained by the fact that the older programmes belong to what may be termed the 'development phase' of the foundation's activities. A standardised form of or demand for reporting result and input indicators in the final reports would however have further enhanced the possibilities for comparisons between the programmes.

5.2 Programme management

As can be seen in the programme overview in annex 4 the evaluated Mistra programmes have included participation from different research environments and organisations. Researchers participating in the Mistra funded programmes have with few exceptions been from Swedish universities. In some programmes like *URBAN WATER*, there were many departments and universities participating. In others like *Heureka* and *Greenchem*, only one university was involved, although the work was shared between different departments. We should also note that in the programme with many organisations involved, virtual co-operation has generally been the primary mode for operation. These are aspects that need to be borne in mind when Mistra's mode of organisation is assessed.

The mode or organisation of Mistra programmes may from an outsider perspective be reviewed to be rather rigid, 'over-organised' and demand a rather large overhead with the functions stipulated. These functions are viewed as vital in overseeing cooperation, producing user friendly results and steering these extensive programmes etc. According to the respondents the organisational structure of the programme including a main contractor, programme director and executive committee is considered to have contributed to the implementation of the programmes. However a difference may be seen in some programmes which had unresolved conflicts. For instance in the questionnaire a respondent perceived the organisation to be decentralised and that opportunities existed for adaptations to the specific conditions related to the programme.

Notwithstanding how the organisation is designed and how *de facto* the management is carried out communication is always important. It is especially important for bridging over the 'death valley' implying a good utilisation of the research results. In addition, external communication is part of the universities' 'third task',

to disseminate research to society. In addition however internal communication is important in forming *one* programme, handling conflicts and creating synergies.

In the questionnaire, the burden of the requirements of reporting and the number of *ex-ante* and *midterm evaluations*, which those working in the projects at this time were simply not used to, is mentioned by some as being problematic. However, most of the respondents consider that the organisation of the programme has been good while some respondents also state that now in hindsight they can see the benefit of the organisational model.

5.2.1 Role of main contractor

Examples do exist where the main contractor was ignorant of the real complexities of the programme in such cases issues relating to a lack of support, attention and interest, inevitably hampering implementation, did arise. Additionally, among several main contractors severe problems also arose in terms of economic accounting and reporting with some simply being unable to produce the kind of follow-up data required by Mistra. Our experience from both this and other evaluations is that the standards and practice of project accounting has improved over the years. A different attitude clearly now exists in respect of interdisciplinary research, externally funded research programmes and the requirements for accounting at the organisations concerned.

Mistra funded programmes were, and remain, two phase programmes. Mistra has undertaken numerous dialogues with the main contractors, for instance when the programmes began an agreement was made that the main contractor would ensure a continuation of the research after Mistra financing ended. However, these are informal agreements and after eight years of implementation the prerequisites and context might look very different to the main contractor and therefore it may be difficult to keep the promise.

5.2.2 The role of the executive committee

Based on the questionnaire and also the interviews undertaken in relation to some of the programmes the role of the executive committee is clearly very important in the implementation of the programme. The role of the executive committee is to be a bridge between the researches and users, here effective representation from the appropriate organisations as well as individuals is revealed to be crucial in constituting added-value in respect of programme implementation. For instance, an understanding of the different worlds brought together in the context of a Mistra programme is clearly required as is an interest in cooperation as well as a mandate from the parent organisation. Such skills are obviously necessary since, as one programme director put it, the management of a Mistra programme is much like “herding cats”²⁶. The role of the committee is important in prioritising programme activities. This function is seen as being particularly important when programmes are about to enter their second phase, which is generally more orientated toward synthesis work.

In the interviews undertaken in connection with the deepening of the study focus in relation to some programmes the impression is given that the chairman of the committee often functions, in effect, as a “guardian angel” for the programme, while anecdotally, we see that individuals who have filled this role often remain connected to the follow-up activities of the programme in some way or another.

Regarding the executive committees we can also see that the first executive committees that were compiled for the early programmes were very much dependent on suggestions made by Mistra. One explanation given for this is that the researchers themselves did not have the contacts or networks required to fulfil this task. Over time however the programmes themselves have become more engaged in finding the board members. This may also be related to the fact that after some years an

²⁶ Expression from reflections from the executive committee in URBAN WATER, 2007

interim executive committee was also to be engaged in the development of the programme proposal.

5.2.3 Programme director

In the 33 programmes evaluated, one third had a programme director external to the academic world. The position has predominantly been held by men. Most of the directors have however had a background in the academic world and have gained a PhD and consequently have had their own experience of research to draw on, while also having work experience from industry or the public sector. Nevertheless, respondents did stress that scientific management is important in project implementation.

The importance attached to the choice of programme director cannot be stressed enough. Being a programme manager is a crucial function which is highly demanding. It requires an understanding and experience of the research world and good communication skills with both the academic world and stakeholders (society as well as industry). In addition, leadership skills are necessary for the creation of synergies, integration, collaboration and good steering in the programme. Sometimes these skills are put to the test when competition and/or tensions occur among the programme participants and users which risk hampering the development of the programme. In terms of the programmes we have found several examples where conflict management was required. This has not always been successful, sometimes due to weak management skills and sometimes due to other context-related issues.

The capacity to balance interests can also be observed in the programmes adopted in respect of industrial development (research and industrial interests), where we can clearly see tensions and conflicts of interest between researchers and the industrial interests for instance in respect of priorities. Another challenging situation emerges when two programme proposals are 'forced' to merge into a joint programme.

That the position of programme director is demanding is confirmed by the answers to the questionnaire and interviews. It is to be a half time position, primarily in order to not make the person dependent on only Mistra funding, and demands several skills. There are examples, for instance from *MARE* and *Mistra Fuel Cells*, where a dual leadership structure has been put in place with a scientific leader and an administrative and user-oriented leader. In our assessment, this kind of arrangement seems to have been quite successful.

As noted previously, diplomatic skills are needed from the management level as well as the ability to understand the different interests and agendas of the participants. Major efforts have thus been made by Mistra to coach the programme directors on these issues. With this in mind a 'handbook' has been developed²⁷.

Responsibility for managing the programme is not to be left to the programme director alone. A functioning dialogue between the programme management, including the executive committee and the programme director, and Mistra has proven to be important in handling the conflicts that have occurred in the evaluated programmes.

5.3 Financing

Most of the respondents underline the fact that the research would not have been conducted without funding from Mistra. At least not to that extent and with such a broad perspective; the alternative would, if at all, have resulted in smaller and more focused project.

²⁷ Nygren, S., 2007, *Sustained Leadership – Ideas about Managing a Mistra Programme* (Uthålligt ledarskap – en idéskrift att vara ledare i ett Mistraprogram) and *Driva forskningsprogram för en hållbar utveckling. Vad bör ni tänka på. Guide för verksamma i Mistraprogram.*

Attracting financing from several sources does not appear to have caused any major problems in terms of programme implementation. The major portion of the financing for the programmes has been from Mistra. There is one exception, namely, *Ways Ahead*, which was part-financed by six additional funders. Participants in this programme however perceived objectives to be unclear and project steering to being somewhat lacking primarily because it was influenced by the interests of all the various funders.

As stressed in section 3.2., the level of resources allocated to programmes is probably higher than that given in terms of the official reporting. For instance ‘in kind’ contributions may be higher than reported and is not included at all for some programmes. Remuneration levels for being a member of the executive committee have been rather modest.

We can also see in the minutes from the Mistra Board meetings that increased financing from other actors in the programmes has been encouraged, especially in relation to the approval of the second phase. This has also been a strategy to get other financiers committed and to ensure that the programme had the opportunity to continue after Mistra financing ended. It is however rather difficult to gauge how the programmes have actually followed up on this recommendation.

It is also important to stress that the ‘in kind’ contribution is also a means to ensure that the focus of the programme is of real relevance for the users, otherwise they cannot risk being engaged in the programme. Some of the researchers did however state that the companies would have been even more committed to the programme if they also actively co-financed the research.

5.4 Interdisciplinary approach

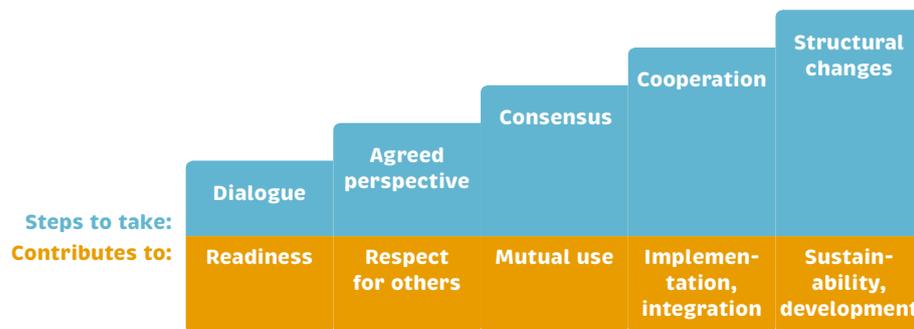
In respect of the interdisciplinary approach most of the respondents are positive and it is perceived by most of the participants to have been a prerequisite for addressing the research question and finding solutions to the identified problems.

The perception of how interdisciplinarity is understood varies. One way to interpret interdisciplinarity is that it entails joint and integrated work between disciplines. Another understanding may be that research is undertaken within a specific discipline or field but that the results are integrated into a synthesis. Interdisciplinarity may also be perceived as a situation where a joint research problem is identified and the research groups try to find ways to tackle them and eventually came up with a joint new solution.

Mistra’s interpretation of interdisciplinarity has not been very strict in terms of how it is to be understood and this may also be seen in the programmes. The point of departure seems to have been to find a solution to a challenge of importance for achieving a better living environment and that cooperation between disciplines will be needed for this. Exactly *how* this work is then undertaken has not however been specified. This is probably also related to the fact that the studied Mistra programmes have addressed rather varied environmental challenges, implying that the approach needs to be ‘tailor-made’ to the specific issue.

Most of the cooperation in the evaluated programmes appears to have been between closely related disciplines in the natural sciences. As noted previously the problem-orientated approach has implied that various competences and disciplines have been gathered in a programme in order to address a challenge/identified problems and find solutions. Among the interdisciplinary approaches described above we can clearly see an emphasis on the synthesis approach, especially in the final phase of the programme implementation. This is also connected to the fact that cooperation has, in the main, been ‘virtual’ between the participating institutions, implying that the division of labour and contributions seems to have been rather well defined.

FIGURE 5. Necessary steps for successful cooperation²⁸



Often we have seen that the PhD courses, for instance in relation to *MARE* and *FOOD 21*, have been a mechanism for successfully integrating parts of the programme, even if there are examples of the students enjoying and working well with interdisciplinary processes while the senior researchers do not.

In some programmes the interdisciplinary approach has been the cause of conflicts and tensions. Many examples of the challenges presented by working in an interdisciplinary manner are however provided. The methods, language and approaches used have all been very diverse. Seeing this through requires responsiveness, interest and good collaboration skills. As such, scientific quality and skills are not enough in the creation of good cooperation.

The cooperation process in *Mistra* programmes is clearly related to the stages that can be found in all sorts of cooperation processes. In figure 5 the necessary steps to successful cooperation are illustrated. The figure displays the fact that cooperation is a developing process and that participants and management must proceed in order to reach the next level and really achieve synergies. If cooperation is stymied at any one step, or if a step is by-passed, the risk that cooperation will fail increases.

For some programmes, for instance *ASTA*, *Marine Paint*, *MARE* and *Heureka*, we can see that the *Mistra* programme is based on an already existing process of cooperation that could be further developed in the *Mistra* programme. Cooperation in such cases had probably already passed along some of the steps outlined above which suggests that a flying start was more likely.

For other programmes, for instance *SUFOR*, *CLIPORE* and *SUCOZOMA*, this was the first time cooperation took place between the researchers while previous experiences of interdisciplinary cooperation among the programme participants have been limited. As such, the baseline for cooperation was very low.

We can also see that difficulties have emerged in relation to some programmes particularly in their attempts to achieve synergies between the participants because there was too much competition and this had not been addressed by the programme management.

5.5 User involvement

As with the interdisciplinary approach, user involvement is a significant characteristic of *Mistra* funded programmes. The interaction and cooperation between researchers and users is, according to most respondents, viewed as a prerequisite for implementing the programme. The programme management and executive board are more positive than researchers in general terms on this issue. For some programmes however it is also claimed that user involvement could have been more extensive.

²⁸ Adaptation of Arne Eriksson's discussion of cooperation in Statens Offentliga utredningar, 1998, SOU 1998:89, s 88ff.

User involvement has varied significantly between the different programmes. In general terms however actors from either the public or the private sector have been involved in the programme in addition to researchers.

User involvement has above all been manifested through their representation in the executive committee. This is also reflected in the fact that few users were defined as potential respondents to the questionnaire. Some programmes state that the users should rather be considered as stakeholders, while in others, such as *SUCOZOMA*, the user involvement – in this case fishermen – was crucial in the completion of this project.

User involvement has also been important in relation to the development of knowledge and products. A concrete example of this is *Greenchem*, where participation from the industry was very important in developing the knowledge and products that it would subsequently use. Nevertheless, it took almost the entire first phase of the project to understand each other. In respect of *Greenchem* they did also introduce so called *applied management groups* in order to focus cooperation between companies and researchers. In the case of *ProEnviro* the projects funded were built upon cooperation between small and medium-sized enterprises and research actors, the ‘user involvement’ here has thus been vital for successful implementation. Another example here is that of *Heureka* where it is stated that the user involvement model helped to develop the research questions and select the methods adopted.

The user value of the research is perceived differently both between the programmes and also *within* the individual programme depending on the function of the participant. Among the positive views, user-involvement has helped to generate knowledge of the demand and needs related to the themes that are addressed in the programme.

Just like any cooperation (see figure 5) time is required to start a dialogue and to gain an understanding of the programme, even if specific activities undertaken and organisational mechanisms put in place long-term funding nevertheless seems to be necessary.

In the evaluated programmes we can see that communication has been undertaken through traditional channels like publications (including popular science outlets) and conferences. Here users are shown how methods were developed in the programmes.

In the 20 years since Mistra began it has significantly evolved in terms of abilities and experience. The executive committee, for instance, now takes part in the initiation of the programme (see section above). In addition, the attitude to user opinions and specifically to their important role in the research process have changed from being rather sceptical of their worth to viewing them as a key resource in terms of programme implementation. This approach has also been adopted by other research funders which reinforces their significance and acceptance in the world of research.

The lack of time available on the users’ part however remains a significant challenge to their effective involvement. In the HagmarksMISTRA it is for instance noted that farmers do not have so much time to participate in cooperation projects.

5.6 Mistra’s added value

Mistra financing is considered to have been important in the implementation of the programme. As noted previously most of the research would simply not have been undertaken without it, and where research would have gone ahead it would likely have focused on highly specific projects or activities. Mistra funding has also helped to speed up various processes and ensure that activities could be up-scaled while additional elements were added. It is for instance noted that in order to assist in international negotiations (*ASTA*) long-term financing is needed and that the fund-

ing available from the Swedish Environmental Protection Agency would, in and of itself, not have been sufficient to finance the comprehensiveness that the Mistra programme allows.

The long-term nature of the financing and its scope are viewed as representing the most important 'value added' in respect of Mistra. But in relation to scope it is also stressed that there have been many researchers involved in some projects.

The members of the executive board have perhaps been seen to appreciate the notion and results of user involvement a little bit more than the other categories of programme participants. Nevertheless, in the questionnaire many comments suggested that it is the blend of Mistra characteristics that is important in respect of programme implementation; however it was only possible to select one option. It is also stated that long-term financing is also important in:

- ▶ addressing the complex issues addressed in Mistra programmes and in providing an environment where academic 'risks' can be taken and the inclusion of grand and challenging ideas is possible,
- ▶ establishing a functional working environment among the interdisciplinary environments in order to develop a common understanding thus enabling joint problem solving,
- ▶ involving users, which demands time in order to establish a functioning working procedure, especially in relation to cooperation between academic scientists and companies.

6. Conclusions and recommendations

The following chapter includes the main conclusions and recommendations of the evaluation based on the results produced. To recap, the aim of the evaluation was to explore the results and effects of 33 completed Mistra research programmes and evaluate the benefits of the investments made by the foundation. The evaluation's task is thus to contribute to a summing up of the results and effects of the financed research during the first 20 years of Mistra's existence and to provide a picture of whether, how and to what extent completed Mistra research programmes have generated their intended effects and impacts. We can conclude that 20 years is a rather long time-period, and besides the inherent difficulties associated with studying impacts and isolating effects, moreover, society has changed markedly during this period with the nature of the research community not remaining untouched. In terms of the notion of sustainability however this time span remains rather short. Below we seek to answer the evaluation questions initially posed while the chapter is concluded by providing some recommendations about how Mistra could proceed in the future with the operation and organisation of funded research.

6.1 Have the research programmes generated the results and impacts that could be expected when the approval of funding was made?

On an aggregated level we can conclude that most of the planned activities have been undertaken and that the objectives have been substantially achieved in the research programmes. However, due to the complexity of the problems addressed, the evaluation also illustrates that although objectives are achieved the actual effects can nevertheless be rather weak. There are many factors contributing to the notions of impacts and tangible effects and they have to interact in order to be fully optimised. Of course, the implementation and achievements, including results and impacts, vary between and within the rather heterogeneous programmes.

It is often claimed that research funding is in its nature connected with risk taking in terms of achieving the expected results; this may also be seen in Mistra programmes. However, programmes or individual projects within Mistra programmes that have not been proved to work have been terminated. Comments have been made that the finalisation of some of the programmes after only two phases was too soon, that is to say that even more could have been achieved if funding had been continued. This must however be viewed in light of the fact that Mistra as a funding organisation simply does not have the ability to provide continual and ongoing financing for any programme.

Most programmes have been able to successfully develop the notion of synthesis work: a difficult task when synthesising a vast number of sub-projects. We have however found examples where integration has not been so successful, implying that a series of individual projects rather than a comprehensive programme was the

actual reality here. This makes the synthesis work more challenging as compared to well-integrated projects where each contributes to the results or solutions produced. Regarding this aspect we see that the mode of organisation and operation has been important in generating the necessary conditions to achieve an impact. Integration is, moreover, generally seen to be facilitated in an intellectual sense by also being, in a more mundane sense physical.

We can also clearly see that some programmes seem to have been able to utilise a positive *momentum* to generate results and impacts, implying that they have been even better than initially anticipated. This momentum consists of context-related factors in combination with the programme's flexibility and its ability to respond to these changes. Timing is thus important, although this factor is rather difficult to foresee and control. An eight year long programme implies that many things might change in the programme context and in the surrounding society. This means that constant monitoring and flexibility are required in order to be able to adapt as far as possible to such changes. This also means that sometimes not much can be done about adaptation etc. However, environmental scanning, analyses and evaluations are some of the means that Mistra has applied in order to increase its chances of picking and creating 'winners'.

Timing is also important in relation to when to implement a specific thematic programme. Here a decision has to be made in terms of whether programmes addressing existing needs and issues are to be funded and whether the proposed research is able to address or contribute to solving a problem or meeting a need, which is expected to arise. The latter approach demands a good understanding of the issues at hand and that dialogue with a variety of actors is entered into in order to identify the relevant issues and research questions. Being located on the 'cutting edge' is also associated with higher risks in terms of the application of research results, since the surrounding society may simply currently lack the capacity to absorb the results.

6.2 Has Mistra invested money in a way that is in line with the statutes of the foundation?

In regards to this question we should first and foremost note that the purposes of Mistra are multifaceted. The activities undertaken and the programmes funded are designed to contribute to the development of a good living environment, the promotion of sustainable development and of strong research environments. Moreover, the programmes are to take advantage of industrial applications. In addition, a significant contribution to Sweden's future competitiveness is also expected to be made. Furthermore, an interdisciplinary approach as well as the notion of user involvement is to be applied in the implementation of the programme.

6.2.1 Development of strong research environments of the highest international standard which are important for Sweden's future competitiveness

In this respect Mistra has undoubtedly proved to be an important source of knowledge. The main output of the programmes has been the generation and development of new knowledge within the various research fields. Some programmes have developed knowledge in rather novel fields while others have pursued further development in already established research fields.

The implementation of the programmes has contributed to the development of substantial progress within certain research field sometimes manifested in the establishment of centres of competence and excellence. However, the 'virtual' research environments established in this context do not seem to be able to remain in being after the finalisation of the programme. Clearly then there is a risk that the outcome of the investments is not fully maximised since the potential for the on-

going development of the research initially undertaken in a Mistra context seems to be rather limited given the nature of the Swedish research funding system. Few other funding bodies for instance take on such long-term programmes. This means that the opportunities for the continuation of such 'virtual' environments remain limited. Research funding for spin-off projects have been granted but additional financing for a comprehensive continuation of the work has been so only in rare cases. Although Mistra has been clear from the outset that funding is only granted for a limited time the lack of continued comprehensive funding undoubtedly entails the risk that competences could be lost along with the benefits generated by the money already invested.

6.2.2 Take advantage of opportunities to generate industrial applications and contribute to Sweden's future competitiveness

The programmes have resulted in the development of products and processes, primarily in those orientated towards industrial application but also in other programmes. Some have already been launched while others are in the pipeline waiting to be launched. Even if the commercialisation aspect remains rather weak, it should nevertheless be stressed that most programmes have, based on the knowledge generated, developed concrete products (goods and services) and processes, which are already in use or are about to be adapted for use by private or public actors. We assess that this application contributes to the development of a more sustainable society, which in itself is a 'process'. Regarding this aspect it may however be concluded that it takes time to generate and develop knowledge that can be further developed into concrete products. Product development processes also often demand additional financing and expertise.

Since it takes time to take advantage of the opportunities available to successfully generate industrial applications there is a significant risk that such processes will be significantly hampered by the abrupt ending of funding. In addition there is also a need to consider which stages of the development process public funding is to support and at what stage private money may be needed in order to drive the commercialisation process further. Since the opportunities for public funding for very early phases of commercialisation in Sweden are limited Mistra potentially has a role to play here.

6.2.3 Other results and impacts

In terms of the added-value of participating in a Mistra programme many of the respondents stated that participation has given them a better understanding of the processes involved and how different actors work. In an ever more complex society this is a factor of increasing importance. Gaining such insights undoubtedly enhance the opportunities for collaboration and perhaps facilitate the seeking of broader solutions in other contexts.

Participants in Mistra programmes have also increasingly come to better appreciate and more clearly understand their role in this context, particularly in the context of finding solutions to defined problems. Increasing awareness, both in industry and in the academic sector as well as across the public sector more generally, that problems can perhaps be solved more easily by addressing them together, points to the increasing opportunities available for a rather more holistic approach to be used in addressing environmental issues. Indeed, the application of a holistic perspective is in itself a key component of any attempt to promote sustainable development work.

It is also clear that the programmes have generated more cooperation between actors and that this cooperation has, to some extent, continued in spin-off projects after the programme ended.

6.2.4 Contribute to a good living environment and find solutions to important environmental problems while promoting the sustainable development of society

Mistra has not defined the concept a good living environment. The advantage is that many themes and issues have been and may continue to be addressed by Mistra programmes and that it is easy to include novel issues. A disadvantage is however that it is difficult to measure results and impact-related issues.

Nevertheless, many of the programmes have addressed major environmental challenges. For instance, the programmes have contributed to fulfilling the environmental objectives adopted by the Swedish parliament as well as important global environmental challenges such as climate issues. In terms of the climate issue the *SWECLIM* programmes in particular seems to have been undertaken at an opportune moment when there was a high and increasing demand for the knowledge and products that were developed in the programme. Moreover, specific environmental issues connected to Swedish context such as forestry (*SUFOR*) and mining (*MiMi*) may also be observed here. Transnational issues of importance for the sea environment (*Marine Paint* and *MARE*) can also be seen. The industrially-orientated programmes that have been implemented, for instance *KAM*, *Mistra Fuel Cells*, *Black Liquor Gasification*, *PERSEA*, *MAaf/MASE*, and *DOM* have all focused on finding solutions to rather specific problems, but the overarching objective has been that the solution found should contribute to improving the environment.

In sum, it is not reasonable to expect any Mistra programme to solve all environmental problems. Nevertheless, the programmes have made important contributions to finding solutions to the development of a sustainable society and have thus contributed to the development of a good living environment by, for instance, ensuring that the developed knowledge is further integrated into processes of legislation, negotiations and the development of new standards and practices as well as product development.

In our assessment, one of the great benefits of the implemented programmes is not only finding a solution to an identified environmental problem but also aiming to promote and develop cooperation between actors across society. The programmes, being large and extensive, thus contribute to the promotion of a more holistic perspective – in line with the general concept of sustainability.

Moreover, although the evaluated Mistra programmes have not directly solved environmental problems, the programmes have nevertheless contributed indirectly to problem solving by developing new knowledge. In this context the impact of Mistra's funding does fulfil the §3 of the statues and in so doing also contributes to achieving the §1. The attainment of Mistra's stated purposes is thus ultimately dependent on how processes, activities and modes of organisation are managed within the individual programmes and indeed within Mistra itself.

6.3 Identification of success and risk factors in relation to Mistra's mode of operation and organisation of the research programmes

Below we address the risk and success factors that have arisen during the evaluation.

The different demands on a Mistra programme, for instance, user involvement and the interdisciplinary approach increase the risk of tensions arising between different participants. If tensions are managed wisely they can however contribute to synergies and creativity, but if they are mismanaged they will hamper the participant's ability to attain the specific objectives of the programme and in the long run prove detrimental to the overall purposes of Mistra.

Interdisciplinarity represents both a risk and a success factor depending on how it is managed and conducted. It represents a primary tool in addressing the complex issues the programmes are set out to approach. But it is often a source of frustration when the cooperation is not seen to be functioning properly and thus the desired synergies are not achieved. This points to two things: a need to defining how interdisciplinarity is to be perceived in the specific programme when the programme is initiated, and secondly, the need to engage skilled participants, not only scientifically, but also in terms of collaborating skills.

User involvement has also been a challenge for some of the evaluated programmes. Based on the particular evaluation tensions can often be identified between research and commercialisation interests, which may have different agendas for participating in a programme. Conflicts can also be preserved between researchers with different agendas and between researchers and the programme manager. In the conflicts between researchers we underline the significance not only of attracting the right competence, but also of the need for individuals that are open to collaboration, implying that they are responsive, solution-oriented and open to different perspectives. Regarding tensions between programme managers and researchers, the significance of choosing an appropriate programme manager cannot be emphasised enough.

However, **the involvement of companies** in the programmes is a success factor in generating relevant knowledge of use in their product development. Knowledge developed together with users is more rapidly absorbed and incorporated into production processes and is a good example of the benefits of user driven development.

The **involvement of actors from the public sector** enhances the likelihood that the knowledge is applied, for instance that the developed models, tools, processes etc., are utilised. Users have not however been fully integrated in the implementation of some programmes. Nevertheless, both explicit and implicit input into policy and decision making processes can clearly be seen while the programmes have undoubtedly provided actors in the public sector with the appropriate knowledge.

A clear success factor is thus the creation of a **dedicated programme management structure**, including a committed executive committee and programme director which together ensure a common understanding (and prioritisation) of the programme direction. The main contractor is also an important actor in providing academic as well as administrative support to the programme. This evaluation has however also discovered a number of examples of rather unsupportive hosts, who have influenced the programmes' negatively, particularly in respect of the creation of a non-functioning administrative system. More recent programmes seem not however to have encountered as many problems as the earlier ones.

The organisation of the programmes may be perceived as constituting a large overhead. Nevertheless, most participants eventually come to appreciate – though often in retrospect – the key role played by the programme organisational structure. It is clear however that such large programmes incorporating so many different actors require a more solid organisational footing than do shorter and more focused research programmes.

Mistra's role, as a supportive but not decisive actor, also undoubtedly contributes to the generally perceived well-managed nature of the programme. More concretely this general reticence towards becoming involved in the 'details' of a programme while making it clear to the participants that it is always prepared to support the programme management if tensions and conflicts appear that cannot be solved by the programme management team alone.

Despite the rather well defined nature of the organisation and operation of Mistra programmes, another success factor is that there is nevertheless a certain amount of *flexibility in terms of amendments* built in to any Mistra programme. This is necessary since the programmes are rather long term and conditions influencing the focus of the programme often change during the implementation period thus potentially having a significant influence on programme direction.

Long-term financing is essential for implementing a Mistra programme due to the character of the programmes and the complex nature of the issues addressed. The environmental issues and problems addressed have been extensive and thus have demanded a comprehensive approach which simply cannot be handled in small and tightly delimited projects.

6.4 Recommendations

Based on our conclusions and analysis the following recommendations, more or less relating to the programme life-cycle, on the future mode of operation and organisation of the research programmes can be made.

6.4.1 Financing

Mistra is currently a rather small player in the field of research funding in terms of yearly funding totals. Nevertheless it continues to offer an interesting approach to the addressing of environmental issues due to its continuing emphasis on, and encouragement of, an interdisciplinary approach and user involvement. Other research financiers now also apply these approaches, but the long-term financing and orientation focus towards problem solving remains unique. We can also conclude that the complex issues addressed, as well as the interdisciplinary approach and user involvement applied, demand long-term financing, since it takes time to develop this kind of collaboration and there are few short cuts available in the successful establishment of fruitful cooperation in this field.

In the evaluated programme there are numerous examples of activities that have attracted co-funding from other financiers. Except perhaps for one programme we find no evidence that this has caused any major problems for programme implementation. Consequently, Mistra should in future consider the pooling of resources with other financiers in order to create the necessary critical mass which will more easily produce the synergies while also avoiding duplication. Related to this, more commercial co-financing with a view to enhancing the level of commitment may also be considered.

Long-term financing may however be combined with financing for minor and short-term programmes in terms of number of participants of 'seed-money' character in order to allow for more focused and perhaps also more 'risky' projects. Risky programmes may be understood as programmes addressing cutting-edge issues, where questions over the relevance of the objectives arise, where there is involvement from actors not used to interdisciplinary collaboration or where user involvement is an important factor etc. The relevance of objectives is related to the identified environmental issues in combination with the programme's strategy to tackle these as well as other activities in the surrounding world addressing the issue. However, the funding of minor programmes demands more staff resources. Thus far Mistra has however functioned with a rather limited overall staff component.

The financing of a continuation of the programme may also be further developed. Here we see that rather large investments in the development of competence and knowledge may simply be lost within a couple of years since there is often a lack of funding opportunities for a continuation. Mistra should for instance consider increasing the responsibility of the main contractor to gradually finance a larger share of the final phase of the programme. In addition, the establishment and fund-

ing of physical environments may be one means to ensuring that a continuation of the research takes place, since it encourages the development of joint research applications during the implementation of the programme. Again co-financing could be one way of enhancing the chances for a continuation.

The financing of physical environments or of 'virtual' cooperation is also an aspect that Mistra should consider in the further financing of research programmes. Of course it is a risk to establish or support new physical research environments, but the employment of researchers for fixed positions contributes to the reality that these people apply for research funding and in most cases this implies a self-reinforcing process and thus contributes to a continuation of research projects. Shared positions between the physical environment and another institution are also an option.

In terms of maximising the benefit of the invested money, mention should also be made here of product development and innovation. Here we see a risk that products developed in the programmes are stuck in the pre-commercialisation pipeline and do not reach the market in a timely manner if at all. Mistra should consider how the programmes could be better connected to other support schemes provided by public actors, perhaps providing support for product and business development, for instance in respect of incubators.

Recommendations concerning financing: Mistra should

- ▶ Consider co-financing, where this is possible, to achieve synergies and avoid duplication. Co-financing also increases the chances for the wider dissemination of the generated knowledge through the networks and dissemination channels of the other financiers. This calls for well-defined joint goals to be agreed which lay out a unanimous foundation for the programme.
- ▶ Continue the long-term funding of programmes in order to address issues which demand a more holistic contribution or solution and in which a fruitful interdisciplinary collaboration is given a chance to develop.
- ▶ Establish a dialogue with the main contractor in order to establish prerequisites and enhance the possibilities for a continuation.
- ▶ Consider funding of the physical research environment in order to ensure that the generated knowledge and competences are further developed after the finalisation of the programme.
- ▶ Support opportunities for product commercialisation, application and business development by providing contacts with relevant private and public actors.
- ▶ Consider providing extra funds earmarked for commercialisation. One of the purposes of the foundation is "to take advantage of industrial application" and since the opportunities for public funding in respect of the very early commercialisation phase are few and far between in Sweden Mistra potentially has a role to play here.

6.4.2 Thematic orientation and initiation of programmes

In terms of the thematic orientation of future Mistra programmes, the major environmental challenges such as climate change, clean air, marine eutrophication etc., remain. To combine open thematic calls with a more 'blue sky' approach may be wise in order to ensure the continuing existence of both bottom-up and top-down perspectives. It is of course a challenge to define the open thematic calls such that they are specific enough but do not neuter creativity and inclusion of unexpected aspects. Here innovation procurement may be used as something of a role model, aiming at identifying a problem that needs a solution instead of stating from the outset how the solution should look. The identification of potential themes should

be made in dialogue between Mistra, potential users and researchers. It is also important that the application process is transparent.

Based on the experiences reported in some of the evaluated programmes we also strongly recommend that Mistra avoids the forced merger of proposals. Inviting research groups to jointly develop programme proposals in order to achieve a critical mass is one thing but cooperation *must* be voluntary.

A researcher in a Mistra programme is above all expected to deliver research of a high scientific quality. Participation however also demands cooperation skills, interest in societal development, responsiveness and solution orientation etc. In addition, participation does not seem to be of explicit benefit for (academic) careers. The opportunities for, and understanding of, interdisciplinary and user-orientated research have undoubtedly however been enhanced in recent years. However, participation in a Mistra programme is not yet perceived to be of benefit for an academic career, which suggests Mistra programmes are more suitable for senior researchers who have already reached a certain level in their career and thus already hold a position where further career development is not crucial. Instead other ambitions are to be fulfilled by their participation, for instance interest in questions adjacent to their own research field. This also implies that Mistra researchers need to possess qualifications other than just being top ranked scientifically.

Recommendations concerning the thematic orientation and initiation of programmes: Mistra should

- ▶ Combine open thematic calls with a more ‘blue sky’ approach, both approaches require a dialogue with researchers and experts as well as the users.
- ▶ Consider whether a more ‘risky’ cutting-edge approach is desired while also positioning Mistra more clearly as a research funder. This approach is dependent on extensive intelligence in order to be successful.
- ▶ Avoid forced mergers between researcher teams in the development of programme proposals or in implementing programmes.
- ▶ Be clear on the types of qualifications required in respect of participating researchers, focusing on both academic and ‘soft’ skills.

6.4.3 Mode of organisation and operation

We have clearly identified an atmosphere of creativity in some programmes. Mistra may not however be in the best position to explicitly enhance this, but might very well be able to support and create the prerequisites for it to occur. Essential supporting factors here then are the mix of competences in the programme, both as participants and as management and board members. Mistra could also take on the role of ensuring the fulfilment of demands as well as that of the primary supportive and encouraging actor.

There is also a clear need for a more coherent *final* reporting system when the programmes are finalised. Even if having an extensive reporting system is not a primary requirement of success in itself the requirement to have a relevant accounting system as well as the timely reporting of activities and results must be met in the context of final reporting. In order to assess the conducted programmes and evaluate the investments a consistent final reporting system is a necessity. Due to the heterogeneous character of the programmes however the final reporting may be not fully standardised. Nevertheless, it should be a fairly straightforward task to draw up a set of key factors relevant to Mistra-specific conditions. Perhaps a common template with ‘how’ and ‘what’ questions where the programmes may have options to state ‘not applicable’ would be a solution here. A common template would also ensure better conditions for future evaluation processes. The reporting of ‘in-kind’ contribution should also be further developed.

Greater process support may also be considered as one way to better facilitate the programme management. The executive committee and programme director each play an important role here in balancing the various interests potentially involved in a Mistra-programme. Indeed, as the role of the programme director is crucial in this task and in relation to achieving both programme integration and synergies, direct support may be needed. The programme manager has to lead the scientific work, have administrative skills, manage a dialogue with users of various kinds and preferably translate and transfer the scientific results into a language that is comprehensible to the users. In this light then Mistra would do well to consider implementing a dual leadership process for the handling of the complex current role of programme director. This process support may also be important in ensuring the involvement and inclusion of end-users which is also something that Mistra must continue working on and follow up continuously. In addition this process support may contribute to speeding up the process of programme integration and also that of the various researchers and users involved.

We can also see that the timing of the evaluation of the individual programmes is something that the respondents have commented upon. As noted previously it is important to follow the development process through the different stages of a programme. However, the midterm evaluation of the first phase seems to come too early to effectively measure any realistic results. Here on-going/process evaluation may be considered as an alternative in order to ensure that the evaluation is viewed as something that actually helps to improve the quality of programme implementation rather than merely an inadequate and time-consuming attempt to take a snap-shot measure of early and not particularly relevant results. A process evaluation approach is also a good means to ensure that the conflicts of interest – in terms of different agendas and priorities between the various participants – which seem inevitably to be embedded in any Mistra programme, are revealed and managed early in the implementation process.

The scientific review should be made in a scientifically endorsed and accepted manner. In addition, the user evaluation process should be further developed, be made more acceptable to the participants and, above all, be rendered more even in quality. A first step here can be made by benchmarking with other funders how these kinds of evaluations are best undertaken.

Further discussion is also needed here on whether it is good enough for Mistra to create prerequisites such as the research infrastructure, knowledge development, coordination, networks, training etc., alone rather than aiming to actually solve environmental issues in a more direct way. This discussion will be about which of the statutes, §1 or §3, Mistra want to emphasise and whether, in this light, the funding is to be directed differently.

A further concrete recommendation is the need to settle intellectual property rights (IPR) *before* the programme begins. This is an important step in ensuring that good ideas are included in programmes. If benefit will not be made from providing the programme with the best ideas there is a risk that such ideas will simply not be included. This support could be provided by Mistra by, for instance, offering legal counselling.

Recommendations concerning the mode of organisation and operation: Mistra should

- ▶ Apply tools such as environmental scanning, analyses and evaluations in order to increase the chances of “picking and creating winners”.
- ▶ Consider its role in both ensuring that the demands are fulfilled and providing active support to the programme implementation in relation to the creation of “winners”. How can Mistra support, and bring energy to, the programme when needed?

- ▶ Assure the appointment of a suitable programme director possessing excellent leadership skills, an understanding and experience of research and good communication skills with both the academic world and the stakeholders (society as well as industry).
- ▶ Support programmes to help settle the IPR and confidential agreements before the programme begins.
- ▶ Consider providing greater process support to assist the programme management.
- ▶ Further develop the user evaluation process in order to gain greater acceptance from researchers and attain a more even quality by, for instance, investigating how other financiers work with these kinds of evaluation processes.
- ▶ Develop the evaluations further and consider 'on-going evaluation' as a support to the programme management.
- ▶ Develop and design a more coherent final reporting system in order to enhance the opportunities for comparison and the transparency of the programme results produced.
- ▶ Consider and discuss whether it is good enough to create prerequisites such as research infrastructure, coordination, networks, training etc., rather than aiming to actually solve environmental problems in a more direct way.

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7.3 Interviews²⁹

7.3.1 Mistra Board

Rolf Annerberg, General Director, Swedish Environmental Protection Agency, from 1999 kabinettschef EU Commission (chairman 1997–1999), 20 November, 2012.

Charlotte Brogren, Research Director ABB, (member 2004–2009), 22 November 2012.

Ingmar Grenthe, professor the Royal Institute of Technology (chairman 1994–1996), 26 November, 2012.

Sverker Sörlin, professor Umeå University, Director SISTER (member 2000–2005), 26 November 2012.

Lena Torell, professor, Chalmers University of Technology, EU Commission – JRC, CEO Kungl. Ingenjörsvetenskapsakademien (member 1994–1997 and 2000–2004, chairman 2007–), 15 November 2012.

7.3.2 Mistra staff

Britt-Marie Bertilsson, Programmes Director 1995–2011, 3 April 2012.

Lars-Erik Liljelund, board member 2000–2006, General Director, Swedish Environmental Protection Agency; CEO 2010–), 2 April 2012.

Måns Lönnroth, CEO, 1999–2005, 2 April 2012.

Jan Nilsson, Programmes Director 1994–2002, 3 April 2012.

Olof Olsson, Programmes Director 2003–2007, 3 April 2012.

Göran A. Persson, CEO 1994–1999, 2 April 2012.

Marie Uhrwing, Programmes Director 2001–2007, 3 April 2012.

²⁹ The affiliation refers to the position the interviewee had during the period in which the person was either a member of the board or employed by Mistra.

Annex 1. Selection criteria for a deeper study of some programmes

The criteria for the selection of the programmes that were to be more deeply analysed are related to parameters that Mistra can, in one way or another, influence in the financing of future programmes, for instance co-financing, concentration/diffusion of financing to participants, international participation. The following criteria have been used as a foundation for the selection:

	Selection criteria	Motivation
1	Industrial application	Mistra's purpose
2	Strong research environment	Mistra's purpose
3	Environmental development/impact	Mistra's purpose
4	Cooperation	Mistra's mode of operation/organisation, different types of cooperation
5	Start year	How programme design and cooperation have changed during implementation and the influence on impacts.
6	Short/long term programme	Identify risk and success factors in relation to Mistra's mode of operation/organisation.
7	Size (number of participating organisations)	Identify risk and success factors in relation to Mistra's mode of operation/organisation. Different types of cooperation.
8	Co-financing	Identify risk and success factors in relation to Mistra's mode of operation/organisation. Different financing models.
9	Type of main contractor	Identify risk and success factors in relation to Mistra's mode of operation/organisation. Different types of cooperation.

Mistra's purpose

Environmental development/impact

- ▶ The research produced has had a substantial strategic impact in terms of achieving a good living environment.
- ▶ The research has had a substantial impact on solving major environmental challenges and sustainable development.

Strong research environments

- ▶ The research has fostered the development of strong research environments, for instance centres of excellence, spin-off research programmes, etc.

Industrial application

- ▶ The research has had an impact in terms of Sweden's competitiveness.
- ▶ The programme has taken advantage of the opportunities for industrial application.

Mistra's mode of operation and organisation

- ▶ Long- or short term programmes.
- ▶ Different start years in order to see whether and how Mistra's mode of organisation and operation has changed over time.
- ▶ Size, especially in terms of large or small programmes and financing or numbers of participating actors.
- ▶ Shared financing between Mistra and other actors, for instance industry, the university sector or other public authorities.
- ▶ Cooperation with the surrounding society, for instance industry and the public sector, between researchers and including international participation.
- ▶ Type or main contractor, for instance higher education institutions, research institutes, public authorities.

The following five programmes were selected for deeper investigation with interviews conducted with the programme management, members of the board, researchers and users. The criteria for each programme were based on the programme portfolio, document studies (scientific and user reviews, Mistra board decisions, final reports) and the questionnaire. All programmes address selection criteria 5 and 9.

Programme	Criteria	Time period, financing*, number of participating actors**
Mistra Fuel Cells	1,2,3,5,6,8	1997–2010
		Average in financing (industry has co-financed)
		7 participating actors
		Main contractor: Royal Institute of Technology
Greenchem	1,4,5,9	2003–2010
		Average in financing
		1 participating actor
		Main contractor: Lund University
CLIPORE	1,2,3,4,5,7,9	2004–2011
		> Average in financing
		9 participating actors
		Main contractor: IVL
SUFOR	4,5,9	1996–2004
		> Average in financing
		4 participating actors
		Main contractor: Lund University (phase 1) SLU (Alnarp) (phase 2)
MARE	2,3,4	1999–2006
		Average in financing
		8 participating actors
		Main contractor: Stockholm University

* Mistra financing has been assessed whether the programme has received more, less or around the average yearly Mistra funding.

** Actors that have received Mistra funding

Annex 2. Questionnaire

Version distributed to programme directors, members of the executive committee and programme participants.

1. a) Please, check the box for the Mistra programme(s) you have been in contact with?
- b) Please, also indicate your relationship to the programme. (list of completed and on-going programmes)

2. Please, indicate what completed programme (**only 1 one is possible**) that you will refer to when you answer the following questions in the questionnaire. (list of completed programmes)

3. What sector did you work in before you were engaged in the programme? (select all alternatives that apply)

University/higher education institutions	<input type="checkbox"/> Please, specify
Research institute	<input type="checkbox"/> Please, specify
Public administration	<input type="checkbox"/> Please, specify
Private sector	<input type="checkbox"/>
Voluntary/charity/third sector	<input type="checkbox"/>
Other	<input type="checkbox"/> Please, specify

4. What sector do you work in today? (select all alternatives that apply)

University / higher education institutions	<input type="checkbox"/> Please, specify
Research institute	<input type="checkbox"/> Please, specify
Public administration	<input type="checkbox"/> Please, specify
Private sector	<input type="checkbox"/> Please, specify
Voluntary/charity/third sector	<input type="checkbox"/> Please, specify
Other	<input type="checkbox"/> Please, specify

5. What was your highest academic degree at the time you started your engagement in the programme (Associate's, Bachelor's, Master's, Doctoral degree, etc.?)
6. What is your highest academic degree today? (Associate's, Bachelor's, Master's, Doctoral degree, etc.?)
7. What was your occupation before you were engaged in the programme? (select all alternatives that apply)

8. What is your current occupation? (select all alternatives that apply)

9. Please, check the box for each statement to show how much you agree or disagree with it.

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
a) Long term financing from Mistra was a prerequisite for the implementation of the programme.	<input type="checkbox"/>				
b) Spanning disciplinary boundaries was a prerequisite to approaching the research questions of the programme.	<input type="checkbox"/>				
c) User involvement was a prerequisite for addressing the research question(s) of the programme.	<input type="checkbox"/>				
d) The organisation of the programme, with a main contractor, programme management and a programme board contributed to the better implementation of the programme.	<input type="checkbox"/>				
e) Mistra's management of the programme definitely contributed to the better implementation of the programme.	<input type="checkbox"/>				

Please, comment on your answers: _____

10. Please, check the box for each statement to show how much you agree or disagree with it.

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
a) All planned programme activities could be implemented according to the programme plan.	<input type="checkbox"/>				
b) All together the programme achieved its objectives.	<input type="checkbox"/>				
c) The programme has contributed considerably to the identified research problems.	<input type="checkbox"/>				

Please, comment on your answers: _____

11. Please, check the box for each statement to show how much you agree or disagree with it I estimate that the programme has contributed, or will, contribute to

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
a) ...Reduced Climate Impact (stabilisation of concentrations of greenhouse gases)	<input type="checkbox"/>				
b) ...Clean Air (decreased emissions of sulphur dioxide, nitrogen dioxide, tropospheric ozone, etc)	<input type="checkbox"/>				
c) ...Natural Acidification Only (decreased emissions of sulphur and nitrogen influencing land and water)	<input type="checkbox"/>				
d) ...A Non-Toxic Environment (decreased emissions of metals and other substances that have a negative impact on human beings and biological diversity)	<input type="checkbox"/>				
e) ...A Protective Ozone Layer (decreased emissions of ozone reducing substances)	<input type="checkbox"/>				
f) ...A Safe Radiation Environment (increased protection towards radiation from radioactive substances)	<input type="checkbox"/>				
g) ...Zero Eutrophication Nutrient levels in soil and water (decreased emission of nitrogen and phosphorous)	<input type="checkbox"/>				
h) ...Flourishing Lakes and Streams (lakes and watercourses must be ecologically sustainable and their variety of habitats must be preserved)	<input type="checkbox"/>				
i) ... Good-Quality Groundwater (use of land and water that do not imply negative consequences on the ground water)	<input type="checkbox"/>				
j) ...A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos (decreased noise from shipping and protection of endangered species)	<input type="checkbox"/>				
k) ...Thriving Wetlands (protection of endangered species)	<input type="checkbox"/>				
l) ...Sustainable Forests and protection of endangered species	<input type="checkbox"/>				
m) ...A Varied Agricultural Landscape (protection of the farmed landscape and preservation of biological diversity)	<input type="checkbox"/>				
n) ...A Magnificent Mountain Landscape (decreased damages on land caused by human activities and protection of biological diversity)	<input type="checkbox"/>				

CONTINUED ON NEXT PAGE ►

o) ...A Good Built Environment (Protection of cultural assets. Cities, towns and other built-up areas must provide a good, healthy living environment. Human beings must not be exposed to air pollution, noise or radon)	<input type="checkbox"/>				
p) ...A Rich Diversity of Plant and Animal Life (protection of biological diversity)	<input type="checkbox"/>				

Please, comment on your answers: _____

12. Please, check the box for each statement to show how much you agree or disagree with it. The programme has ...

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
a) ... contributed to publications of articles in peer-reviewed journals with a high impact factor.	<input type="checkbox"/>				
b) ... resulted in a great number of Doctoral Thesis / Licentiate Thesis.	<input type="checkbox"/>				
c) ... substantially contributed to the development of already existing research environments.	<input type="checkbox"/>				
d) ... contributed to the establishment of completely new research environments.	<input type="checkbox"/>				
e) ... contributed to the development of contacts between researchers belonging to different disciplines.	<input type="checkbox"/>				
f) ... contributed to the development of contacts between researchers orientated towards basic research and researchers orientated towards applied research within the same discipline.	<input type="checkbox"/>				

Please, comment on your answers: _____

13. Has the programme resulted in new research programmes / projects within the same or neighbouring themes?

Yes <input type="checkbox"/>	No <input type="checkbox"/>
If yes, please specify the research financier(s)	

Please, comment on your answers: _____

14. Has the programme resulted in new education programme(s) / course(s)?

Yes <input type="checkbox"/>	No <input type="checkbox"/>
------------------------------	-----------------------------

Please, comment on your answers: _____

15. Has the programme resulted in non-commercial spin-offs such as (research centres, institutes, networks etc.)?

Yes	<input type="checkbox"/> If yes, please specify,
	How many?
	Type of spin-off?
	The name of the spin-off
No	<input type="checkbox"/>

Please, comment on your answers: _____

16. Please, check the box for each statement related to the interdisciplinary approach to show how much you agree or disagree with it.

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
a) We have worked in an interdisciplinary fashion in the programme.	<input type="checkbox"/>				
b) The interdisciplinary approach has resulted in a new type of research questions.	<input type="checkbox"/>				
c) The interdisciplinary approach has implied that we have used methods from other disciplines.	<input type="checkbox"/>				
d) The interdisciplinary approach has enriched our own research.	<input type="checkbox"/>				
e) We have succeeded in creating a common analytical framework and language.	<input type="checkbox"/>				
f) We have enjoyed good access to joint meeting places within the programme.	<input type="checkbox"/>				

Please, comment on your answers: _____

17. Please, check the box for each statement related to the user involvement to show how much you agree or disagree with it.

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
a) We have had strong contacts with users in the programme.	<input type="checkbox"/>				
b) The user involvement has contributed to the development of contacts between researchers and decision-makers / civil servants in the public sector.	<input type="checkbox"/>				
c) The user involvement has contributed to the development of contacts between researchers and decision-makers / officials in the private sector.	<input type="checkbox"/>				
d) The user involvement has resulted in a new type of research question.	<input type="checkbox"/>				
e) The user involvement has enriched our research.	<input type="checkbox"/>				

Please, comment on your answers: _____

18. Has the programme resulted in patents?

Yes	<input type="checkbox"/> If yes, please specify how many
No	<input type="checkbox"/>

Please, comment on your answers: _____

19. Has the programme resulted in the registration of substances?

Yes	<input type="checkbox"/> If yes, please specify how many
No	<input type="checkbox"/>

Please, comment on your answers: _____

20. Has the programme resulted in the development of a demonstrator / prototype?

Yes	<input type="checkbox"/> If yes, please specify how many
No	<input type="checkbox"/>

Please, comment on your answers: _____

21. Has the programme resulted in commercial spin-offs, for instance companies?

Yes	<input type="checkbox"/> If yes, please specify,
	Which ones?
	How many employees does the spin-off(s) have today?
	What was the turnover of the spin-off(s) last year?
No	<input type="checkbox"/>

Please, comment on your answers: _____

22. Has the programme resulted in substantially improved goods, services and / or processes which have been launched on the market?

Yes	<input type="checkbox"/> Goods, please specify,
	<input type="checkbox"/> Service, please specify,
	<input type="checkbox"/> Process, please specify,
No	<input type="checkbox"/>

Please, comment on your answer. If yes, how were the goods / services / processes launched? If no, why have such goods, services or processes not been launched on the market?

23. In what way(s) have the programme results mainly been disseminated?

Research network or research cooperation partners	<input type="checkbox"/>
Publications	<input type="checkbox"/>
Conference participation	<input type="checkbox"/>
Recommendations, counselling	<input type="checkbox"/>
Cooperation with companies	<input type="checkbox"/>
Cooperation with the public sector	<input type="checkbox"/>
Specific dissemination and information activities	<input type="checkbox"/>
Education	<input type="checkbox"/>
Other	<input type="checkbox"/> Please specify

Please, comment on your answers: _____

24. Please, check the box for each statement related to the strategic impact of the programme to show how much you agree or disagree with it.

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
a) The programme has promoted the development of strong research environments.	<input type="checkbox"/>				
b) The programme has had an impact on Sweden's competitiveness.	<input type="checkbox"/>				
c) The programme has been important for solving important environmental problems and for achieving an environmental friendly development of the society.	<input type="checkbox"/>				
d) The opportunities for industrial application have been utilised in the programme.	<input type="checkbox"/>				

Please, comment on your answers: _____

25. Please, check the box for the statement to show how much you agree or disagree with it.

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
The programme has contributed to substantial progress being made in the field of research.	<input type="checkbox"/>				

Please, comment on your answers: _____

26. With some year(s) of perspective behind you, what do you think is the most important output of the programme? If several, please rank them.

27. With some year(s) of perspective behind you, what do you think is the most important impact of the programme? If several, please rank them.

28. The way I perceive the outputs and impacts of the programme ...

...has changed in a positive direction after the completion of the programme	<input type="checkbox"/>
...has changed in a negative direction after the completion of the programme	<input type="checkbox"/>
... is very much the same today as when the programme was completed.	<input type="checkbox"/>

Please, comment on your answers: _____

29. Please, check the box for the statement to show how much you agree or disagree with it.

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
Participation in the programme has directly benefited my career.	<input type="checkbox"/>				

Please, comment on your answers: _____

30. Please, check the box for the statement to show how much you agree or disagree with it.

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
The research would have been undertaken without financing from Mistra.	<input type="checkbox"/>				

Please, comment on your answers: _____

31. What is Mistra’s most important added-value / strength compared to other research financiers financing strategic environmental research? Please, select only 1 (one) alternative!

Time span of financing	<input type="checkbox"/>
Scope of financing	<input type="checkbox"/>
The programme management and organisation	<input type="checkbox"/>
Requirement for an interdisciplinary approach	<input type="checkbox"/>
Requirement for user involvement	<input type="checkbox"/>
Other,	<input type="checkbox"/> Please, specify
Do not know	<input type="checkbox"/>

Please, comment on your answers: _____

- 32.** Would you have preferred that Mistra’s management of the programme had been more or less extensive than it actually was?

5 More extensive	4	3	2	1 Less extensive	Do not know
<input type="checkbox"/>					

Please, comment on your answers: _____

- 33.** a) Please, check the box for the statement to show how much you agree or disagree with it.

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
According to my assessment it is reasonable to assume that the programme results will contribute to a good living environment.	<input type="checkbox"/>				

- b) “A good living” environment can be understood in many ways, how has the concept been perceived in the programme?

- c) Please, give some concrete examples of how the programme results have contributed to achieving “a good living environment”.

- 34.** Please, check the box for the statement to show how much you agree or disagree with it.

	Strongly agree	Agree	Disagree	Strongly disagree	Do not know / Not applicable
All together the programme has been very successful.	<input type="checkbox"/>				

Please, comment on your answer. In what way(s) has the programme been successful or not so successful?

- 35.** What general “lessons-learned” for the future would you like to raise, for instance related to the implementation of Mistra’s research programmes? It can be input regarding the selection process of the programmes, how Mistra or the programmes are administrated, evaluated, financed, dialogue, communication etc.

Annex 3. Interview guides - main headings

Programme related

About participation in the Mistra-programme

Initiation: aim, participants, contact with Mistra.

Implementation: time period, contact with Mistra, cooperation.

Programme result impact (Mistra's purpose)

Relation to mode of working, further development of the results, counterfactual aspects, comparisons with other research funding bodies.

Overall assessment

Additionality, success / risk factors, strengths / weaknesses mode of organisation and operating Mistra programmes, recommendations.

Mistra staff and member of the board

Background

Involvement and function.

Mistra's role as a research financier

Interpretation of Mistra's statutes, any amendments in mode of organisation and operation, comparison with other research financiers, attractiveness, definition of "additionality" and users.

Mistra's programmes

Programme portfolio, initiation and approval as well as implementation of programmes, results and effects of the programmes, mode of organisation and operation, any amendments, strength and weaknesses.

Annex 4. Overview of the evaluated Mistra programmes (in alphabetical order)

	Year	No	Total financing Mistra MSEK	Other financing MSEK	Mistra yearly financing MSEK / year	Main contractor	Type of main contractor	Budget allocated to main contractor MSEK	Budget allocated to other project partners MSEK
ASTA	1999–2007	9	59.7		6.6	Swedish Environmental Research Institute (IVL) AB	Research inst.	29.3	30.4
Biosignal	1996–2005	10	68		6.8	Swedish University of Agricultural Sciences	University	68	-
Black Liquor Gasification	2004–2010	7	42.9	Swedish Energy Agency	6.1	BLG-programmet AB	Company	21.7	21.2
Bygg-MISTRA	1996–2002	7	38.6		5.5	Chalmers University of Technology	University	26.6	12
CLIPORE	2004–2011	8	107.3		13.4	Swedish Environmental Research Institute (IVL) AB	Research inst	31.4	75.9
COLDREM	1997–2002	6	43.5		7.3	Umeå University	University	20.3	23.2
DOM	2003–2011	9	61.2		6.8	Swedish University of Agricultural Sciences	University	61.2	-
Fjäll-MISTRA	1998–2006	9	84		9.3	Swedish University of Agricultural Sciences (Umeå)	University	57.6	26.4
FOOD 21	1997–2004, 2005–2007	11	125	Industry 22.6	11.4	Swedish University of Agricultural Sciences	University	105	20
Greenchem	2003–2010	8	70.1		8.8	Lund University	University	70.1	-
Hagmarks-MISTRA	2001–2008	8	43		5.3	Swedish University of Agricultural Sciences	University	34.6	8.4
Heureka	2002–2009	8	21.1	Industry 30, SLU 30	2.6	Swedish University of Agricultural Sciences (Umeå)	University	21.1	-
KAM	1996–2002	7	90	Industry 18	12.9	Swedish Pulp and Paper Research Institute AB (STFI)	Research inst.	40.2	49.8
LUSTRA	1999–2007	9	59.5		6.6	Swedish University of Agricultural Sciences	University	36.8	22.7
MAaF	1996–2003	8	65	Industry 14	8.1	Swedish University of Agricultural Sciences	University	65	-
MARE	1999–2006	8	63.5		7.9	Stockholm University	University	38.5	25

	Year	No	Total financing Mistra MSEK	Other financing MSEK	Mistra yearly financing MSEK / year	Main contractor	Type of main contractor	Budget allocated to main contractor MSEK	Budget allocated to other project partners MSEK
MASE	2004–2010	7	57.7	Industry 27.6	8.2	MASE Laboratorier AB	Company	57.7	-
Marine Paint	2003–2010	8	82.6		10.3	University of Gothenburg	University	58.1	24,5
MiMi	1997–2004	8	76.1	Industry	9.5	Luleå University of Technology	University	22.03	54.07
Mistra Fuel Cells	1997–2010	14	121.1	Industry 40	8.7	Royal Institute of Technology	University	43.8	77.3
News	1999–2006, Stafettväxlingsfas 2007–2009	11	75	Rådet för arbetslivsforskning (RALF), Environmental Protection Agency, KemI, Eka Nobel, European Chemical Industry Council (CEFIC).	6.8	Royal Institute of Technology	University	19	56
PERSEA	2003–2010	8	34.5		4.3	Ångströmlaboratoriet, Uppsala University	University	30.7	3.8
ProEnviro	2007–2010	4	30	30	7.5	n/a	n/a	n/a	n/a
RESE	RESE Fjärranalys för miljön: 1997–2002, RESE Miljömål: 2003–2005	9	88	around 15 MSEK (final phase)	9.8	Metria Miljöanalys, Lantmäteriet	Public auth	23.9	64.1
Soundscape support to health	2000–2007	8	39		4.9	Chalmers University of Technology	University	12.6	26.4
SUCOZOMA	1997–2004	8	80		10	University of Gothenburg	University	48	32
SUFOR	1996–2004	9	108	Industry 10	12	Lund University (phase 1) Swedish University of Agricultural Sciences (Alnarp)(phase 2)	University	69.7	38.3

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	Year	No	Total financing Mistra MSEK	Other financing MSEK	Mistra yearly financing MSEK / year	Main contractor	Type of main contractor	Budget allocated to main contractor MSEK	Budget allocated to other project partners MSEK
SWECLIM	1996–2003	8	66.7	SMHI 17,8 Other 1,7	8.3	Swedish Meteorological and Hydrological Institute	Public auth	53.2	13.5
Transport-Mistra	2006–2008	3	30	Environmental Protection Agency, Road administration, Rail administration 10	10	Trivector AB	Company	5.6	24.4
URBAN WATER	1998–2006	9	63		7	Chalmers University of Technology	University	37.7	25.3
VASTRA	1996–2005	10	68.5		6.9	Linköping University (phase 1) University of Gothenburg (phase 2)	University	16.7	51.8
Ways Ahead	1996–2001	6	22	27	3.6	Lund University	University	n/a	n/a
Ångström Solar Centre	1996–2004	9	75	Swedish Energy Agency 75	8.3	Uppsala University	University	75	-
Total		8.2	2159.6		7.9				

Annex 5. Citation analysis

The method behind the citation analysis

The citation analysis is built upon the number of citations from *Web of Science* (*WoS; Version 5.8*) as well as from *Google Scholar*. The analysis of the number of citations from *Google Scholar* is implemented through the program *Publish or Perish 3* (*PoP*). The reason for using *PoP* instead of the web version of *Google Scholar* is that the analysis is performed faster in terms of search time. Moreover, it is more convenient when the results are extracted from *PoP* into the database where the records are stored. The analysis procedure follows:

Step 1: Search for the title of the article.

The starting point of the analysis is the title of the article. In *WoS*, the article title is written in the search field when “Title” is marked in the drop-down list. The corresponding procedure in *PoP* is to type the article title in the field “All of the words”.

Step 2: Analyse the search result.

Three scenarios are possible.

a) The article is found.

If the article is found, then the analysis proceeds in the next step (step 3).

b) Many results are found.

If many results are found (e.g. articles with similar names but not the one sought), then the search is supplemented with the last name of the author(s). In *WoS*, the search is extended by entering the name(s) of the author(s) in an added search field when “Author” is checked in the drop-down list for that specific search field. In *PoP* the name of the author(s) is entered in the field “Author(s)”.

c) No articles are found

When no articles are found, this is often due to misspellings or the use of symbols instead of words in the article title (e.g. & instead of and). Sometimes, the article title consists of sub indices (e.g. X_1 is written as $X1$). When such situations arise, the article title is shortened at the point where the problematic symbol(s) or sub index/indices are found. When misspellings occur or sub-indices are present, the search for the article title is often complemented with the author name (as in step 2b).

Examples are given below:

Case 1: The article title is “The analysis of A and B” but is written as “The analysis of A & B”. The solution is to reduce the search string into “The analysis of A”.

Case 2: The article title is “The analysis of sub-indices and ” but is written as “The analysis of sub-indices and X_1 ”. Then the article is restricted to “The analysis of sub-indices” since the article otherwise is not found in either *WoS* or *PoP*.

Step 3: Validate the article found.

The chosen article is validated in terms of author name(s), article title, journal title, journal edition, publication year *et cetera*. Once it is determined that the article is the one requested, the information about the number of citations is documented.

Step 4: Analysing the performance of the research programmes.

Once steps 1–3 are completed for all research programmes and all articles are found, the data is analysed. For each research programme the average as well as the median number of citations per programme is calculated. Hereafter, the average and the median number of citations are examined, both the citations observed from *Google Scholar* and also those achieved from *WoS*. At this point it is established which programmes show high or low averages or median numbers of citations.

Moreover, the mean publication year is calculated for the articles in each programme included in the study. This is done in order to explore the relations between the number of citations and the publication years of the articles submitted by the research programmes in the study.

The reason for using both the average number of citations and the median value when examining the citation figures is to discover whether the distribution of citations is skewed in some direction (either positively or negatively). For instance, it is possible that one or two articles have a very large (small) number of citations and hence increase (decrease) the mean value of citations. In such cases, the median describes the data better in terms of central tendencies (e.g. outliers are present). If the mean and the median value are similar, this is an indication that the articles have somewhat similar numbers of citations and a few articles that are extremely often (or rarely) cited do not exist in the data material for the examined research programme.

The performed analysis

In the analysis, *Web of Science* and *Google Scholar* have been used. *Google Scholar* displays more citations than the analysis performed in *WoS*, since *Google Scholar* is wider in scope in terms of data collection. *WoS* covers only citations to and from Scientific Journals while *Google Scholar* also includes working papers and papers that are not yet published in journals. This is the main reason why the number of citations in *Google Scholar* is greater than that found in *WoS*. However, in a few cases, the number of citations is larger in *WoS* than in *Google Scholar*.

The correlation between citations in *WoS* and *Google Scholar* are high (often greater than 0.9). This means that it does not matter which database is used when comparing the number of citations between the articles and the research programmes. Moreover, it is noteworthy that the difference between the number of citations in *WoS* and *Google Scholar* is relatively small in comparison with some other research fields. For instance, in innovation research, the number of citations in *Google Scholar* is up to 6 times higher than the corresponding figure in *WoS*.

Some research programmes³⁰ in the study have not submitted a list of publications and therefore the citation analysis does not cover all programmes in this evaluation. The programmes that sent in articles perform quite well since the articles referred to normally have citations, some of them many citations. This should be seen in light of the fact that many scientific articles never get cited.

In the analysis, some articles have very few citations or no citations at all. This is often the case for articles published during the last couple of years. An explanation behind this phenomenon is that there is, in general, a time lag after the article is published before citations occur. It takes some time for the article to become

³⁰ Lists are lacking from *ByggMISTRA*, *COLDREM*, *FjällMISTRA*, *NewS*, *ProEnviro*, *RESE*, *SUFOR*, *VASTRA* and *Ways Ahead*.

known in the field, and it also takes time until the “citing” articles are published because of peer review and revisions. Therefore, it might take several years before an article is cited. The citation analysis shows that the main result does not depend on whether the average number of citations or the median number of citations is examined. The results are very similar in both cases. Programmes with a high (low) number of average citations also have a favourable (unfavourable) position when the median value is examined. When the research programmes that have performed well with respect to citation figures are compared, the same programmes show up in the top, irrespective of which measure of central tendency (mean or median citations) is used. The same is true when comparing the result from the *Google Scholar* analysis and the citations from *WoS*. It is more or less the same programmes that perform well or poorly regardless of which database the analysis is based on.

The expected result is that research programmes with an early average publication year should perform better in terms of citations. There are two main arguments for this. Firstly, articles that have been available for many years are more likely to be cited. Secondly, the time lag plays an important role. Articles that were published many years ago have already passed the time lag stage. However, articles that were recently published are in the time lag process and are therefore not cited as much.

TABLE 1. Web of Science
- Average citations per
program and year.

Programme	Average citations per year
SWECLIM	11.7 (9)
URBAN WATER	8.6 (7)
ASTA	8.1 (6)
SUCOZOMA	7.2 (11)
MARE	6.9 (6)
HagmarksMISTRA	6.4 (5)
Mistra Fuel Cells	6.1 (8)
DOM	5.4 (3)
MiMi	5.2 (10)
MAaF	5.2 (7)
Greenchem	5.1 (4)
CLIPORE	4.8 (4)
Biosignal	4.6 (11)
Ångström Solar Centre	4.0 (11)
FOOD 2 1	3.6 (9)
Marine Paint	3.3 (8)
Soundscape support to health	3.2 (5)
Heureka	2.9 (7)
Black Liquor Gasification	2.4 (2)
PERSEA	2.3 (8)
TransportMistra	2.0 (3)
KAM	0.7 (10)

* Values within parenthesis are the number of years that have passed since the average publication year for the articles in the programme.

In Table 1 the average citations per year and programme is presented. The figures are corrected for the average publication year for each programme. Since the general findings from *Google Scholar* and *WoS* are similar, the *WoS* analysis is only presented in this report. According to Table 1, *SWECLIM*, *URBAN WATER* and *ASTA* are among the top cited programmes. Moreover, the programmes *SUCOZOMA* and *MARE* have high average citations. However, it is obvious that *SWECLIM* has a considerably higher number of citations than the other programmes. Some programmes have a late average publication year and may be hindered by the time lag. It is however obvious that *SWECLIM* has more citations than other programmes with the same or longer time since the average publication year (see e.g. *MiMi*, *Biosignal*, *Ångström Solar Centre* and *KAM*). This is partly true for *SUCOZOMA* as well.

Table 1 reveals that *Black Liquor Gasification* and *TransportMistra* receive rather few citations on average. A potential time lag may however have distorted the results for these programmes. According to the figures in Table 1, *KAM* receives few citations even though the average publication year is 10 years ago. One could also expect that both *PERSEA* and *Heureka* should have higher average citations per year since the submitted articles were, on average, published 7–8 years ago. Moreover, it is noticeable that *DOM* has a large number of citations on average even though the programme submitted articles published 3 years ago on average.

In Table 2, the analysis includes median citations per programme and year with average publication year taken into account. Table 2 reveals that *SWECLIM* receives very high numbers of citations. This is in correspondence with the result found when the average citations per programme were analysed. The same is true with regard to *ASTA*, *SUCOZOMA* and *URBAN WATER*. The average number of citations for these programmes was high in Table 1 and is also high when the median number of citations is considered in Table 2. However, when the median value of citations is examined, *MAaF* also has a high number of citations. This programme was placed in the middle of the citation ranking when the average number of citations was reviewed in Table 1.

It is also noteworthy that *DOM* is found at the bottom of the cited programmes list in Table 2. This was not the case when the average number of citations per year was considered. Since the median number of citations is a single middle point value of ordered citation data, it is not affected by extremely high (low) cited articles. Hence, the result arises since the *DOM* programme has submitted a couple of articles with many citations while at least half of the submitted articles have few or no citations at all. Furthermore, *PERSEA* and *Heureka* have relatively few citations in the median-based calculation. The submitted articles are expected to have achieved more citations since the average publication year was 7 and 8 years ago, respectively. This result was also found when the average number of citations per programme and year was examined.

The main conclusion found in the analysis is that *SWECLIM* performs better than the programmes with the same average time in publication years. *SWECLIM* have relatively higher numbers of both average (Table 1) and median citations per year (Table 2) compared to all other programmes. In the bottom layer, *KAM*, *TransportMistra* and *Black Liquor Gasification* have few citations overall, both in terms of average and median citations per year. The distinguishing feature however is that *KAM* on average submitted articles published 10 years ago while *TransportMistra* and *Black Liquor Gasification* submitted articles published rather recently. The latter programme is not expected to have a high number of citations on average or median at this point in time. According to the analysis *KAM* does not perform well in terms of citations. *PERSEA* and *Heureka* also have few citations. One could expect that these programmes should have had more citations since their submitted articles have already been available for citation for 7–8 years.

TABLE 2. Web of Science
- Median citations per
programme and year.

PROGRAMME	Median citations per year
SWECLIM	8.9 (9)
ASTA	7.5 (6)
MAaF	6.1 (7)
SUCOZOMA	5.8 (11)
URBAN WATER	5.3 (7)
Mistra Fuel Cells	5.3 (8)
Greenchem	4.2 (4)
MARE	4.1 (6)
Biosignal	4.0 (11)
MiMi	3.7 (10)
Ångström Solar Centre	3.2 (11)
Marine Paint	3.1 (8)
HagmarksMISTRA	3.0 (5)
Soundscape support to health	2.9 (5)
CLIPORE	2.9 (4)
FOOD 2 1	2.5 (9)
Heureka	2.3 (7)
PERSEA	2.0 (8)
TransportMistra	1.7 (3)
DOM	1.6 (3)
Black Liquor Gasification	1.5 (2)
KAM	0.4 (10)

* Values within parentheses are the number of years that have passed since the average publication year for the articles in programme.

Some caveats in the analysis should be highlighted. When *Sweco Eurofutures* requested the submission of the articles, the 10 most relevant scientific articles that have been published in a scientific journal and which build upon the research in the programme were asked for. It was also noted that a citation analysis would be made on the basis of the articles. The articles submitted from the research programmes may, however, have been chosen in different ways. For example, some programmes may have sent the most cited articles, while others might have submitted articles that are from a specific period of time. In order to evaluate the programmes, the optimal situation is when the articles are chosen randomly. The fact that it is unknown exactly how the articles were selected by the different programmes likely creates some bias in the results. The extent of the bias is not however possible to determine. If all programmes followed the practice of submitting the most cited articles, the bias is of less importance.

Another source of bias is that the participating programmes were founded at different points in time. Some programmes may be more affected by the time lag. The articles provided by such programmes may have high potential in terms of citations during the coming years but this has not yet materialised. Research programmes that have existed a long time have overcome the time lag and receive citations continuously.

In order to get more robust results from the analysis, more articles from each programme would be necessary. Future studies with more articles and a higher respondent rate from the research programmes would provide more precise results. As stated above, the quality of the study would also have been higher if the articles were selected randomly. Additionally, the option to exclude “new” programmes to make the research units more comparable would have been possible if the respondent rate had been higher.

Nonetheless, this study shows tendencies and interesting aspects even if the results found in the study should only be interpreted with some caution. As noted previously, comparability between the different programmes is affected by the years since the research projects were founded and the publication years of the submitted articles. One aspect that has not been discussed above is that the submitted articles each have a variable potential to become cited, primarily since the research areas differ to some extent and hence attract audiences in different sizes and scopes. As such, some of the submitted articles are exposed to a greater mass of readers and are probably more likely to be cited than those articles that attract fewer readers.



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