

R&D COOPERATION USA – NORWAY

**Financial and organizational implications related to a
targeted increase in R&D in the areas of Energy and
Environment**

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Preface

Increased internationalisation of Norwegian research is one of the main goals of The Research Council of Norway. The reason for this is obvious: international cooperation is needed to reach the cutting edge and to perform high quality research in most scientific fields. Such cooperation is a necessity in research requiring large installations or equipment or research involving several countries. Close contact and cooperation across borders is therefore of the greatest importance for the further development of Norwegian research.

This is why the RCN supports the launching of a new strategic plan for increased research- and technology cooperation with North America. This region contains some of the world's most successful and high-rated institutions. In the USA and Canada the traditions for close cooperation between universities and industry have had a major impact on industrial innovation and modernisation in the two countries.

Norwegian R&D cooperation across the Atlantic has long traditions. Despite Norway's great success in the EU framework programmes and the impact this participation has had on Norwegian R&D, the USA still is one of the most important singular countries for Norwegian international cooperation. We need, however, to maintain and strengthen the transatlantic ties.

This report is made by two senior researchers, describing main experiences from their contacts with institutions and cooperation with colleagues in the USA, what is needed to achieve results, and their recommendations for future transatlantic cooperation. The authors emphasise that their experiences are based on cooperation within one particular field of research: energy and environment. Other conclusions may be drawn from other fields. However, experienced researchers representing a variety of fields have checked out the views and recommendations in this report. Even if we do get a few different viewpoints and nuances on some of the conclusions drawn, the general picture is broadly supported.

We would like to thank Rolf Marstrander and Bjørn Bakken who made this report on commission from the RCN. As authors they carry full responsibility of the content, conclusions and recommendations of the report.

The Research Council considers it important to discuss international cooperation in general and – in this specific context – our future transatlantic links. Everyone reading this report is invited to express their views on the conclusions and recommendations. We hope you will enjoy reading it.

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Background

October 10-11 2003, the Norwegian Embassy in Washington D.C. arranged its yearly Forum on Trans-Atlantic R&D cooperation with special focus on energy and energy related environmental challenges. In a closing remark to the forum and its follow up seminar the next day, it was pointed out that an increased R&D cooperation between two countries so different in size and relative R&D intensity had to be based on

- a clear understanding of where the two countries have overlapping interests, and
- how the increased interaction should be financed.

In November 2003 the Embassy granted SINTEF (The Foundation for Scientific and Industrial Research at the Norwegian University of Science and Technology: NTNU) on behalf of TRANSES, an R&D project with participation from NTNU, Massachusetts Institute of Technology (MIT) and Chalmers that focuses on modeling of sustainable energy supply and demand systems, NOK 100 000 to cover expenses for a study on how we could strengthen the cooperation between MIT and NTNU in relation to TRANSES.

This grant was later followed up by a grant by The Research Council of Norway, RCN, to Rolf Marstrander to look into the more general challenge of strengthening the R&D cooperation between Norway and the USA in relation to “energy and environment”.

We normally find that R&D cooperation is discussed relative to North America. In this report we have limited the discussion to cover cooperation between USA and Norway.

This report is a response to both grants. It is written as a background document with observations and reflections, based on interviews and experiences from actual projects. The report focuses on

- important institutions in the US and Norway related to R&D financing
- differences between the institutions in Norway and the USA with reference to how they give priority, budget and follow up R&D support
- possible strategic measures that could be installed to make a long time improvement on the R&D cooperation between the USA and Norway

To make the study possible within a reasonable time frame it has been focused on “energy and environment”. The examples and interviews are all taken from that area, and the recommendations therefore relate to “energy and environment”. In the few R&D programs we have looked into and/or make reference to outside the area of “energy and environment” we observe patterns that support the recommendations made for “energy and environment” R&D. We do not think that all the recommendations will have general validity, not least because the examples studied all relate to engineering and/or natural sciences.

Originally, the results from the study were to be presented and discussed under the umbrella of a US-Norwegian workshop in May this year. Because of developments underway we have changed the workshop agenda somewhat. The final workshop is now planned in October this year in relation to this year’s Forum on Trans-Atlantic R&D cooperation.

This report does not discuss the content and specific goals of R&D related to the two countries' common interests in "Energy and Environment". That is specifically taken care of in a parallel effort undertaken by the US Department of Energy, DoE, and the Norwegian Department of Petroleum and Energy, OED, in relation to the development of a separate Memorandum of Understanding between the two departments/countries. The report is however partly based on experiences gained related to the development of TRANSES and also efforts undertaken to establish a structured scientific and educational cooperation between NTNU and University of Maryland, UMD. It has also been discussions with people from University of California at Berkeley (UCB) and some US National Labs.

The views expressed in this report relates to

- interviews with a long list of people in different organizations,
- the activities related to TRANSES and the cooperation between NTNU and UMD and
- some personal observations.

The experiences on cooperation are seen mainly from NTNU/SINTEF and partly University of Oslo (UiO). The observations and conclusions that can be drawn from the Forum discussions in October will be part of the report from that event.

Organization of the work

By the help of Science advisor Jostein Mykletun at the Norwegian Embassy in Washington D.C. and personal contacts at MIT, UMD and in Norway a series of interviews has been undertaken.

From the RCN we find data on US-Norwegian R&D activities. From the Swedish Institute for Growth Policy Studies, we find data and info on US R&D organizations, their financial structure and their policies. It is not made specific reference to such reports even if some of the info is referred to in more general terms.

The work with this report has been undertaken in the following steps (in addition to in between reading):

- February
 - Meetings and discussions at MIT. The visit was made in connection with a program meeting on TRANSES
 - Interviews in the Washington area, including NSF
- March
 - Interviews in Washington including EPA and DoE's program on renewable energy
 - Meeting and initial discussion at UMD
- April
 - Meetings and discussions in California; SRI International, EPRI, Berkeley Lab
 - Initial discussion at UCB
- May
 - Mini seminar on cooperation UMD and NTNU.
 - A follow up discussion with MIT on TRANSES and possible interests related to the new Gas Technology Center at NTNU
 - A presentation and discussion of this work at DoE and OED workshop arranged by DoE in New Orleans
- Several meetings with SINTEF/ NTNU regarding TRANSES , and with R&D management in Hydro
- Updates and discussions with Kari Kveseth, Terje Emblem, Trygve Riis and Karin Refsnes, all from the RCN

Observations

Observations relate to a) general observations on developments in R&D cooperation related to activities on energy and environment in Norway and the USA, b) matters relating to the financial structure around R&D support in the USA and Norway, and c) some observations on possible challenges related to the sustainability of changes towards regional secure energy supply.

General observations

The general observations relate to the four categories

- Undergraduate students
- Graduate students
- Post docs and sabbaticals
- Major projects

The number of Norwegian undergraduate students in the USA is decreasing. The number of Norwegian students taking a year or their complete education abroad is generally low. The matter will not be discussed any more in this report, but it seems to need some more in-depth understanding. Related to the specific topic of energy and environment we cannot observe any structures or agreements between a US university and a Norwegian one that as of today would support exchange of students both ways. From the 5-year program on eco-design between NTNU and IISc in Bangalore, India, sponsored by Norsk Hydro in the years 1998-2002, we know that such a structure strongly supports students to go abroad in both directions.

The number of Norwegian graduate students going to the USA is also decreasing. The number of US graduate students going to Norway is insignificant. It seems that good students from an academic point of view get necessary support to fulfill their studies and follow their own interests on where to go.

It seems to be a stable flow of post docs and professors on sabbatical. In the USA post docs and people on sabbatical leave from Norway will normally also be economically supported. It is interesting to note that both this category and the graduate students go abroad out of their own interest and with limited institutional links between host and home university. Seen from the point of view of NTNU, where this has been discussed, this is not optimal. It does not support the development of the strength of the institution in the desired direction. We observe a “conflict” between the academic freedom and the wish to build strong and lasting links between Norwegian universities and selected US universities. This discussion will not necessarily be the same seen from the USA. This may be illuminated in the discussions going on between NTNU and UMD about a strengthening of the cooperation between the two universities related to “energy and environment”. The view expressed at NTNU is that they want to develop MoUs, followed by concrete programs, with selected US universities. The idea is that MoUs/programs will act as catalysts for increased and lasting cooperation.

Norwegian authorities have normally not been willing to enter into major projects on a general financial term. The exception is CERN and ESA. The real result from these projects should be taken into the discussion on the matter of strengthening R&D between USA and Norway. Our impression is that the formalized long term Norwegian participation in CERN and ESA has been a strong support to the internationalization of Norwegian natural science.

In the last 10 years we have seen some major projects in US universities supported by Norwegian industry. Statoil and Hydro have been active in supporting projects at MIT. The general experience from these projects is that it is costly, it puts strong demands on the companies' efforts in following up and it has to be long term. These initiatives have not received any support from the RCN. To our knowledge it has not been formally applied for support, but in discussions it has been made clear that support will not be given to Norwegian participation in international projects. Today the two companies have reduced their general financial support of projects at MIT. However, the activities have led to the definition of TRANSES, a project that seems to lead to a broader base for cooperation between MIT and NTNU and possibly with activities related to US National Labs. Today, TRANSES has a financial base primarily in Norwegian industry.

In Norway we have a very good base for judging the impact of longer term major R&D projects related to industrial innovation in the so called "Technology agreements" tied to the oil and gas development in the North Sea. These agreements tied Norwegian R&D to the major oil and gas companies of the world and led to the development of Norwegian deep sea offshore technology as world leading. Today the "technology agreements" have been terminated but the links to international cutting edge oil and gas technology is maintained. Beyond doubt this has also led to a strengthening of US-Norwegian R&D cooperation, but only part of it is visible in the university sector. The experiences from the major projects referred to above are identical. When we think long term, are willing to make a strong follow up and have a focus on further development, we get a network that supports further growth and strengthens the scientific and technical links between the participating parties.

We can also observe a certain pattern in the financial and organizational structure of major projects. At MIT and Stanford we have several examples of major energy and environment related projects. They all have the same characteristics:

- They work at advanced cutting edge problems
- They have an extensive industrial sponsorship
- They are given visible support from their host university and are normally initiated by that university
- Their major workload are carried out by scientific personnel from the host university
- They serve as host for foreign participants and enter into cooperation with other universities or centers
- They get a role as being part of the profile of the host university

The results from the newly formed centers of excellence at Norwegian universities seem to serve a similar function. TRANSES represents a similar project, but is still in its making.

The structure of splitting the discussion in principally two different activities:

- *The individual person* working with his specific interests and in a setting freed from formal strings other than those following from his employment by a university or R&D-organization, and
- *The organized effort* with clear focus expressed through an R&D project/program embedded in a university strategy,

can give a lead to some important elements in a future strategy for a strengthened US-Norway R&D cooperation. The Norwegian tradition seems to be primarily to follow the “individual route”. It is difficult to see results towards an organized strengthening of Norwegian R&D from this strategy. To the contrary we find that we probably export our best expertise more than build the Norwegian platform through this route. That does not mean we should not give priority to the individual freedom in research but we should relatively seen give increased priority to the institutionalized programs as a tool for increased R&D cooperation. This is especially true in relation to the technology heavy area of “energy and environment”.

Any cooperation has to be based on a principle of “take and give” and a setup that gives both parties positive results. When we compare the USA and Norway in relation to energy and environment we find some obvious advantages on both sides.

The general view is that the USA with its size in resources, complexity and number of universities covers all R&D fields of interest to “energy and environment”, while Norway has a more limited set of interests and needs to concentrate its resources. This makes USA a very interesting partner for cooperation for Norway simply because it gives a good look into all available possibilities for energy supply and demand technologies of tomorrow. One major advantage in the “energy and environment” area is that Norway is part of a complex system fully integrated inside well-defined systems borders. This makes Norway a very good field for testing of alternatives inside a well-defined system. It also gives a better organizational link between ideas and their test in the field as we see with CO₂ sequestration in the North Sea. We should also bear in mind that Norway even in absolute numbers is a major exporter of oil and gas. With its energy riches Norway has developed an infrastructure and industry that also are clearly energy intensive.

Financing structure

There are some major differences between the financing structure of US and Norwegian R&D. The differences are probably general, but we have looked specifically into “energy and environment” so the comments relate to that.

The US system can be characterized as follows:

- DoE runs/finances huge programs on energy, \$1.2 billion/year on new/renewable. The programs run at universities and national labs and are primarily focused on applied research. This also means that it has already been made a national priority as a basis for the more detailed formulation of the R&D. We can say that the direction has been politically given.
- “Committee on Climate Change Science and Technology Integration” reports to the Office of the President. The Committee oversees the Climate Change Science Program. This structure signals a strong political involvement in the coordination and prioritizing of Energy and Environment R&D in the USA.
- An observation that has to be made explicitly is the seemingly strong link between industry and government in energy related R&D. This is different from what we observe in Norway.
- EPA (Environment Protection Agency) runs/finances programs on sustainable energy in addition to more specific environmental studies.
- National Laboratories work as governmentally run laboratories and serve as national pools of knowledge in their specific areas of interest. It is also our impression that

National Labs work in close relation to government and as a consequence are related to the long term national priorities and policies represented by their funding governmental departments. It is expressed that they are interested in getting (good) foreign post docs and faculty on sabbatical, and as a consequence in some cases can fund part of such visits if the funding the persons bring with them does not match the costs of staying. It has been pointed out that since the National Labs are fully sponsored by the government, this can in some cases lead to confidentiality demands that cannot be met by visiting scholars.

- NSF, National Science Foundation, finances academic research and is clearly more oriented towards basic research. It is typically the source of financing for graduate studies. This implies that NSF works more as a recipient of R&D suggestions and decides on support as a consequence of academic quality.
- Both the NSF and the Departments stress that they are primarily financing activities in the USA. But they are both open to foreign participation. DoE says that foreign companies are welcome to take memberships/sponsor projects in their programs. Foreign companies may also get contracts with the projects as long as most of the work is carried out in US based universities or R&D labs.
- The major US universities like MIT, Harvard and Stanford are private and operate with a basis in their own funds, tuition, governmentally sponsored projects, and industrial participation and funding. This leaves the universities with a freedom to choose and prioritize their activities. This also means that the costs of activities are directly visible and charged to participants and sponsors. Typically a student with professor involvement will cost \$50-100 000 a year.
- The general sponsorship of programs/projects at a university or national lab may cost \$50-150 000 a year just to have access to ongoing work in terms of reports and presentations, workshops etc. In addition to that come necessary travels and time spent to follow up on the info available. The dimension and time horizon of the projects are such that an involvement will easily span 5 years to have any real meaning for the sponsoring company. It is important to note that the access to the program, also in the form of having students/researchers involved goes via the sponsorship.
- The number of companies taking part as sponsors on the energy projects supported by DoE was told to be ca 250. This says something of the general interest in new renewable energy technologies in the USA. It also says something about a culture for direct industrial participation in major R&D projects.

Norway can be characterized along the same lines:

- Norwegian authorities are less coordinated from the top in R&D matters. There are exceptions from this; the new fund on gas-technology is one. The proceeds from the fund will be the basis for financing of gas technology R&D. The funding itself and the priorities will be carried out through a new governmentally funded innovation body. The Norwegian Authorities have limited their role to the design and establishment of the body and structure that will carry out the financing function.
- The Department of Environment does not seem to have a similar role as OED has taken on gas technology.
- The Research Council of Norway, RCN, is funded by the different departments with “earmarks“ attached. This gives the RCN a role similar to a combination of what we

see as the NSF and the different ministries in the USA. A noteworthy difference is the fact that the RCN is generally not acting as a governing body, but there are examples of governing boards of programs that relate to the more applied industrial research area.

- Norway has national labs or labs operating in a similar mode related to the environment (air-, water-, radiation-, biosphere- institutes). The other Norwegian research institutes are operating more in line with what we see at the major US universities. They operate as contract research institutes.
- The Norwegian universities are state financed with no strong prioritizing body at the top as we find in private US universities. As a consequence, the amount of sponsored or contracted financing is closer to 30 % compared to the 90 % we see in the private US universities. There are no tuitions paid.
- The close research cooperation between SINTEF and NTNU, and between NTNU and Institute for Energy Technology (IFE) makes the difference between Norwegian and US universities less in financial terms.
- The understanding of the importance of industrial sponsors both in Norwegian industry and in academia is less developed in Norway than in the USA.
- It is a major difference between the best, Ivy League, US universities and the Norwegian. The US universities are rated at the world top. In a recent rating the best Norwegian University is rated as no. 63.

Seen from the view of the single student, graduate and undergraduate, as well as the professor on sabbatical leave, the US and the Norwegian system probably don't look very different. The major difference between the two systems do we find in A) the willingness to give more political direction to R&D priorities, B) the difference in economic structure and governing of private universities in the USA and the Norwegian governmentally funded universities, and C) the amount of industrial sponsorship. The last point has as consequence that industry as sponsors in the US system become to a certain extent a necessity to the projects and programs while industry in the Norwegian system plays a lesser role in most cases.

The differences in ranking make it easier for a Norwegian student to go to the US than for a US student to go to Norway. Norwegian "hot spots" like NTNUs program on "energy and environment" have to be identified and made known to improve this.

The possible challenge of sustainability in a world of regional secure supply of energy

We cannot leave the list of observations related to an increased R&D cooperation between the USA and Norway, with specific reference to energy and environment, without pointing at an area of possible conflict of interests, but also with an interesting opportunity for Norway. As is pointed out, the US government, supported by their major industrial actors in the energy field, has given top national priority to development towards a secure and sustainable energy supply and demand structure. The goal is technically and scientifically to understand possibilities and threats on the road towards a sustainable and secure energy supply and demand structure. A prerequisite for a sustainable US energy supply will have to be that the dependence on foreign supply is clearly reduced - today the trend is clearly opposite.

We find similar discussions inside the EU on energy related matters as we find in the USA. Germany expresses similar views in their long-term plans. France is working along the same line, and EU in Brussels expresses the same views.

This leads to some interesting perspectives for Norway's role. A secure supply of energy for the USA is not necessarily a secure supply for the EU. Regional differences may give different solutions. But we may also experience that different global relations may give different preferred solutions. This may lead to the conclusion that a sustainable and secure supply of energy may be given different solutions in different parts of the world. Differences in solutions may include possible conflicts of interests. By other words; a secure and sustainable energy supply may also mean different conclusions on how we view sustainability in an energy related context.

Norway has major interests in the energy area, and has also political prestige related to the discussion on sustainability. This leaves Norway with two opportunities:

- To choose the "Follower" role. This role is very much the role discussed in this report. Norway may choose to increase its level of energy related R&D sufficiently to support Norwegian active participation in major R&D efforts in USA and EU. By so doing Norway also sets down one of the corner stones needed to secure its interests in a time of rapid changes in energy supply and demand technologies.
- To choose the "proactive" and sustainable development supportive role. This role would be in line with Norway's role in UN. It will also be in line with Norway's role as a small and independent country. This role will mean that Norway in addition to taking care of its obvious obligation to look after its own interests in a world of rapidly changing energy technologies, also undertakes initiatives at an international level to come to better scientifically grips, also seen from a social point of view, with the real meaning and consequence of a sustainable energy future.

Norway already has a good platform to expand into and undertake the more proactive role. It will mean that Norway takes necessary steps as discussed in this report to improve and strengthen the R&D links with the USA to a level similar to our present level of cooperation with the EU. In addition Norway will have to take steps to bring the non-technical R&D into the same frame of cooperative initiatives.

Recommendations

A prerequisite for any cooperation is that we can

- Find common interests either in terms of development of products, technologies, system understanding or scientific results
- Establish a certain structural equality in the partnership that allows equal access to results/benefits
- Establish equality in terms of financial input

The common interest is easily defined inside the frame of energy and environment. Even if the span of interests from a US point of view is wider than the Norwegian interests there is enough left to be of interest to both parties. There may also be a specific political interest in an expanded cooperation. That factor may be seen as a driver to establish cooperation, but the demands on that cooperation have to be met as discussed in this report.

The structural equality will relate to:

- Undergraduate student access and interests
- Graduate student interests and access
- Post doc/sabbatical arrangements that allow for exchange both ways
- Industrial active participation as sponsors and in some cases as R&D partners

The inequality in financial input between the USA and Norway cannot be fully compensated for, but it can be sufficiently compensated in selected areas where Norway has special interests or can offer special conditions for R&D of interest, like CO₂ sequestration and studies of energy supply and demand systems within well defined system boundaries.

The undergraduate students represent a challenge in relation to an increased US-Norwegian R&D cooperation. One reason may be that we in Norway do not have any, or at least a clearly limited number of, structured common R&D programs with US universities that will support an increased flow of students.

The graduate students and post docs/faculty on sabbatical seem to have sufficient financial mechanisms. As discussed, we see an increase in these flows as a consequence of changes in incentives through programs and university strategies that are based on increased cooperation. Changes in the economic arrangements alone may have limited effects.

In line with our observations we think that an increased US-Norwegian R&D cooperation can only be achieved through:

- mechanisms that support long term organized R&D programs of common US - Norwegian interest and with industrial participation, and/or
- implementation of strategies that allow financial support to Norwegian universities entering into long term cooperation with US counterparts. It goes without saying that such arrangements have to be limited to a few US universities. The arrangements will include exchange of students, common R&D projects and, if possible, development of

common educational material. It will be important that support of industrial participation is included in these arrangements.

An increase in R&D-cooperation along these lines depends on maintenance of at least today's level of support to individual researchers. The quality of programs depends on the R&D qualities of the individuals.

Developments already underway in the USA and Norway support these recommendations and can serve as examples on where necessary actions along the lines recommended will support further development:

- The initiated discussions between DoE and OED have identified several areas of common interest. Funding should be made available for pre-studies in a selected number of topics. These may serve as immediate examples of possible R&D programs.
- TRANSES has been used as an example of a project that could have common interest in the preparation of this report. The responses are such that we know that
 - MIT
 - UCB
 - UMD

are interested in participation with parallel graduate students at NTNU and the US institutes. The experiences we can draw from TRANSES so far indicate that as long as TRANSES meets the scientific demands for support, the program should be given support along the lines of other R&D projects with an industrial base and participation. That would give the program budgetary strength and also give the industrial sponsors positive feedback. Discussions so far with the RCN indicate that such a support will be difficult as long as there are no budgetary mechanisms that give exclusive priority to a strengthening of US-Norwegian R&D cooperation. It is strongly recommended that such mechanisms should be established in the RCN budgetary rules.

- An increased cooperation through programs in the USA where DoE is the main sponsor will require Norwegian industrial participation as sponsors and as active participants. Discussions with industry indicate that this can only come through under the present industrial climate in Norway if the RCN is allowed to support such sponsorship and active participation. It is also important that such support facilitates long time industrial presence in the programs chosen.

Along the lines in the discussion under observations on energy and sustainability we recommend that the RCN in addition to the above recommended "follower" projects include an initiative related to a proactive role towards sustainability in a perspective of a secure and sustainable energy supply. We recommend that Norway takes initiatives to establish joint US-Norwegian R&D projects with the specific aim to understand also from a social science point of view the implications of changes towards a sustainable and regionally/nationally secure technical system of energy supply and demand. This possible expansion of US-Norway cooperation on energy related matters has not been discussed in the many meetings that have led to this report. As a consequence it may be necessary to undertake a minor pre study on scope and content if this specific recommendation were to be presented to our US counterparts.