KTH International RAE 2008

REPORT PANEL 5: ENERGY TECHNOLOGY and ELECTRICAL ENGINEERING

GENERAL ASSESSMENT OF THE RESEARCH FIELD

The four Units of Assessment (UoA) making up the research area to be evaluated all have very different research topics and profiles. Two of the Units, *Energy Transformation* (ET) and *Electrical Power Engineering* (EPE) are focused on applied research and education (at both MSc and PhD level). The *Fusion and Space Plasma Physics* unit (FSP) projects are mostly basic research but, through large international experimental programmes, involve instrument development and thus potential for applications. *Nuclear Power Safety, Reactor Physics and Reactor Technology* (NPS) services the maintenance of nuclear engineering skills in Sweden. Given this diversity of approaches, it is not surprising that there are only few and rather weak links between the UoAs, while some of the UoAs have quite intense collaborations with other departments at KTH. For example, the links between EPE with Information Technology and Material Sciences has proven successful.

All UoAs actively participate in international collaborations. Within FSP, research is conducted in wide international collaborations. The other, more industrially oriented units also have Europe-wide networks and actively participate in the EU framework programmes. However, there should be more incentives for young scientists to spend longer periods at foreign universities or laboratories either as part of their PhD studies or post-doctoral training.

The Panel notes that while, in general, the quality of PhD theses is high, some of the students working on industrially funded projects get only limited international exposure and training in academic skills such as writing scientific journal articles.

The KTH strategy is accommodating, and the groups are free to choose their research topics. However, two aspects will require special attention in the future: firstly, KTH needs to develop a strategy for research in the nuclear technology area; secondly, the present and upcoming professor retirements within the assessed Units calls for top-level strategic decisions about the future research directions.

The financial system at KTH is close to full-cost accounting, which means that the overhead on salaries is relatively high. This, together with the fact that the overall external funding level approaches 50%, means that senior staff members are quite burdened by the need to seek research funding for the groups. The high costs and the high percentage of external funding make it difficult for newly recruited professors to start up their research programmes and establish new facilities with modern equipment.

There is a clear signal from the UoAs that the high-quality energy research (or energy and environment research) should have a higher visibility and more active branding within KTH. Successful branding would lead to increased numbers of students and more opportunities for research funding.

UoA: Energy Transformation (ET)

General Assessment

The UoA comprises the Department of Energy Technology and consists of four divisions: two large ones concentrating on heat and power technology, applied thermodynamics and refrigeration, and two new divisions with few staff members on sustainable building systems and energy and climate studies. The group has excellent laboratory facilities, which are used in experimental work complemented by computer modelling.

The UoA focuses its studies on sustainable power generation and sustainable energy utilization in the built environment. A large portion of the work is motivated by the need to mitigate and adapt to climate change and the consequent need for new innovative technical solutions in the various energy-related problems. The Unit recognizes its strategic role in the KTH planning, as energy is mentioned as one of the key areas in the KTH development plan.

The UoA is highly committed to education, both at the MSc and PhD levels. The number of MSc students has doubled in the past few years, and the number of graduate students is over twice the amount of staff members with PhD degrees. International MSc programmes and distance e-learning tools are central activities at the UoA. The staff expressed a concern that the visibility of the education they provide is not good either at KTH or outside, and a strong wish to start up a programme for both BSc and MSc education on “Energy and Environment”. On the downside, the strong focus on MSc education and the small number of professors implies that the PhD students take on teaching responsibilities. This leads to longer-than-average graduation times, which the UoA wishes to reduce to 4 years, but keep at 4 years in contrast to the 3 years proposed in the Bologna process. It should be recalled that, whilst educational activities are strong, they account for just one third of the UoAs total income.

Staff members are well networked with both industrial and scientific partners in Europe and in Sweden. However, researcher mobility both to and from the group is rather low. Due to recent retirements and recruitments, the balance is shifting from study of individual components to more systems-level studies.

Performance Against Evaluation Criteria

Scientific Quality (basic research)

Although the scientific productivity of the UoA is moderate (perhaps due to a recent relocation); the publication activity reaches one paper per PhD-level scientist per year; part of the UoA currently performs at a world-leading standard with the main part performing at an internationally high standard. Given the large number of PhD students, it seems that their potential as workforce in academic research is under-utilized. The low level of academic research funding limits the possibilities for the staff or students to concentrate on academic productivity.

The UoA is clearly more focused on (MSc-level) education than on academic research. The UoA has created international programmes for MSc students (e.g. Erasmus Mundus, Nordic MSc programme) that also include e-learning tools for distance learning. The educational programme is vital and clearly fills a market need.
The UoA has excellent laboratory facilities that range from internationally leading research devices (some of which appear to be unique in Europe and maybe even worldwide) to versatile student exercise setups.

As a scientific highlight, the panel would like to mention the work done within the turbine group on aero-elasticity at full scale, unique in size and sophistication of the measurements among university laboratories. Likewise, the panel was impressed by the investigation activity, both theoretical and experimental, on boiling mechanisms in microtubes. This area is the present new frontier in heat transfer research with important implications both of fundamental nature and in practical applications (such as the cooling of the modern more and more overloaded electronic devices).

Applied Research

The UoA aims at strong interaction with Swedish and international industries. The collaboration is realized by the industry participating in joint projects and contributing equipment, knowledge and manpower and, thus, the majority of the UoA can be seen to currently perform at a world-leading standard. The IPR and patenting rights are mostly left to the industrial partners. The Panel points out that the UoA's industrial links generally involve high-tech companies who are world market leaders in their field.

Starting two new programmes on energy and climate studies and sustainable building systems require cross-disciplinary activities and strong interaction between different institutes both within and outside KTH. The aim is to broaden the knowledge base and research area by combining different disciplines. Simultaneously, this would provide a more complete scope for the energy education. However, it seems that institutional boundaries are rather high, and there is little or no incentive for interdisciplinary activities crossing organizational boundaries.

The UoA has a strong focus on work within the third world and the emerging Asian powers such as China. This is justified by the high demand for new solutions in these areas both from a humanitarian and an environmental standpoint. Moreover, the collaboration gives strong development potential for the Swedish industry and human potential for education.

As a highlight, the panel would like to mention the development of structured porous surfaces promoting energy efficiency of heat pump PHE evaporators.

It is to be recognized that the UoA has pioneered the promotion of environmentally benign energy technologies through top-level studies on e.g. innovative combustion, gasification technologies, biomass-based energy processes, new heat pump applications such as GCHP (ground-coupled heat pumps), the use of friendly refrigerants including carbon dioxide, ammonia, hydrocarbons, solar-driven refrigeration, and reduction of the charge inventory in cooling equipment. The UoA research activity in this area, now including additional topics (building physics), continues to be a well-recognized world leading reference.

Scholarship

Scholarship is emerging across the majority of the UoA. The UoA has concentrated on teaching, and the number of MSc students has doubled in the past few years. This has resulted in a large number of PhD students, but is not yet showing in the numbers of graduating PhDs. The low ratio of graduating PhDs to the total number of PhD students is acceptable at a stage of expansion, but should be expected to improve in the next few years.

Vitality and Potential

Vitality and potential was considered excellent in some parts of the UoA, good in the remainder. The UoA has very good research infrastructure after the recent relocation and opening of the new laboratory facilities. Concerning human potential, even though the total number of staff is large, the PhD-level staff size is small compared with the number of

students. This limits the possibilities of the PhD students to concentrate fully on their research activities.

Direct collaboration with industry provides substantial support in terms of access to equipment, knowledge, and manpower. The unit's budgets have been quite variable in recent years, showing also gaps in the external funding. Variability in the funding has created some sense of insecurity within the group.

The two new groups established by the recent recruits have very strong potential that will most likely show as an increased productivity and KTH-wide collaboration in the next few years.

Strategy

The UoA has a strong aim to become a leading partner in "energy and environment" research and education at the KTH level and, thus, strategy was considered good with a real potential to achieve. However, the group has mainly expertise on the thermal engineering side, and the setup of collaborations with electrical and automation engineering, architects, economists, environmental sciences etc. needs to be developed further.

The research focus is on sustainable solutions and renewable energy solutions. The UoA does not envisage itself to cover a full range of renewable energy research, but to use its existing competence to assess particular problems within that area. The focus seems to be in creating an integrated energy education programme rather than a full-scale research programme.

The group has actively participated in the EU pilot project SUCCESS, which has opened new collaborations and possibilities.

Actions for Development

The UoA has a strong focus on education, and indeed the market for the graduating students seems to be in place. However, the research activities should be tied closer to the educational activities. This can be achieved first by organising the educational activities such that the PhD students can better concentrate on their research and secondly by defining the PhD projects such that they support the overall research aims. Furthermore, it is important that the PhD study times become shorter, which can be achieved if the students are encouraged to focus on research rather than being overwhelmed with teaching activities.

The UoA has excellent international connections, especially concerning MSc-level education. In the opinion of the Panel, these should be expanded and complemented by enhanced research collaborations with more European universities and research institutions.

Additional Information

The move of both office and laboratory facilities to new premises has been very positive, but has hampered especially experimental work in the past two years, when delays in the moving process has limited the full use of the equipment. This has delayed the graduation of several PhD students. The panel recommends that PhD thesis projects be defined such that they are to some extent independent of the experiments, which would allow a shift in focus if the external conditions unexpectedly hamper the experimental work.

UoA: Electrical Power Engineering (EPE)

General Assessment

The UoA is one of the largest power engineering research organizations at European universities, consisting of 12 research areas that reside in four laboratories. The UoA has close ties to the Swedish power industry and is mainly orientated toward applied research, as is typical of many university groups in this area. The UoA hosts already a second centre of excellence funded by the industry and the Energy Agency.

The UoA sensitively follows changes in society. The Unit's strategy is based on developing new technologies in response to the needs of industries producing power engineering equipment as well as transmission and distribution network operators who supply electricity for society. This work is also associated with mitigation and adaptation to climate change. The group aims at "development of knowledge, methods and products", a challenge well-suited for a research environment with facilities and personnel to tackle interdisciplinary problems and complex modelling challenges. The emphasis on applications somewhat compromises the unit's academic productivity and networking. While the staff acknowledges the need to focus on academic connections and productivity, conferences have often been considered a more useful channel for contacts and publication of the results.

The UoA has versatile and well-functioning research networks also with groups outside the electric power research area. These interdisciplinary connections have in many cases led to excellent new results. Good management and a fruitful work climate greatly contribute to the unit's functionality and success.

The unit is focused on education of graduate students, whose number is more than double that of the senior staff. The large number of students on the one hand and industrial contracts on the other probably contribute to the relatively low number of scientific publications, which however has been increasing recently. The quality of the work done is high, which implies that the present capabilities for publishing may not be fully exploited. As a whole, the UoA is well organized and in many ways the most advanced university Unit in its field in the Nordic countries.

Performance Against Evaluation Criteria

Scientific Quality (basic research)

While the number of peer-reviewed journal articles is relatively low (less than one journal article per academic researcher per year), their quality is good and the recent trend is upward. The majority of the UoA thus currently performs at an internationally high standard. It seems that the quality and quantity of the work is not capitalized to its full extent, as there is no clear incentive to publish journal articles after the results have been presented at conferences.

Even though the external funding level is good, the total budget for operations is rather low; in particular, the number of non-academic support staff is rather low. This is to some extent compensated for by in-kind contributions by industry in terms of equipment and manpower.

Applied Research

The exceptionally close and fruitful connections to the Swedish power industry and the wide-ranging collaboration and staff exchange with companies form a firm basis to the applied research. This creates very good industrial career paths for graduating PhDs, and means that the majority of the UoA currently performs at a world-leading standard. The applied research

has resulted in spin-off companies and patented products in many fields, although the IPR and patenting rights are mostly left to the industrial partners. The centre of excellence funded by the industry provides an easy means to conduct joint projects.

As highlight areas, the panel would like to mention insulation diagnostics, innovative motors and drives, integration of wind power into power systems, and control centre architectures. The panel was delighted to notice that all EPE's four laboratories have strong high-quality research programmes.

Scholarship

The UoA is the leading Unit in electric power research among the Nordic universities, and has a very active collaboration with industry. Thus, scholarship was considered excellent in some parts/individuals. The Unit forms a very attractive research environment for application-oriented students. The relatively low level of academic research funding focuses the work on applications rather than e.g. publishing in peer-reviewed journal articles. The UoA has significant interdisciplinary activities especially with the information technology sector and material sciences.

Vitality and Potential

Vitality and potential were excellent in some parts of the UoA and good in the remainder. Three key persons are near retirement, which requires focused attention to recruitment and strategic planning of the future research directions. The mostly internal recruitment should be complemented by external hires to provide renewal. The staff size is small compared with the number of PhD and MSc students, which poses a large workload on the senior staff as well in terms of acquiring external funding, supervising students, and teaching.

Strategy

The UoA strategic planning is largely dictated by societal and industrial needs, and the staff seems to be in terms with the external driving forces. Even with the high level of industrial funding, the group has developed a coherent strategy and defined areas of expertise that form the Unit's intellectual backbone. The industrial contracts have guaranteed a good level of resources. Strategy was considered excellent but challenging to achieve.

The group has positioned itself well; nationally by strong participation in the new Swedish Power Circle and internationally by active involvement in the new European Institute of Innovation and Technology (EIT) and the EU pilot project SUCCESS. A slightly heavier emphasis on basic research would benefit the group's vitality in the future.

Actions for Development

The UoA should continue its highly competitive applied research, but at the same time make sure that the staff and students develop their academic merits by publishing the results in peer-reviewed publications. The unit should take care also that the application-oriented PhD students get sufficient international exposure and training in basic scientific skills such as writing scientific articles. The role of basic research might be strengthened when writing project plans for the Elektra programme and the centre of excellence. For the same purpose, applying for more funding from research councils would be beneficial.

One of the key areas is the future of electricity distribution. Medium-voltage overhead lines are presently being replaced by underground cables also in rural areas for preventing power outages. This is a heavy and costly process that requires innovative solutions for cutting costs and improving supply reliability. Possible solutions for the medium-term include utilizing DC

and several frequencies; the latter is already being generally applied in electric drives and insulation diagnostics applications at EPE. However, use of multiple frequencies might have wider applicability, as utilization of radio frequencies in e.g. telecommunication has shown. A long-term perspective might be wireless electricity distribution.

Optimization of energy systems, including generation, distribution, and utilization, is important especially e.g. for suburban areas. Alternative forms of energy such as co-generation, district heating, or natural gas in addition to electricity, as well as evaluation of the economical, environmental and social aspects are vital for these studies. Co-operation with Energy Technology UoA, as well as with universities such as Linköping, Chalmers and Trondheim (NTNU) would be fruitful. Co-operation with Tampere (TUT), where Electric Power studies are popular among students, might help in recruiting high-quality students.

The Unit should work toward KTH branding as a leader in energy research. The assets are there, while the multi-disciplinary connections need to be established.

UoA: Fusion and Space Plasma Physics (FSP)

General Assessment

The UoA consists of two divisions dealing with fusion and space plasma physics problems. The fusion and space plasma groups work independently, focused on research within the EURATOM and the European Space Agency (ESA) programmes. The plasma technologies activity, while being rather small, seeks to exploit the large potential of various plasma applications in collaboration with other institutions and industrial companies.

The fusion and space groups are intimately tied with large international programmes: the fusion group with the EURATOM fusion programme including ITER, and the space group with the ESA science programme. While the large international collaborations may somewhat limit the possibilities for the UoA to define their scientific focus, both groups have clearly identified areas of expertise within the international community. The broad international network with long term goals guarantees long-term continuity and progress, as well as providing unique opportunities for relative small groups to make significant contributions that have strong international impact.

The activities in fusion research are an integrated part of the European Fusion Programme under the Association EURATOM-VR and coordinated through the European Fusion Development Agreement (EFDA). The UoA is involved in a broad spectrum of fusion research covering both materials science and fusion plasma physics, including work carried out “in-house” around the EXTRAP T2R device. The research programme is concentrated on the areas of MHD, plasma turbulence and confinement, plasma-wall interactions, and radio frequency heating and current drive. The UoA contributions to these high-priority areas within EFDA are highly valued.

The activities in space plasma physics are tied to the ESA programme and other international space projects. The UoA has developed a strong expertise in building electric field instrumentations for space plasma missions and are involved as principal investigators in several international missions implying world-wide leadership in that area. The main fields of activities include terrestrial and planetary magnetospheres, complex plasmas, and plasma applications.

Both the fusion and the space activities need in-house experimental development work to enter the large international consortia. Therefore, it is vital that KTH support the experimental facilities at a sufficient level, even if their maintenance in a university environment is relatively costly. Both the space and fusion groups are involved in an amazing number of international research projects, which is only possible by having a sufficient number of technical and support staff.

The UoA aims to provide its students with a broad knowledge on plasma physics. A MSc programme in Electrophysics combines plasma physics and electromagnetic field theory. The fusion division is furthermore involved in a newly established Erasmus Mundus programme for European MSc in Nuclear Fusion Science. The new complex plasma research activity has enhanced the otherwise limited collaboration between the divisions of the UoA. Overall, the scientific productivity of the UoA is very high.

Performance Against Evaluation Criteria

Scientific Quality (basic research)

The scientific productivity of both the space and fusion groups is very high: the publication activity averages above two peer-reviewed journal papers per year per academic researcher (even including PhD students). The external funding level is relatively good, although the number of PhD students seems to be limited by the availability of funding. The external funding is dominated by academic grants from the research councils and the programme funding from EU and ESA. Thus, the majority of the UoA was considered to currently perform at a world-leading standard.

The work at the UoA is dominated by large projects by EURATOM and ESA. The funding for these projects is adequate, and provides the groups with long-term stability, although the projects could easily involve more PhD students. The projects have high international visibility, they are competitive, and the good success rate in the international competition demonstrates the high quality of both experimental and theoretical scientific work within the UoA.

As a highlight, the panel would like to mention the work at EXTRAP-T2R on the feedback stabilization of MHD modes, which is world leading and has led to collaborations with various fusion laboratories. On the space physics side, the work on auroral acceleration processes builds on a long-term observational background using radars, rockets, and satellite measurements, and has resulted in a paradigm-shift in the understanding of how the field-aligned currents couple the high-altitude magnetosphere with the ionosphere.

Applied Research

The majority of the UoA currently performs at an internationally high standard concerning applied research. Plasma applications are an increasing trend all over the world. The group attempts to find a limited number of specialized problems where the diagnostics, modelling, or other special knowledge at KTH can be used within the project. The main part of the work is close to basic research and is mostly performed in collaboration with other research institutions, to some extent also with industrial companies. It is an important activity that provides additional funding as well as new understanding and knowledge to the group. The UoA strategy is to keep this activity at a relatively limited level in terms of funding and personnel.

The fusion physics is intimately tied to the industrial development of fusion energy, and has substantial long-term contributions to applied research. The group's work within the EURATOM projects will improve possibilities of Swedish industrial participation in the construction of the ITER project. The space physics projects, while basic research by nature, develop advanced technologies related to e.g. miniaturization, automatization, and durability that may have a variety of applications. This potential is largely unexploited by the UoA.

Scholarship

The academic record of the group is excellent. The publication activity is high, despite the high workload in the long-term experimental projects and scholarship is excellent in some parts/individuals of the UoA. In the large international consortia, the UoA authors have taken a leading role in particular questions, and frequently appear as first authors of journal articles. They are the leading institution in Swedish participation in EURATOM, and are among the leading space physics groups in the country. On both fronts, the UoA scientists hold major positions of trust, and are active in shaping international research strategies. The large projects, involvement in both experimental, modelling and theoretical work make the research environment very attractive to students as well as senior researchers. The UoA scientists have been successful in obtaining highly competitive research council funding and junior researcher positions.

Vitality and Potential

The research environment is healthy, the total income level is good and the programme is maintained by the long-term projects, meaning vitality and potential were considered good across the majority of the UoA. However, the staff size is small given the tasks and responsibilities, and the number of PhD students could be higher given the size of the academic staff. Furthermore, it seems that the number of senior staff (professors and lecturers) has decreased in recent years. Researcher mobility in terms of longer visits is not very high, but the strong involvement in large international projects requires extensive travel and collaboration at foreign institutions. Staff recruitments have mainly been internal.

Strategy

The UoA strategy is tied to the large international programmes, where the UoA members have successfully striven to have a decisive influence. They have been competitive on the international arena to win these projects, and have also been able to gain national funding for the projects. The programme is highly ambitious, but it appears to be feasible provided the excellent track records of the groups, and thus strategy was deemed excellent but challenging to achieve by the Panel.

Actions for Development

The research activities within the UoA are at a high international level, but more focus could be paid to both undergraduate and graduate education. The Bologna system and the respective MSc programmes should be established to full effect, and the number of PhD students should be increased. The education gives an excellent background to work in the academia as well as in industry, and the demand for PhDs in both fusion and space applications will only increase in the future. For those remaining in academia, there should be incentives to spend a post-doctoral period at a foreign laboratory.

The plasma applications activity provides an excellent opportunity to train both physicists and engineers for exploitation of the largely unused potential for technological plasma applications. While the panel does not recommend this to become a major activity, it is clearly something that should be fostered.

Almost all research is already done in wide international collaboration. These networks should be fostered and new ones created, especially with the emerging industrial powers. This requires maintenance of the in-house experimental activities, as the capabilities they provide are often the "entry ticket" to the large international programmes. The UoA should have an active strategy to seek influence in the governing bodies of the large international organizations.

UoA: Nuclear Power Safety, Reactor Physics and Reactor Technology (NPS)

General Assessment

The UoA consists of three research areas on nuclear fission technology: nuclear power safety, reactor physics, and reactor technology. The research methods involve both modelling and experimental laboratory testing; the latter is facilitated by the experimental laboratory group.

The UoA is known for its activities in severe reactor accident research and transmutation of nuclear waste. While many of the research topics are selected to have relevance for industrial applications and nuclear power regulation, the waste transmutation studies is orientated towards basic research. The UoA has focused on European collaboration, and their strategic aim is to become a key player in selected research areas within Europe.

An important background issue for this UoA is the nuclear phase-out legislation in Sweden. This has resulted in funding cuts for nuclear research, which in turn has caused problems to recruit and maintain permanent research staff and talented students. Most of the funding to the UoA comes from external, non-academic sources: the Unit gets very little funding from the KTH budget, and the research councils have thus far not been able to, or chosen not to, fund nuclear safety research. Furthermore, the number of permanent staff positions is very small. These problems are reflected in the relatively low productivity in terms of peer-reviewed journal publications.

The UoA sees its role as working for the regulating authorities and for industry, and the focus of the projects is thus to serve the Swedish nuclear regulators and power industry. Long-term contracts from these sources form the main part of the budget, as the KTH funding for this activity is small. On the positive side, the contract funding guarantees relative stability to the work, but on the other hand the long-term contracts and the unique laboratory facilities at KTH make the funding almost totally non-competitive. The UoA, rather than being viewed as a university department, is treated more like a "national centre" for maintaining nuclear engineering competence.

The staff pointed out a contradiction in working both for the regulating authorities and for industry, and indicated the need for a more formal agreement in the future to separate the two roles. It is important that a strategic decision is made on the future of nuclear power technology research at KTH. If research in this field is continued, funding from KTH needs to be increased to an adequate level.

Performance Against Evaluation Criteria

Scientific Quality (basic research)

Although the publication activity within the UoA is dominated by conference proceedings, the majority of the UoA was considered to currently perform at an internationally high standard. The total budget of the UoA is sufficient given the staff size. The external funding level is high with the largest grants coming from the ministries, the EU, and the nuclear power industry. The low level of competitive academic research funding obtained from scientific councils is reflected in the relatively low scientific output. The number of produced PhD degrees has been low, but seems to be increasing as the number of students is increasing.

Probably because of the Swedish policy on the phase-out of nuclear power, the majority of PhD students come from other countries. Because there are only limited job opportunities in the nuclear power industry in Sweden for non-Swedish students without fluent language skills, most PhD students pursue academic careers, mostly outside Sweden. This situation is less than ideal for the industry, which covers a large part of the costs for the education.

As of 2005, the group has been a part of the physics department in the KTH organization. This has brought all nuclear science and technology together, while the Unit has continued to develop ties to the engineering groups. The combination of scientific and engineering skills has allowed a fruitful combination of experiments and numerical simulations in a field where full-scale experiments are not possible (e.g., accident scenarios or heat transfer).

As an illustrative highlight, the panel would like to point out the enthusiasm of several PhD students about their research; as an example, Roberta Hansson on steam explosion using a miniaturized experimental setup with advanced diagnostics to monitor individual droplets.

Applied Research

Stability for applied research is provided by a long-term contract between KTH and the Swedish nuclear power industry and regulating authorities, which includes support for professors and lecturers in the field. The panel would like to highlight the efforts in actively getting involved in several EU projects and recognises that part of the UoA currently performs at a world-leading standard, with the main part performing at an internationally high standard.

Scholarship

The Swedish policy of the phase-out of nuclear power has hampered the development of academic scholarship in the field and has resulted in lack of commitment from the senior staff at KTH. Because of the small size of the teams, the loss of a single individual in many cases may lead to a loss of an entire research area; several of the research activities operate below a critical mass. However, scholarship is seen to be emerging in some parts/individuals of the UoA. At present two of the three senior professors are on leave, which shows a lack of leadership and strategic planning within the UoA. This hampers the continuation and evolution of scientific research.

Vitality and Potential

The political decision by Sweden to phase out nuclear power has caused significant funding cuts for nuclear research both from KTH and from the research councils. This has led to lack of professors and talented students. External funding from the regulating authorities and the industry has increased the number of research staff, but has left PhD-level teaching virtually without support. Despite this, vitality and potential can be said to be good in some parts of the UoA, but needs to be improved in the remainder.

Recent external hires have brought new blood to the UoA, and the number of PhD students has increased likewise. The UoA envisions the growth to continue for the next five years at a similar pace. The increase of the number of students should be complemented by an increase in the senior staff. The panel noted specifically the shortage of senior staff in the Nuclear Technology area.

Economically, the UoA is faring reasonably well, the budgets have developed positively and the total income level is high compared to the size of the unit. The positive development seems also sustainable in the future, especially when senior staff recruitment is accomplished.

Strategy

The presented UoA strategy is to expand its research infrastructure to become a world-wide leader in selected research areas. However, the lack of senior staff and clear leadership, as well as a lack of strategy in developing thrust research areas, leave it quite open what those research areas would be or how excellence would be achieved. Thus, the strategy is good but challenging to achieve.

For continued nuclear power use and development, the research should also focus more clearly on basic and applied nuclear power studies such as investigations of long-term operation and power upgrading. Also the good expertise in severe accident studies should be maintained and further developed.

Actions for Development

The academic research component needs to be strengthened, and this will mean clear strategic choices and emphasis on fewer strategically selected projects because of the small size of the group. The unique laboratory infrastructure provides an element to be included in the strategic planning. In all fronts, the UoA should focus on developing academic contacts with international research organizations worldwide, which will bring more new innovativeness to the research planning.

More multidisciplinary work inside KTH with the UoA as one active player should be encouraged. The panel especially welcomes the planning for such work in the materials area.

The UoA should recognize the need to get more Swedish graduate students. The recently started MSc programme offers a good opportunity to entice more young scientists in this research area. Also efforts should be made to recruit young engineers from industry for PhD work.

At present, the UoA is receiving a very low level of funding from KTH. At this level of institutional support, it will be difficult to maintain the facilities and a vital and healthy research programme. Clear strategic decisions are required at the KTH level for the future of nuclear research in the UoA. KTH management should also take actions to actively support the implementation of more permanent senior staff positions within the UoA.

Additional Information

The move of both office and laboratory facilities to new premises is having a positive outcome, but has hampered especially experimental work in the past two years, when delays in the moving process has meant that the equipment has not been in full use.

Summary and Conclusions

The theme on ***energy and environment*** is a very strong combination that involves crucial questions that society needs to address in the immediate future and therefore has large potential to attract students as well as research funding. In the present KTH organization, the energy research does not have a clear "brand", in a sense that energy research and/or energy education would be visible in the KTH programmes. Focusing more on developing overarching themes that would encompass a variety of energy and environment related sciences would certainly be beneficial both to the university and to the individual research groups.

While the assessed units have the international connections in place, other forms of collaboration are not always at optimal level. Cooperation between ET and EPE, and perhaps also FSP and NSP is modest, possibly because the UoAs are strong and independent, and have not felt the need for further networking within KTH. Even if this is true, enhanced collaboration would increase the potential of the individual units. The panel noted a relatively weak level of collaboration within the Swedish (technical) universities. For example, there seems to be no national joint courses within the research area. Common PhD courses offered for all students have, in other places and fields, been shown to intensify research and doctoral studies. National collaboration with other universities with similar ambitions should therefore be encouraged and enhanced.

All UoAs within the research area have a significant (>50%) level of external research funding, whether coming from industry, governmental sources, research councils, or international sources. The UoAs seem to be well able to compete with both national and international peers, and to manage multinational, complex projects with multiple funding sources. However, the strong burden that the high percentage of external funding exerts on the senior staff indicates the need to discuss at KTH level what the adequate level of required external funding is.

The UoAs assessed are heavily dependent on experimental work and high-quality, in-house laboratory facilities. This places a considerable burden on the UoA budgets. KTH should review its accounting policy; the panel would recommend some KTH-level support that would foster maintenance and further development of the valuable in-house experimental capabilities.

In some cases, the panel learned, cross-disciplinary work or research involving several partners at KTH is realized through the centres of excellence. Such activities should have been better highlighted in the evaluation process.

Many units at KTH are highly orientated toward research done in collaboration with and funded by Swedish industry. This is positive, and in many cases in the reviewed UoAs the research was of very high quality, leading to new innovations and in some cases even patents. However, neither KTH nor the individual scientists or students showed strong interest in capitalizing on this research, even if the capital gained might facilitate further research projects and/or equipment purchase. KTH should review its possibilities to support and fund the patenting and commercializing process as a way to increase its income.

The recently recruited professors were concerned about the external funding requirements and indicated that there are some difficulties in starting up a financially stable programme. KTH should revisit its strategy in staff recruitment and startup funding for incoming staff.

All UoAs within the research area are very active in both undergraduate and graduate education. This includes many Europe-wide collaborations (e.g. Erasmus Mundus programmes), e-learning tool development, and significant investments in PhD education. However, most of these activities are driven by motivated individuals with limited connection to and coordination with other education activities. There should be some KTH-level coordination of the education programmes in order not to repeat efforts and to allow students to take full advantage of the education offered at different parts of KTH.

Most UoAs feel that the Bologna process and the creation of independent, English-speaking MSc programmes has increased their possibilities to attract (foreign) students, and has therefore been an asset to the research area. However, there are some concerns about the ability of KTH to maintain the high quality of the PhD education if the study time is limited to the 3-4 years after MSc degree. The panel recommends that the Bologna process be completed KTH-wide, combined with reviewing and possibly revising the criteria for a PhD thesis. Furthermore, KTH should sharpen its criteria for a PhD thesis such that also the industrially orientated students get sufficient academic exposure.

In summary, the research in the evaluated UoAs is generally at high level. In order to ensure future positive development, the role of basic research within each research area should be emphasized, and staff and students should be encouraged to spend extended periods at high-level foreign research institutions.