

# **IOP** | Institute of Physics In Scotland

## **Science and Innovation Strategy for Scotland: Consultation Institute of Physics in Scotland response**

The Institute of Physics is a scientific membership organisation devoted to increasing the understanding and application of physics. It has an extensive worldwide membership (currently over 34,000 with 2,400 in Scotland) and is a leading communicator of physics with all audiences from specialists through government to the general public. Its publishing company, IOP Publishing, is a world leader in scientific publishing and the electronic dissemination of physics.

The Institute welcomes the opportunity to submit its views and comments on the Scottish Executive's Science and Innovation Strategy for Scotland.

### **Consultation questions and response**

#### **Theme 1: In relation to maintaining and developing the excellence of the science research base:**

*1. Do you agree with the long term aspirations listed at the end of theme 1?*

Institute agrees with and welcomes these aspirations.

*2. Do you agree with the short to medium term action points listed at the end of theme 1?*

The Institute fully supports Scottish Executive on these action points.

*3. What do you consider are the two or three most important or pressing science and innovation policy issues under this theme that need to be addressed, and how should the Executive address them?*

- The Scottish Funding Council should reconsider the allocation of their teaching funds for STEM subjects, in particular physics and chemistry. A recent survey of the finances of physics departments in England, commissioned by the Institute, concluded that in 2003-04 all of the departments surveyed were in deficit on a full economic costing (FEC) basis. In part this reflected their very heavy dependence on public funding and the metrics used to allocate those public funds. There is anecdotal evidence to suggest that the situation is similar in Scotland. The Institute of Physics in Scotland were disappointed to hear in an answer to a written Parliamentary Question that SFC have no plans to provide additional funding to support particular departments and would urge the Executive to ask SFC to reconsider.
- The UK government and the Scottish Executive, in recent years, have made a significant commitment to the science base, by doubling the science budget,

which followed years of chronic under funding. Curiosity-driven research, particularly in physics, is long-term in its nature, and the Institute hopes that the money invested into the science base will continue to support this research through responsive mode research council funding.

*4. How should activity under this theme be developed to have most impact on supporting environmental sustainability?*

When decisions are made about the research base, environmental sustainability should be a mandatory part of that decision making process. Research on technological methods to aid environmental sustainability needs to be made available or more readily available if funds are already being provided.

*5. How should activity under this theme be developed to have most impact on improving the quality of life of the people of Scotland?*

The Institute endorses the comments made in the recent report of an independent panel of eminent international physicists and astronomers entitled, *International Perceptions of UK Research in Physics and Astronomy 2005*

[[www.iop.org/Our\\_Activities/Science\\_Policy/Projects/International\\_Review/index.html](http://www.iop.org/Our_Activities/Science_Policy/Projects/International_Review/index.html)], which states:

*“Curiosity-driven research is important in its own right and attracts the most able people into physics and astronomy, but it is also the foundation for the improvement of quality of life and wealth creation in a knowledge-based society. The Panel has noted that some new money entering the science base has been tied up with specific initiatives. Many of these initiatives may be of strategic importance to the UK. However, the Panel is concerned that this could be a creeping trend that would undermine the opportunities of physicists and astronomers to follow their instincts in research, and the UK’s ability to pursue curiosity-driven research at the highest level. The Panel recommends that the research councils monitor the balance between targeted and curiosity-driven research and maintain a healthy balance between the two funding streams.”*

*6. How should activity under this theme be developed to have most impact on encouraging innovation?*

To enable Scotland to reap more of the commercial benefits of its physics base, university physics departments and related groups should have more mechanisms in place to exploit their research in industry. Scottish Enterprise and Highlands and Islands Enterprise have a role to play in facilitating links.

Business innovation can be hampered due to a variety of factors such as a lack of market knowledge, market uncertainty, risk associated with the adoption of new technologies, absence of standards, and a lack of access to relevant skills and expertise. Many of these barriers can be reduced by ensuring that the infrastructure is well developed so that companies can secure necessary help easily and effectively.

In recent years, universities have made enormous progress in interacting with businesses. However, the interests of the business and the academic communities are so different, for example, the timescale and focus for solving problems, that major improvement in Scottish innovation should not rely so heavily on improving the direct interface between business and universities. In any case, the support that universities can provide is restricted in scope and based largely on local technological capabilities.

*7. How should activity under this theme be developed to have most impact on improving connections and synergies between the science research base in Scotland and other sectors, both within Scotland at a UK level and internationally?*

The report, *International Perceptions of UK Research in Physics and Astronomy 2005* [[www.iop.org/Our\\_Activities/Science\\_Policy/Projects/International\\_Review/index.html](http://www.iop.org/Our_Activities/Science_Policy/Projects/International_Review/index.html)], highlighted that the environment in which physics and astronomy research is undertaken has improved vastly in recent years, in part, due to the increased investment in infrastructure through the JIF and SRIF initiatives. This has had a significant impact on attracting and retaining academic staff, who are now working in modern/refurbished laboratories and buildings. In addition, they welcomed the additional direct investment in human resources, such as the much-needed adjustment of stipends for PhD students to an acceptable level, without which many PhD students would not have been able to start or complete their studies. However, many concerns persist, including the effect of successive RAE exercises that have led to the concentration of the best researchers into fewer university physics departments, and a 'one size fits all' policy by government to address issues affecting individual STEM subjects.

Also, it would be useful if the Scottish Funding Council and the Scottish Executive could provide a co-ordinating role between the relevant bodies and organisations such as SUPA, while supporting individual establishments' international efforts.

*8. Which developments or investments under this theme could generate the best return for the people of Scotland, and why?*

No comment.

*9. Which major areas of achievement or excellence under this theme should be promoted by the Executive and its partner organisations?*

The achievements of the renewable, opto-electronic and nanoscience sectors in Scotland should be promoted. The multi-disciplinary approach of major research successes should also be celebrated.

*10. Which performance measures under this theme should be introduced to track Scotland's progress as a "science nation"? What would be appropriate targets?*

No comment.

## **Theme 2: in relation to enhancing international connections and capturing overseas investment.**

*1. Do you agree with the long term aspirations listed at the end of theme 2?*

Institute agrees with and welcomes these aspirations.

*2. Do you agree with the short to medium term action points listed at the end of theme 2?*

The Institute supports these actions and would like to add an aspiration of encouraging our world class younger researchers to spend some time abroad and return to Scotland with new skills and connections.

*3. What do you consider are the two or three most important or pressing science and innovation policy issues under this theme that need to be addressed, and how should the Executive address them?*

Fostering a rich and productive interchange (both ways) between researchers internationally.

*4. How should activity under this theme be developed to have most impact on supporting environmental sustainability?*

No comment.

*5. How should activity under this theme be developed to have most impact on improving the quality of life of the people of Scotland?*

As stated earlier in this response, research is “the foundation for the improvement of quality of life and wealth creation in a knowledge-based society”. So anything which encourages excellent research will improve the quality of life of the people of Scotland.

*6. How should activity under this theme be developed to have most impact on encouraging innovation?*

An extension of the Royal Society of Edinburgh’s exchange scheme for researchers would be helpful.

*7. How should activity under this theme be developed to have most impact on improving connections and synergies between the science research base in Scotland and other sectors, both within Scotland at a UK level and internationally?*

See the answer to Question7 in theme 1.

*8. Which developments or investments under this theme could generate the best return for the people of Scotland, and why?*

No comment.

*9. Which major areas of achievement or excellence under this theme should be promoted by the Executive and its partner organisations?*

Promotion of where international researchers have been successful in Scotland and have enjoyed their stay would help to attract further talent.

*10. Which performance measures under this theme should be introduced to track Scotland's progress as a "science nation"? What would be appropriate targets?*

Numbers of international researchers attracted to Scotland should be measured, as well as their output. Also, it would be useful to know how many home grown researchers go abroad and then return.

### **Theme 3: Intensifying knowledge exchange between academia and business.**

*1. Do you agree with the long term aspirations listed at the end of theme 3?*

Institute agrees with and welcomes these aspirations.

*2. Do you agree with the short to medium term action points listed at the end of theme 3?*

The Institute fully supports Scottish Executive on these action points.

3. *What do you consider are the two or three most important or pressing science and innovation policy issues under this theme that need to be addressed, and how should the Executive address them?*

- Both the Lambert Review of Business-University Collaboration, Final Report, December 2003 and the DTI's Innovation Report suggest that there is little evidence of synergy between company R&D strategies and university research priorities. We see real value in a forum to encourage better understanding of and hence alignment of priorities in the two sectors. However, we urge that there should be good sector diversity, as the risk is that if only those sectors, such as electronics or aerospace, where business-university collaboration is already working relatively well are represented, then the overall problems will remain.
- Links between Universities and Industry is a key issue and, while Scottish Enterprise and Highlands and Islands Enterprise play an important role in catalysing links, we believe that many professional bodies, such as the Institute, have an important role to play in catalysing university-industry links and that this role as an independent and trusted 'bridge' will become increasingly important in future.
- The Institute's physics-based industry report 2003, [http://www.iop.org/activity/business/Publications/Physics\\_Based\\_Industry\\_Report/page\\_4388.html](http://www.iop.org/activity/business/Publications/Physics_Based_Industry_Report/page_4388.html) identified that limited personal interaction between academia and industry is a major barrier to technology transfer. There is no shortage of good ideas in physics departments, but there is limited effective communication of the potential opportunities to industry, and there is less chance to secure funding from industry because of the long term nature of physics research. The Institute is developing programmes to stimulate technology transfer activities in physics-related areas, and in building trust between university physics departments and companies who would be well placed to exploit the ideas. We are in strong agreement with Lambert's conclusion that "the most effective forms of knowledge transfer involve human interaction".

4. *How should activity under this theme be developed to have most impact on supporting environmental sustainability?*

Collaboration in the renewables sector should be vigorously pursued.

5. *How should activity under this theme be developed to have most impact on improving the quality of life of the people of Scotland?*

No comment.

6. *How should activity under this theme be developed to have most impact on encouraging innovation?*

The current grants systems already do a good job in encouraging innovation. See answer to question 3 above.

7. *How should activity under this theme be developed to have most impact on improving connections and synergies between the science research base in Scotland and other sectors, both within Scotland at a UK level and internationally?*

The Institute is in a good position to act as a “bridge” between the various different bodies, given that our membership is drawn from both industry and universities, as well as having an international aspect.

*8. Which developments or investments under this theme could generate the best return for the people of Scotland, and why?*

A concentration on interaction between SMEs and universities would generate the best return, given the high numbers of SMEs in Scotland.

*9. Which major areas of achievement or excellence under this theme should be promoted by the Executive and its partner organisations?*

Examples of successful collaborations are helpful in encouraging others. Perhaps some headline figures of how many collaborations there have been and their contribution to the economy might be helpful.

*10. Which performance measures under this theme should be introduced to track Scotland's progress as a "science nation"? What would be appropriate targets?*

The issue of the difficulty of assessing multi-disciplinary activity and industry-linked research in a consistent way is a critical one. Appropriate recognition and credit to reward multi-disciplinary work and collaborative research with industry is vital. There is a view in the physics community that the RAE has driven ‘applied physics’ out of physics departments because elements of the RAE process, as applied to physics, favoured ‘pure’ science. We need to find a way to redress this.

#### **Theme 4: Expanding Business Innovation**

*1. Do you agree with the long term aspirations listed at the end of theme 4?*

Institute agrees with and welcomes these aspirations.

*2. Do you agree with the short to medium term action points listed at the end of theme 4?*

The Institute fully supports Scottish Executive on these action points.

*3. What do you consider are the two or three most important or pressing science and innovation policy issues under this theme that need to be addressed, and how should the Executive address them?*

- Increased research and development by Scotland's businesses is essential. Business innovation can be hampered due to a variety of factors such as a lack of market knowledge, market uncertainty, risk associated with the adoption of new technologies, absence of standards, and a lack of access to relevant skills and expertise. Many of these barriers can be reduced by ensuring that the infrastructure is well developed so that companies can secure necessary help easily and effectively.
- The flow of high-quality professional physicists into industry is also an issue of concern. Physics graduates are particularly well suited to the needs of industry and business. However, many of those with a four-year MPhys qualification have accumulated debts during their undergraduate study, which will be exacerbated by the introduction of tuition fees. However, they appear to be attracted by the salaries and conditions in the City and other sectors, where their intellectual strength are recognised and rewarded. The result is that too few of them are

staying in research in academe and industry. The problem, primarily, requires attention to the salaries, status, conditions and prospects pertaining to careers in research, both in academe, but particularly in industry. The Institute believes government should provide financial incentives in order to encourage high-quality graduates to train in research. Industry must similarly review the benefits package it offers its researchers

*4. How should activity under this theme be developed to have most impact on supporting environmental sustainability?*

See answers to question 4 of themes 1 and 4.

*5. How should activity under this theme be developed to have most impact on improving the quality of life of the people of Scotland?*

No comment.

*6. How should activity under this theme be developed to have most impact on encouraging innovation?*

Scotland should consider establishing a Scottish Innovation Agency with a remit to promote broad-based innovation and not limited to technological innovation. Such an agency will need to build links and partnerships with other networks and centres.

*7. How should activity under this theme be developed to have most impact on improving connections and synergies between the science research base in Scotland and other sectors, both within Scotland at a UK level and internationally?*

See answer to question 6.

*8. Which developments or investments under this theme could generate the best return for the people of Scotland, and why?*

No comment.

*9. Which major areas of achievement or excellence under this theme should be promoted by the Executive and its partner organisations?*

No comment.

*10. Which performance measures under this theme should be introduced to track Scotland's progress as a "science nation"? What would be appropriate targets?*

As stated in the consultation document, OECD measures of R&D would be a useful measure, with a target to reach the top quartile of EU regions.

#### **Theme 5: Modernising Science Education and Promoting Science Careers.**

*1. Do you agree with the long term aspirations listed at the end of theme 5?*

Institute agrees with and welcomes these aspirations.

*2. Do you agree with the short to medium term action points listed at the end of theme 5?*

The Institute fully supports Scottish Executive on these action points.

*3. What do you consider are the two or three most important or pressing science and innovation policy issues under this theme that need to be addressed, and how should the Executive address them?*

- It is crucial to have a good supply of well trained and motivated teachers in each subject specialism. These teachers also need to be supported by subject specific CPD, which can incorporate generic training in a relevant way. High quality CPD is also required by teachers of science who are not specialist, i.e. primary teachers, S1, S2. The Physics Teacher Networks, covering the whole of Great Britain and Ireland, have been established by the Institute to provide support for physics teachers by physics teachers. Local coordinators organise and co-ordinate local group activities and in service training, including a summer school, which help to forge better links between school sectors and between schools and HE, act as a source of information about local initiatives and activities, and generally provide help and advice in response to requests.
- Practical and experimental work are key to enthusing school pupils in science subjects (especially girls), and large class sizes and a lack of resources make it difficult to provide pupils with this experience. This means that science laboratories should be well funded and that teachers have support from well trained and motivated technicians.
- It is imperative that an educated student market is created. A significant problem facing science, and particularly physics, is that students are making ill-informed subject choices between the ages of 12-15. Teachers, parents, careers advisors should be in a position to highlight the benefits and the wide variety of career options that are available from science. This might be achieved by a combination of approaches, including training of career's advisors (who tend to come from non-scientific backgrounds) and science teachers in careers. The Institute recognises that the need in schools and colleges is to promote opportunities across the whole spectrum of STEM and therefore careers work must be done in partnership. The Institute already works with other professional bodies to produce a joint literature and attend events promoting careers in STEM.
- The Scottish Funding Council should reconsider the allocation of their teaching funds for STEM subjects, in particular physics and chemistry. A recent survey of the finances of physics departments in England, commissioned by the Institute, concluded that in 2003-04 all of the departments surveyed were in deficit on a full economic costing (FEC) basis. There is anecdotal evidence that the situation is similar in Scotland. In part this reflected their very heavy dependence on public funding and the metrics used to allocate those public funds.

*4. How should activity under this theme be developed to have most impact on supporting environmental sustainability?*

Environmental sustainability should be incorporated into the curriculum. It would fit very nicely in a cross-curriculum way.

*5. How should activity under this theme be developed to have most impact on improving the quality of life of the people of Scotland?*

If science can be seen as part of the culture of every single person in Scotland, this will have a huge impact on the quality of life of people in Scotland, in that a scientifically

literate population will be able to take part in meaningful debates on the scientific issues of the day, such as genetically modified foods and climate change.

*6. How should activity under this theme be developed to have most impact on encouraging innovation?*

When sciences are learned in schools, it should be seen and taught as an innovative, relevant, practical, creative and investigative subject, rather than a body of facts to be learned.

*7. How should activity under this theme be developed to have most impact on improving connections and synergies between the science research base in Scotland and other sectors, both within Scotland at a UK level and internationally?*

More connections between schools and universities should be encouraged and funded. These links could be expanded out to international exchanges.

*8. Which developments or investments under this theme could generate the best return for the people of Scotland, and why?*

The biggest return will be generated by maintaining and increasing the supply of scientists into the economy, with particular attention given to science teachers, across the whole of Scotland. Perhaps consideration should be given to giving bursaries to students who go on to do strategically important subjects at university. The Institute already has a bursary scheme which offers £3000 to do a physics degree to selected students.

Up-to-date, high quality and region specific careers advice should be readily available to the main influencers of students and pupils.

*9. Which major areas of achievement or excellence under this theme should be promoted by the Executive and its partner organisations?*

Successful and co-ordinated partnerships with various different bodies for CPD of teachers through SSERC, the Local Authorities and the Science Centres should be promoted.

Collaborative involvement of all the various organisations in developing and implementing "A Curriculum for Excellence" should be promoted.

*10. Which performance measures under this theme should be introduced to track Scotland's progress as a "science nation"? What would be appropriate targets?*

The numbers of people taking STEM subjects at school and university should be measured, as well as the number continuing in a STEM career. Appropriate targets at higher levels of study should be tied into the predicted requirements for STEM skills. The Scottish Executive should set targets for the proportion of science classes taught to the 14-19 age range by subject specialists and collaborate with educational and scientific bodies to implement policies designed to meet the new targets.

## **Theme 6: Increasing Public Engagement with Science.**

*1. Do you agree with the long term aspirations listed at the end of theme 6?*

Institute agrees with and welcomes these aspirations.

*2. Do you agree with the short to medium term action points listed at the end of theme 6?*

The Institute fully supports Scottish Executive on these action points.

*3. What do you consider are the two or three most important or pressing science and innovation policy issues under this theme that need to be addressed, and how should the Executive address them?*

- A more strategic approach to outreach is necessary. A co-ordinating body for STEM outreach should be set up. This should include representatives from the main providers of STEM outreach and should maintain a strategic overview of outreach to avoid overlaps and to fill gaps in provision.
- It is important that scientists communicate their work skilfully. Methods of communication should be chosen carefully so that good role models are provided to counter any negative stereotypes perpetuated by the media.

*4. How should activity under this theme be developed to have most impact on supporting environmental sustainability?*

Communicate to the public and the academic scientific community that science (and physics in particular) is at the forefront in developing new technologies which are tackling climate change and is integral to understanding its processes, via climate change models.

*5. How should activity under this theme be developed to have most impact on improving the quality of life of the people of Scotland?*

A good combination of public engagement activities is required to satisfy the diversity of needs. Rural outreach should not be forgotten.

*6. How should activity under this theme be developed to have most impact on encouraging innovation?*

Although the Institute recommends a co-ordinating group, this group will have to strike a balance between encouraging innovative and diverse outreach and co-ordination. There is a danger that such a body might stifle creativity and innovation in the sector.

*7. How should activity under this theme be developed to have most impact on improving connections and synergies between the science research base in Scotland and other sectors, both within Scotland at a UK level and internationally?*

Partnerships with universities and industry should be brokered to encourage greater communication between these sectors and the general public.

*8. Which developments or investments under this theme could generate the best return for the people of Scotland, and why?*

Strategic co-ordination of public engagement would generate the best return. Events throughout the year could be designed to culminate in a big event, such as the “Young Scientist of the Year Competition and Exhibition” held in Ireland. This is a hugely successful event, which has generated excellent and significant publicity for science in Ireland.

*9. Which major areas of achievement or excellence under this theme should be promoted by the Executive and its partner organisations?*

No comment.

*10. Which performance measures under this theme should be introduced to track Scotland's progress as a "science nation"? What would be appropriate targets?*  
One measure would be public attitudes to science through Mori polls, etc. Another would be the number of people taking up science at school and university.

**Theme 7: Developing Better Use of Science by Government.**

*1. Do you agree with the long term aspirations listed at the end of theme 7?*  
Institute agrees with and welcomes these aspirations.

*2. Do you agree with the short to medium term action points listed at the end of theme 7?*  
The Institute fully supports Scottish Executive on these action points.

*3. What do you consider are the two or three most important or pressing science and innovation policy issues under this theme that need to be addressed, and how should the Executive address them?*

Good, independent science and evidence should be a consideration in every aspect of policy making. The appointment of a Chief Scientific Adviser and Office is an excellent step in this direction. Formation of a subject committee for science in the Scottish Parliament would be a useful way of scrutinising science policy and further raising the profile of science in the parliament and amongst the wider public.

*4. How should activity under this theme be developed to have most impact on supporting environmental sustainability?*

Environmental sustainability should be considered in every aspect of government policy.

*5. How should activity under this theme be developed to have most impact on improving the quality of life of the people of Scotland?*

Policy decisions based on scientific evidence would have the most impact.

*6. How should activity under this theme be developed to have most impact on encouraging innovation?*

No comment.

*7. How should activity under this theme be developed to have most impact on improving connections and synergies between the science research base in Scotland and other sectors, both within Scotland at a UK level and internationally?*

A pairing/exchange scheme between top civil servants, Scottish Executive ministers, Parliamentarians and a research scientist could be developed.

Also links with the Chief Scientific Adviser in Whitehall should be continued, as well as appropriate links internationally.

Links with possible funding streams should be explored, e.g. from the Research Councils and large charities.

*8. Which developments or investments under this theme could generate the best return for the people of Scotland, and why?*

Some futures thinking and then action about what technologies and skills will be required in a modern Scotland would generate excellent returns.

*9. Which major areas of achievement or excellence under this theme should be promoted by the Executive and its partner organisations?*

The Chief Scientific Advisor should continue to be promoted vigorously.

*10. Which performance measures under this theme should be introduced to track Scotland's progress as a "science nation"? What would be appropriate targets?*

One measure would be the number of policy decisions based on scientific evidence, with a target for all of them.

### **General issues**

*11. Do you consider the themes identified are the most useful, or are there others which should be added? Are there any that should be dealt with in another way?*

The Institute agrees with the themes chosen. That said, an overarching, strategic theme would be useful. This would be an “enabling” theme, which would set out possible methods of making the most of synergies and links between the themes. This could include communications, strategic structures, etc.

*12. Please feel free to comment on any important aspect of science and innovation strategy that you think is not adequately covered by the themes and questions above.*

The Institute would like science to be seen as a core part of everyday life. One method would be to have science as a core part of the curriculum, with a similar status to that of English and mathematics.

### **Girls and women in physics**

Over this period the participation rate of girls in Higher physics has remained fixed at around 30% since 1990. If girls were more proportionally represented, recruitment to physics A-level could be improved substantially. The emerging evidence is that key determinants of students' attitudes to physics are:

- How relevant students see physics being to them both now and in the future;
- Their experience of school physics; and
- A personally supportive physics teacher.

Negative experiences in these areas appear to have a greater impact on girls than boys. Therefore, the key issues to address are:

- Strategies to engender greater engagement and participation by girls in physics;
- Helping teachers to improve their understanding of gender issues and implement change;
- Quality of careers guidance in science and the awareness of careers advisors and teachers of the gender dimension in relation to STEM; and
- The extent to which the National Curriculum portrays an accurate and contemporary picture of the role of physics in the modern world and supports students' understanding of professional and technical careers.

The proportion of young women in physics after Higher falls to around 20% through undergraduate physics and postgraduate physics but thereafter declines at every level in both academia and industry. In academia, a particular barrier for women wishing to have

children is the series of short-term contracts that is required prior to the first permanent appointment, for which the average age is 35 This is also a negative effect of the RAE, where departments want established researchers who can produce high-quality papers, and women are disadvantaged especially if they go on career breaks, along with young, up and coming academics. Therefore, funders of HE and research should continue to press for positive action on the recruitment, retention and promotion of female researchers and academic staff.

The Women and Work Commission's report, *Shaping a Fairer Future*, made several recommendations on increasing the role of part-time and flexible working in higher status jobs. These recommendations should be followed through.

If you have any queries about any of the points raised, please do not hesitate to contact me.

Yours faithfully

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