

Campaign for  
Science &  
Engineering  
in the UK



The views of members and supporters of CaSE

April 2007

# ***Science and Engineering Policies for the Next Welsh Assembly***

## ***Agenda 2007-2011***



**[www.sciencecampaign.org.uk](http://www.sciencecampaign.org.uk)**

## Introduction

For centuries, scientists and engineers have contributed to the social, economic, environmental and cultural life of Wales. Their potential contribution to the well-being of the nation is huge, and if that potential is to be fulfilled, Welsh scientists, educators, technologists and businesspeople will need to operate in a supportive and positive framework of policies.

Recent months have seen a revival of interest in science policies in Wales, with both the National Assembly and the Welsh Government conducting policy reviews [Refs 1 and 2]. The First Minister in the Assembly that sat between 2003 and 2007, Rhodri Morgan, appointed himself as Science Minister because of the importance the subject has across all areas of Government.

This document, *Science and Engineering Policies for the Next Welsh Assembly: Agenda 2007-2011*, sets out a shortlist of science policy priorities for Wales, together with some of the facts and analysis that supports them. As a campaigning organisation, CaSE believes that this list represents a challenging but realistic programme for the National Assembly for Wales that will sit between 2007 and 2011.

## Cyflwyniad

Dros y canrifoedd bu gwyddonwyr a pheirianwyr yn cyfrannu'n helaeth a chyson i fywyd cymdeithasol, economaidd, amgylcheddol a diwylliannol Cymru. Er bod gan wyddonwyr, addysgwyr, technegwyr a phobl busnes Cymru gyfraniad sylweddol i'w gynnig i'r genedl o hyd, ni wireddir y potensial hwn oni bai ei bod yn bosibl iddynt weithredu yn rhan o fframwaith integredig o bolisiau cefnogol a phositif.

Yn ystod y flwyddyn ddiwethaf gwelwyd adfywiad diddordeb mewn polisi gwyddoniaeth yng Nghymru. Arweiniwyd arolygon gan y Cynulliad Cenedlaethol a Llywodraeth Cymru [Cyf. 1 a 2], a sefydlodd Rhodri Morgan, Prif Weinidog y Cynulliad rhwng 2003 a 2007, ei hun yn Weinidog Gwyddoniaeth. Gwnaeth hyn am iddo deimlo bod safle a chyfraniad gwyddoniaeth mor bwysig ar draws holl adrannau'r Llywodraeth.

Mae'r ddogfen hon, *Polisiau Gwyddoniaeth a Pheirianneg i Gynulliad Cenedlaethol Cymru: Agenda 2007 - 2011*, yn cyflwyno fframwaith o flaenoriaethau o bolisiau gwyddoniaeth i Gymru, ynghyd â ffeithiau a dadansoddiad cefndirol. Fel cyfundrefn ymgyrchu, cred CaSE (Ymgyrch dros Wyddoniaeth a Pheirianneg) y cyflwyno'r rhestr hon rhaglen realistig, ond heriol, i Gynulliad Cenedlaethol Cymru ar gyfer 2007 - 2011.

---

1. *Review of Science Policy in Wales*, Enterprise, Innovation & Networks Committee of the National Assembly for Wales, 2006.

2. *A Science Policy for Wales: The Welsh Assembly Government's Strategic Vision for Sciences, Engineering & Technology*, Welsh Assembly Government, 2006.

## Science and engineering policies for the next Welsh Assembly

- The Government of Wales needs a vibrant, wide-ranging set of policies on science and engineering that encompasses the ways in which science education and research are organised and funded. Its current science policy is in fact little more than a list of areas of political priority, such as health and the environment, in which science and engineering inevitably play a major role. It says little about how to harness the power of science to address the challenges.
- Wales's science policy suffers because it has no centre of focus within the structure of the National Assembly. The Assembly should appoint an independent Chief Scientist from academia or industry, with the power to drive forward a scientific and engineering agenda for Wales.
- The quality of Welsh research is high. Levels of funding for university research in Wales need to be raised at least to the levels of other parts of the UK, preferably higher. The core research funding budget of the Higher Education Funding Council for Wales is in urgent need of a substantial boost. Since this would enhance the platform from which institutions could apply for external funding, the benefits of such a move would be disproportionate to the costs.
- Like the rest of the UK, there is a shortage of well-qualified science teachers in Wales. There is also evidence that Welsh schools are less well-endowed with science facilities. The teacher shortage is exacerbated by the need to appoint staff who can teach science through the medium of Welsh. Urgent action is needed to increase the recruitment and retention of science teachers, including salary premiums for those in shortage subjects.
- There is a very low rate of work-based learning in engineering and manufacturing in Wales. Since Wales has a relatively high number of small, high-technology companies, more must be done to encourage these employers to engage with training and education system.
- Funding per university student is about £1,000 per head per year lower in Wales than in other parts of the UK. Unless this is addressed within the next few years, some parts of the Welsh higher education system are at risk of becoming second class places for the study of crucial science and engineering subjects.
- Wales has few large companies but a relatively high proportion of smaller, science-based enterprises. Everything should be done to capitalise on this strength, within the confines of the devolution settlement which does not allow Wales to offer these companies attractive rates of corporation tax. Existing small companies should be given help to grow and the formation of new small companies encouraged.
- Wales's universities have an admirable track record of generating income from their research and should be careful not to follow the more restrictive routes to commercialisation that are stifling such activities elsewhere.
- To obtain the highest quality scientific advice to inform policies on a wide range of relevant subjects, the Welsh Government should invest substantially more in policy-driven scientific research.
- Welsh science should be given opportunities by the people of Wales to celebrate its achievements to the same degree that literary, artistic and musical prowess is celebrated in Wales.

## The science & engineering research base in Wales

The science and engineering research base in Wales is the foundation on which all other scientific aspects of national life depend. It is the bedrock of the knowledge economy.

### The outputs of the research base

Figure 1 shows the output of scientific research papers published by researchers in England and Wales over the last two decades. Over that period, and especially since about 1990, the research output of Wales has grown faster than that of England.



Figure 1. Number of scientific papers published each year where at least one of the authors had an address in England (black line) or Wales (red line), scaled so that in each case, 1981=1 [Ref. 1].

At the same time, the overall quality of Welsh scientific research has also improved. Figure 2 shows how the number of times that Welsh researchers' articles are cited by others in the scientific community has risen relative to English research. In the 1980s, the impact of Welsh science and engineering was only about half as great as that produced by English researchers. It is clear that measured in this way, it is now roughly comparable to the output of English research.

This is consistent with the results of the last Research Assessment Exercise. Welsh universities had departments that were active in research in 21 science and engineering subjects. Of these, the average score in Wales was higher for ten subjects than it was in the rest of the UK [Ref. 2].

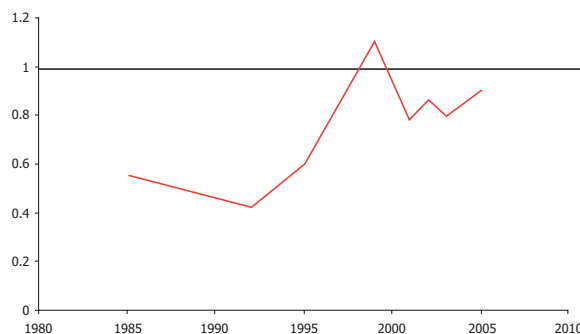


Figure 2. Average number of citations per paper for research papers published from Welsh addresses, relative to the number for English papers, scaled so that the English average=1 for all years [Ref. 3].

### Funding for Welsh research

Unfortunately, despite its achievements and potential, the level of investment in the Welsh science base is lower than in other parts of the UK.

For example, Figure 3 shows how much less research funding the UK-wide Research Councils invest in science in Wales than they do in Scotland or England.

In part, these differences are due to historical factors relating to the location of the Research Councils' own institutes, of which there are two in Wales (The Institute of Grassland and Environmental Research in Aberystwyth and

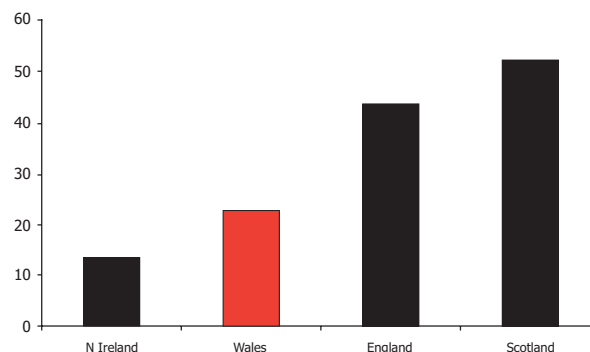


Figure 3. Investment by the Research Councils in the different countries of the UK in the financial year 2005-06 in £ per head of the population [Ref 4].

1. *ISI Web of Science* database.
2. *2001 Research Assessment Exercise The Outcome*, HEFCE.
3. *ISI Web of Science* database, using random samples of 200 research papers (excluding book reviews, letters etc.) with English and Welsh addresses for each year.
4. *Hansard*, House of Commons, 7 March 2007, Column 1996W.

The Centre for Ecology and Hydrology at Bangor). In Wales, 17% of total expenditure is used in this way. Because England and Scotland have greater concentrations of such institutes, they receive 28% of total funding in Scotland and 37% in England, and their overall allocations are much greater.

That does not, however, explain the whole picture, because even with Institute expenditure removed, Research Council investment per head is 60% higher in England - and 136% higher in Scotland - than it is in Wales [Ref. 5].

Research Council income is obtained through a competitive process of bidding for grants, and the First Minister has rightly pointed out that if Welsh researchers were more successful in obtaining such grants, the Welsh scientific economy could be boosted [Ref. 6]. Since the Research Councils are not devolved, this could occur without impacting on the Assembly's budget.

However, success in obtaining Research Council grants depends in part on the strength of the base from which university researchers apply. In the 'dual support' system of funding that operates in UK universities, the basic infrastructure of laboratories is funded by the Higher Education Funding Councils. These budgets are devolved in both Scotland and Wales.

As Figure 4 shows, researchers in Wales lose out in this element of funding. Per head of the population, their funding from this source is only 60% of the level in Scotland and 80% of the level in England or Northern Ireland.

The single most important difference that could be made to science in Wales's universities would be for the Welsh Assembly to show the political will not just to close but to reverse that gap. This would create a stronger base from which to apply for other external funds, both from the Research Councils and from other sources such as charities and industry. Because of the extra resources that would be attracted in this way, the effect would be disproportionately greater than the cost to the Assembly's budget.

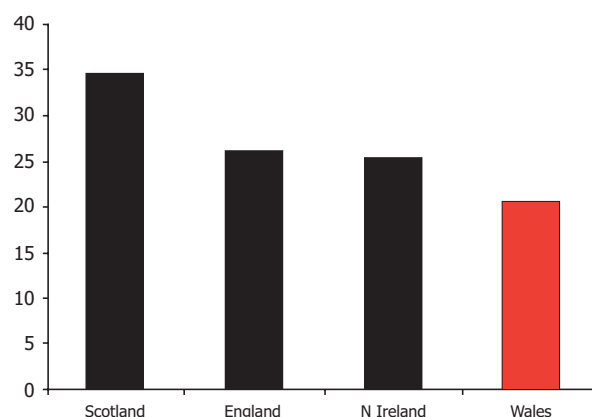


Figure 4. Annual Quality-Related funding for research by the Higher Education Funding Councils, in £ per head of the population [Ref. 7].

### **Overall assessment**

***The science and engineering base in Wales is of high quality, but is threatened by severe underfunding.***

5. Hansard, House of Commons, 4 December 2006, Column 15W.

6. In a speech to the Institute for Welsh Affairs, 16 October 2006.

7. Websites of HEFCW, SFC, DELNI and HEFCE.

## Science & engineering education in Wales

### Primary school level

Although the Welsh Government claims that 'at the schools level, the standard of science teaching and learning have risen impressively in primary schools' [Ref. 1], there does not appear to be any evidence that Welsh primary schools are in a strong position to deliver an early grounding in science. Indeed, most primary school teachers are not trained scientists (for example, 47% across the UK have no physics qualification of any kind).

Partly as a consequence, primary school teachers lack confidence in their own ability to engage children with scientific topics. Only about half of primary school teachers say they have 'a lot of confidence' in teaching science, appreciably lower than the two thirds who are self-assured in teaching English [Ref.2]. Moreover, some aspects of primary-level science may be worse in Wales than in England. For example, a very recent survey shows that while only 50% of primary school teachers in England and in Scotland believe they have 'good resources' for teaching science, in Wales the figure was even lower at 42% [Ref. 3]. A third of primary science teachers lack the confidence to relate scientific material to everyday life.

Clearly, more needs to be done to support science at primary school level if young people are to be given the best start in contributing to science-driven economy of the present and the future.

### Secondary level

Of the teaching vacancies in secondary schools in Wales in 2006, 14% were in mathematics, and 19% in the sciences. Since 1991, the shortage of teachers had grown (as a percentage of all vacancies) in physics, mathematics, computer sciences and general science [Ref. 4].

When the General Teaching Council for Wales surveyed schools in Wales [Ref. 5], it found the largest numbers of unqualified teachers were in mathematics and computer science, and a fall in

the number of applicants for each advertised post in maths and sciences. There were four subjects where schools were not able to fill at least 90% of posts, and three of those were chemistry, physics and mathematics. Further, the number of experienced teachers who are leaving to seek employment elsewhere or who are retiring early means that in one year alone, 482 years of collective experience was lost from the mathematics workforce in this way and 302 years from biology teaching (these figures do not include teachers dying, reaching retiring age, moving to schools outside Wales or leaving the classroom to take up posts such as that of head teacher).

Although direct comparisons with other parts of the UK are impossible, these figures show that Welsh schools certainly cannot be complacent, and that the supply of well-qualified teachers is no less problematic in Wales than it is elsewhere.

Wales has a special challenge in teacher recruitment because of the need to teach pupils a variety of subjects through the medium of the Welsh language. The scientific community feels that some areas of science may be especially badly affected by this requirement [Ref. 6]. That is consistent with the fact that less than 1% of those students most likely to become Welsh language science teachers - science students at Welsh universities - are given any teaching in Welsh [Ref. 7].

Moreover, the Teaching Council found that for jobs where staff needed to teach in Welsh, there were three applicants for every post in geography, 2.4 in religious education and two in history, there was only one applicant for every chemistry post and 1.1 for every mathematics post [Ref. 5].

This means that Wales has to work even harder than England to solve the problem of a lack of qualified science teachers. There is some reason to hope that improvements are possible, with rises in the number of trainee teachers in Wales

1. National Assembly Economic Development & Transport Committee, Paper EDT(2) 12-05 (p1).
2. *A study into the professional views and needs of science teachers in primary schools*, Council for Science & Technology, 2000.
3. *Primary Horizons: Starting out in science*, The Wellcome Trust, 2005.
4. National Assembly for Wales, *Schools in Wales: General Statistics 2006*.
5. *Teacher Recruitment and retention survey*, General Teaching Council for Wales, 2002.
6. *A coordinated and effective science policy for Wales*, CaSE, 2005.
7. *Welsh in Higher Education Institutes 2004-05*, Office for National Statistics, 2006.

between 2000 and 2004 of 25% in mathematics, 40% in chemistry and 50% in physics [Ref. 9].

### Further education & training

Figure 5 shows that although the proportion of people in further education and training in science and mathematics in Wales is, if anything, marginally higher than it is in England, there is a significant failure in the fields of engineering and manufacturing. This problem is especially acute in work-based learning, where England has a proportion almost four times as great as Wales.

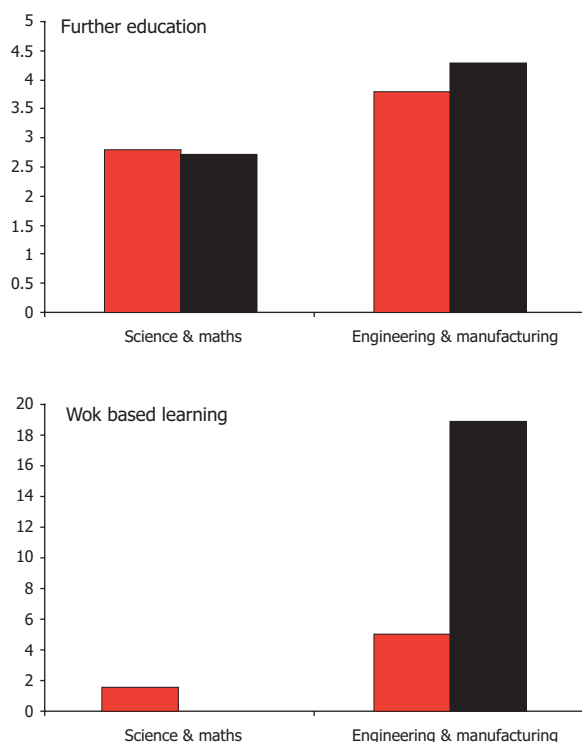


Figure 5. Percentage of students in further education and in work-based learning in science/mathematics and in engineering/manufacturing in Wales (red) and England (black) [Refs. 10 and 11].

### Higher education

Between 2002 and 2004, the number of British students studying physical sciences in the UK as a whole rose by almost 10%, but in Wales, the

figure fell by 7%. While the number of students registering to study mathematics at Welsh institutions was constant, in the UK as a whole, there was an increase of almost 20% in mathematics students. Engineering and technology were the only scientific disciplines to buck the trend, with a modest increase in enrolments in Wales (of 3%) compared to a small fall (of 4%) in the number of students throughout the UK [Refs. 12 and 13].

Funding per student is much lower in Wales than in England. Exact comparisons are difficult and data are always slightly out of date, but Figure 6 shows that grant aid per science student in Wales was already almost £1,000 lower per year in 2003 than it was in England and Scotland [Ref 14].

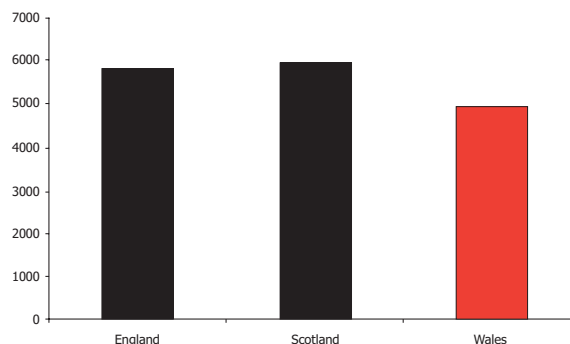


Figure 6. Public funding for science students at university (2003) in £ per student per year [data explained in Ref 14].

That gap has grown and the relative situation for Wales was exacerbated still further at the end of 2006 when the English Funding Council announced an additional £75 million for students of chemistry, physics, materials science and some parts of engineering [Ref 15].

### Overall assessment

***A shortage of qualified science teachers threatens the future of the Welsh economy, not enough people are training as engineers and university science departments are underfunded.***

9. *Initial Teacher training in Wales 2004-05*, Office for National Statistics, 2006.

10. *Learning activities at FEIs, Adult CL or other training providers*, Welsh Assembly Government (accessed in February 2007).

11. *Further education, work-based learning and adult community learning - learner numbers in England 2005/06*, Office of National Statistics, 2006.

12. *Higher Education Enrolments at Welsh Higher Education Institutions*, Welsh Assembly Government (accessed in February 2007).

13. *All HE students by level of study, mode of study, subject of study, domicile and gender 2004/05 and 2002/03*, Higher Education Statistics Agency.

14. The best description of the problem with an explanation of data is in *Agenda*, Spring 2006.

15. HEFCE to provide an additional £75 million to support very high cost and vulnerable science subjects, HEFCE press release, November 2006.

# The contribution of science & engineering to the economy of Wales

## Private sector investment in research

Science and engineering are major drivers of the economies of advanced industrialised nations, and it is crucial to Wales's future success that companies in Wales perform vibrant research and development, and that they have in place strong mechanisms to utilise both their own research findings and those of the universities.

As Figure 7 shows, overall private sector investment in research and development has grown substantially in Wales in recent years, faster than many other regions in Europe. Wales, however, started from such a poor base that industrial investment in research and development remains stubbornly low in Wales relative to many other parts of Europe.

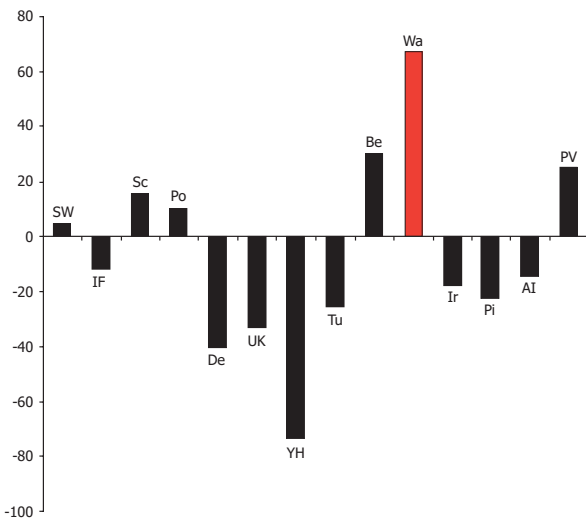


Figure 7. Percentage change in private sector R&D as a proportion of GDP between 1996 and 2003 in the South West of England, the Ile de France, Scotland, Poland, Denmark, the UK, Yorkshire and Humber, Tuscany, Belgium, Wales, Ireland, Piemonte, Alsace and Pais Vasco [Ref. 1].

Figure 8 shows how, despite the rapid percentage growth in recent years, private sector investment remains lower in Wales than in other small industrialised countries like Denmark and Belgium, lower than the UK average and less than half that of the neighbouring region of the South West of England.

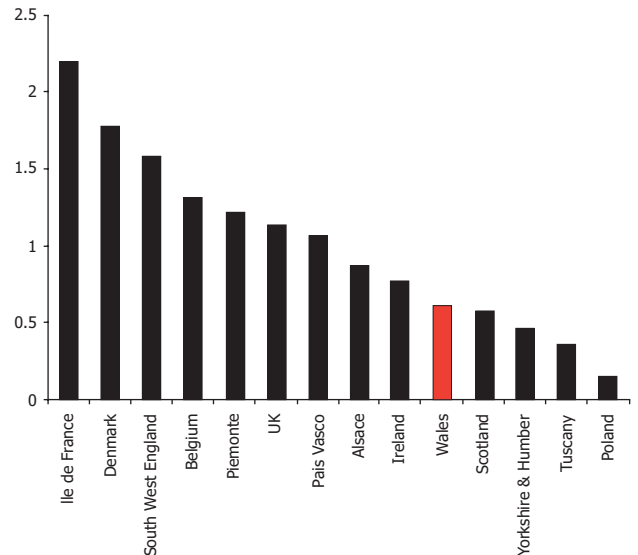


Figure 8. Percentage of GDP invested in business R&D in different countries and regions of Europe (2003) [Ref. 1].

## Companies in Wales

Although Wales has a very low number of companies listed on the stock exchange (7.4 per million of the population compared with 14.0 in the English Midlands, 25.5 in the South West of England, 32.9 in East Anglia and 37.0 in Scotland), it performs relatively well in the science-based business sector.

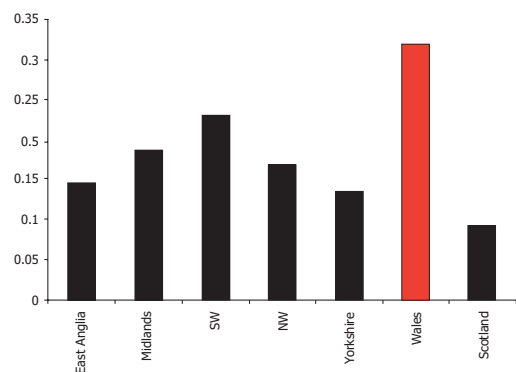


Figure 9. Proportion of listed companies that performed enough R&D in 2005 to be included in the R&D Scoreboard 2006 [Refs. 2 and 3].

As Figures 9 and 10 demonstrate, a relatively high proportion of the listed companies based in Wales are research-intensive, and among those

1. Total intramural R&D expenditure (GERD) by sectors of performance and region, Eurostat.  
 2. www.londonstockexchange.com (accessed in February 2007).  
 3. R&D Scoreboard 2006, DTI, 2006.

science-based companies, there is a high percentage of smaller enterprises.

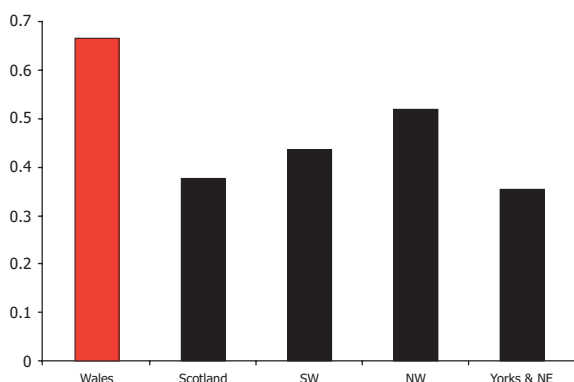


Figure 10. Proportion of companies in the R&D Scoreboard that have a market capitalization of less than £50 million [Refs. 1 and 2].

**Knowledge transfer from the universities**

In terms of generating economic activity from the science base, the universities in Wales are very efficient at generating profits from their discoveries. This is not so much because the Welsh universities are generating a huge income from their intellectual property, but because their costs in doing so appear to be very low (11% of the income generated compared with 23% in Scotland, 62% in Yorkshire and the North East and 84% in the South West of England), so their efforts are financially very efficient.

As Figure 11 shows, this means that the income generated for the Welsh economy from such activities is currently high by the standards of

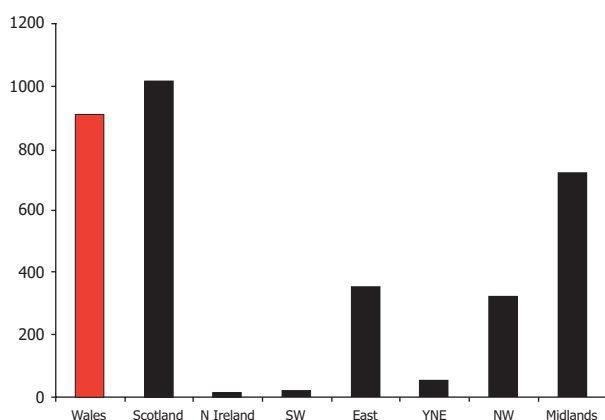


Figure 11. Net income per 1000 head of the population from universities' intellectual property in different parts of the UK [Ref. 3].

other parts of the UK.

In general, UK universities have been putting more and more resources into protecting their intellectual property, but have generated less and less income from doing so [Ref. 3]. Wales must preserve its relatively *laissez faire* efficiency in this field and not go down the route experienced in England.

**Overall assessment**

***Small, high-technology companies are a strength in the Welsh economy and Welsh universities are making a strong contribution, but more needs to be done to stimulate private sector research, development and innovation.***

1. www.londonstockexchange.com (accessed in February 2007).  
 2. R&D Scoreboard 2006, DTI, 2006.  
 3. Higher education-business and community interaction survey, HEFCE 2006.

# The importance of science and engineering to society and government

## Science to inform government policy

The amount of money invested in science for policy making in Wales has risen at a faster relative rate than in other parts of the UK since devolution (see Figure 12).

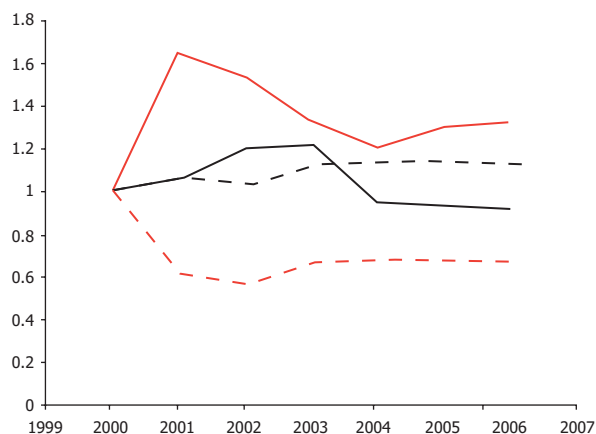


Figure 12. Investment in research via civil ministries in real terms in Wales (solid red line), Scotland (broken black line), England (solid black line) and Northern Ireland (broken red line) scaled so that the year figure for the year 2000=1 in each case [Ref 1].

However, as Figure 13 demonstrates, in absolute terms such investment remains low by the standards of the rest of the UK and other parts of Europe.

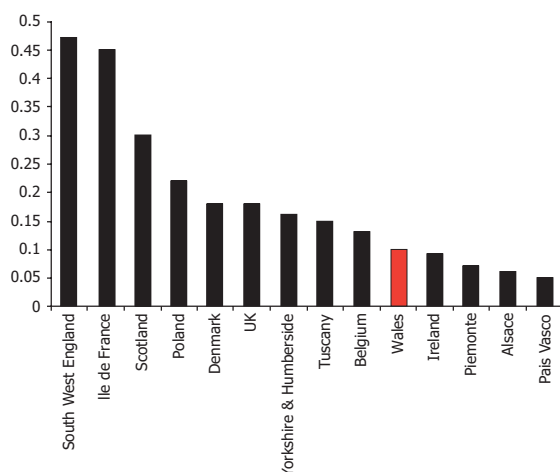


Figure 13. Government-sector research and development as a proportion of GDP in some different countries and regions of Europe [Ref. 2].

## Public attitudes to science

Wales has an excellent track record in science and engineering dating back at least to the sixteenth century, when Robert Recorde revolutionised mathematics by inventing the equals sign (=). In engineering, radar was developed by a team of pioneers among whom Eddie Bowen, a native of Swansea, was especially important. From North Wales, Martha Hughes Cannon of Llanrwst was a pioneer of children's medicine. The Health Department of the State of Utah is named after her. As demonstrated on pages 3 and 4, this excellence continues.

But in part, this is all overshadowed because Wales has such a unique method of celebrating its other achievements - notably those in literature, musics and the arts - through eisteddfodau. Scientific achievements do not tend to be celebrated with the same energy.

## The devolution settlement for science

While the Government of Wales Act 1998 gave primary jurisdiction over some aspects of science to the National Assembly, it reserved other issues to the UK Government.

The result is a complicated picture, with educational issues largely devolved, but research issues only partly so, and with many economic issues (such as tax breaks for research) being wholly outside the competence of the Assembly.

The First Minister has said that since 'science policy' is formally not devolved, his Government is hampered in what it can achieve [Ref. 3]. But this is true only to the extent that the Assembly's lack of ambitions make it so. There is nothing in the devolution settlement, for example, to stop the Assembly investing more in science.

## Overall assessment

***To maximise the benefits of science and engineering under devolution, the Welsh Government needs a stronger focus on what could be delivered.***

1. Net Government expenditure on R&D by departments in real terms, SET Statistics, DTI (accessed in February 2007).  
 2. Total intramural R&D expenditure (GERD) by sectors of performance and region, Eurostat.  
 3. In a speech to the Institute for Welsh Affairs, 16 October 2006.

## CaSE in Wales

CaSE is a small organisation with a primary focus on science policies in Westminster and Whitehall. But we believe that science policy in the devolved administrations is very important, and we seek to represent the views of our members in Wales wherever possible. The Executive Committee of CaSE includes Dr Hefin Jones of Cardiff University, who acts as CaSE's principal point of contact for Welsh science policy matters.

Other recent activities in Wales include the following:

- During campaigns for the election of Welsh Assembly members, we publish the responses of party leaders to a series of questions about science policy.
- In 2006, CaSE published an important article about Welsh attitudes to science in the national newspaper, the *Western Mail*.
- CaSE gave both written and oral evidence to the Assembly's review of science policy, and its views were quoted extensively in the final report.
- CaSE's Director took part in a panel discussion on science in Wales at the Institute of Welsh Affairs conference on Welsh science policy during 2006.
- CaSE gave evidence to the First Minister's review of science policies and had regular correspondence and meetings with the Welsh Government.
- In January 2007, CaSE published a major article in *Agenda*, the journal of the Institute of Welsh Affairs entitled Get Serious about Science.
- CaSE is one of the organisations involved in the event called *Science and the Welsh Assembly*, held annually in the Senedd to promote interaction between the scientific community and members of the Assembly.

[www.sciencecampaign.org.uk/activities/wales.htm](http://www.sciencecampaign.org.uk/activities/wales.htm)



**[www.sciencecampaign.org.uk](http://www.sciencecampaign.org.uk)**

Campaign for Science & Engineering  
29 Tavistock Square  
London  
WC1H 9QU  
020 7679 4995  
[info@sciencecampaign.org.uk](mailto:info@sciencecampaign.org.uk)

CaSE 07/05