THE CARBON TRUST

INNOVATION AND INVESTMENT

A report for the National Audit Office

by

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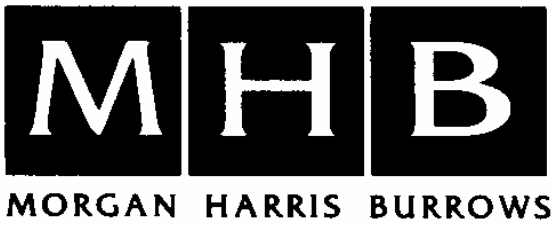

June 2007

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1. Executive Summary

1.1. Background

This report examines the activities of the Carbon Trust's **Innovations** and **Investment** activities[1]. It considers the contribution of the Trust to the process of developing and commercialising new low carbon technologies, and makes recommendations on where there are improvements in its processes which the Trust could address.

Carbon Trust Innovations includes the awarding of grants for applied research, the Carbon Vision research programme run in conjunction with the EPSRC, the incubation of fledgling companies commercialising new technologies and programmes to accelerate the development and introduction of new, low carbon, technologies. **Carbon Trust Investments** includes co-investment in low carbon new business and the development of seed funding of early stage companies.

1.2. Carbon Trust Innovations

The innovation activities fall into a number of distinct programmes.

Applied Research

The applied research programme makes three open calls for proposals each year and receives 50-75 applications per call of which about 10% will be funded with a grant of up to £250,000. The Trust follows a detailed, robust process for assessing grant applications, including the use of expert outside assessors. The total of new grants approved varies year on year and has been constrained by the quality of applications rather than by budgets. Approvals were £2.2 million in calendar year 2005. The total expenditure on grants was approximately £3 million in the last financial year. The Trust reports that there is an upturn in good project applications.

Examples of technologies for which grants have been awarded include wave power, photovoltaics, fuel cells, low energy building design and technologies for reducing energy consumption in industrial processes.

- **There is a robust, efficient process for assessing grant applications,** but although it is stringent, the process has steps to minimise the exclusion of valuable research projects.
- **The selection process is not "Risk Averse**", but the limited size of the grants reduces the range of projects that can be supported and the size of risk that is taken.
- **The use of expert Assessors in the initial application review might be reduced**. While this approach was sensible when the Trust was set up, and provides validation of decisions, Trust staff should now have the necessary expertise to handle initial applications with less external support.

[1] Previously known as "Pillar 2" of the Trust's activities.

- **Technical aspects of application should be discussed at the mentoring stage.** The mentoring process should encompass an examination of technical issues and the scale and scope of proposals. At present the process misses this opportunity. Inclusion of outside experts in mentoring might improve this potential, and the mentoring meeting might be made a part of the assessment process.
- **The use of consultants for project supervision distances Trust staff from projects.** Trust staff do attend meetings with some research teams during the course of projects, but only at breakpoints, at the end of a project or if something has gone seriously wrong. If there were more regular meetings, more intelligence would be gained about the latest trends and risks of a loss of continuity in developing technologies could be reduced.
- **The Trust could do more if it had a stronger international approach;** the Trust has focused on technology within the UK, however if it were able to do more internationally, this could help bring technologies to the UK but requires improved intelligence of inventions and international developments.

Incubation

At present the Carbon Trust funds four "virtual" incubators. These provide advice (but not premises) for new companies that have brought a technology to the point of exploitation but are not yet ready to attract investment.

Some, but not all, of the teams forming a company successfully apply for an Applied Research Grant. This would normally happen before incubation, but in some cases has occurred afterwards. In addition, the firms providing the incubation service provide a flow of candidate companies for investment, both to the Trust and to the wider market. The Trust provides up to £60,000 of advice for each incubated company[2].

There is a selection process whereby the incubator managers make the case for the inclusion of a company. Thirty three companies have now completed incubation; of these:

- Twenty have raised investment, and of these,
- Four have received investment from the Carbon Trust.
- Eleven also received Applied Research Funding.

Fifteen companies are currently within the incubation process.

The total expenditure on incubation is estimated at £2.9 million of which £2.3 million will have been paid to the companies providing incubation services. Current annual expenditure is in the order of £1 million.

- **The incubators have delivered a significant number of successful candidates for investment.** Both of the longest established incubators have succeeded in this; however one of them (Angle

[2] This is under the "de minimis" provisions within the EU State Aid rules

Technology) with no university connection has been particularly successful.

- **Appointment of a full time manager for the incubators allows good communication with the incubators** and as a result the quality of intelligence gained for the Trust is improving.
- **The need for specialist incubation support may decline** as low carbon technology achieves greater acceptance. While incubation is additional at present, this service should therefore be kept under review.

Carbon Vision

This is a programme of academic research co-funded with relevant Research Councils. It was an early initiative to which the Carbon Trust made a once-for-all commitment of £7m. The Trust's aims for the programme were to encourage more top quality research related to carbon saving, to promote greater cooperation between academia and industry, to assist in the exploitation of results and to enable the newly formed Carbon Trust to get to know key university research groups and encourage interest in the other programmes it was planning to develop. These aims are being achieved.

The focus has been on:

- Energy Supply – enhancing EPSRC's existing 'SuperGen' research programme on low carbon methods of generating electricity, making up part of the £6 million contribution in an overall cost of £33million.
- Energy Efficiency – low carbon buildings and footprint methodology for the building industry, contributing towards the overall cost of £6.5million, and
- Capacity Building – to support key researchers with the additional skills to become leading advocates for carbon reduction.

- **It is clear from the interviews carried out there are different interests and priorities**. The Research Councils focus on the excellence of research as judged by academic peers, whereas the Trust seeks the Carbon Vision programmes to be practically oriented and have an impact on carbon saving through commercial application.
- **Almost all funds have now been committed**. While present projects have some time to run, both the Trust and the EPSRC say that they do not expect to cooperate in quite the same way again.

Research and Technology Accelerators

The Carbon Trust has identified specific areas where its intervention by funding, coordination and expertise could have the greatest impact in accelerating a sector as a whole.

For the impending **Research Accelerator** the Trust has reviewed in detail each area of potential interest, identified the current centres of excellence, made a judgement on their capability to deliver a programme of research and assessed the UK position in the sector against the rest of the world. It

is devising a focussed programme of support for researchers to enable the move to exploitation.

For the established **Technology Accelerator,** the Trust reviews in detail areas of activity to establish where there are apparent barriers to exploitation.

The Technology Accelerator group currently is working across seven areas:

- European Marine Energy Centre (EMEC)
- Small Scale CHP[3] Pilot Field Trials
- Advanced Metering
- Low-Carbon Building Accelerator (LCBA)
- Biomass Heat Accelerator
- Marine Energy Accelerator
- Support for the DTI's[4] Low Carbon Buildings Programme

£28 million has been committed to this programme, with current projects going through to 2011. Technology acceleration also offers the route to undertake large scale technology demonstration projects - given adequate funding and flexibility within State Aid rules.

Research acceleration is a new initiative. The first topic, photovoltaics, is still at the planning stage. The Trust will engage in Research Accelerator programmes which invest up to £20 million over 3 to 4 years.

- **The Technology Accelerator is a particularly valuable innovation.** This novel approach attempts to identify and address all the barriers to effective exploitation and adoption of particular technologies.

  When a new technology is developed, exploitation does not happen automatically, which is why the Technology Acceleration model is so relevant, and deserves to be copied elsewhere.

- **The Research Accelerator is another valuable innovation.** Here, the Trust is supporting the early stage proof of principle, which is the essential step between applied research and effective exploitation.

- **In the areas of Technology and Research Acceleration, the Trust is becoming properly geared up for knowledge transfer.**

- **Better intelligence on applied research[5] would greatly assist the selection of projects** for support by the Research Acceleration Group.

- **State Aid rules have affected the approach to acceleration.** Acceleration projects are carried out by contracting third parties following competitive tender. This approach has been shaped by the EU State Aid and procurement rules. An increase in the total amount the Trust could give in grants would allow more flexibility in project structure.

[3] CHP: Combined Heat and Power
[4] Since this report was written some Government departments have been reorganised; for consistency, this report retains the old names
[5] See earlier comment on the Applied Research Grants

The Trust is investigating a joint venture structure for its first Research Accelerator which would involve university and industrial partners and allow the Trust to have an interest in the intellectual property developed**.** Possible State Aid issues are being taken into account.

The Trust has taken a cautious view of State Aid Rules; this area should be kept under review to ensure that the optimum level of expenditure in carbon saving can be delivered.

- **International developments have not fully been taken into account** in the technology selection process.
- **Decisions within this area of the Trust are taken at a very high level;** some of these could be devolved to manager level**.**
- **There is an opportunity to scale up activity in this area,** although this would require additional funding for the Trust:
    - The Technology Accelerator model is already demonstrating its potential, and the concept of the Research Accelerator, while still in initial development, is also promising.
    - There is scope to extend the application of both concepts to other technologies. The Trust has included further activities in these areas should it attract enhanced funding in the forthcoming Comprehensive Spending Review 2007.
    - Since the DTI has funding and State Aid clearance for the support of large demonstration projects, there may be scope to explore collaboration on this point.

1.3. Investment

The Carbon Trust has two commercial arms, Carbon Trust Enterprises Ltd, which develops new businesses (not within the scope of this report) and Carbon Trust Investments.

The Trust seeks to invest in companies with low carbon technologies that have the potential to deliver a significant return. It only acts as a co-investor as it is seeking to "leverage" funds from the private sector into new companies, and to avoid the risk of its investments being caught under State Aid rules. While the sums invested are generally larger than those made available, for example, for Applied Research Grants, they are small compared with typical venture capital investments in new businesses and small relative to the total investment that the companies in which the Trust invests will eventually need.

The first investment was in 2002 and up to June 2006 the Trust had invested in eight companies. Although the initial investments did not generate a return (two are in liquidation), later investments have been much more successful. The Trust made a profit of £1.8 million on the sale of its shares in Ceres Power following that company's successful AIM listing and the current portfolio valuation is in the order of £10 million with an overall gross internal rate of return of approximately 19%, the net equivalent of which compares favourably with early stage and technology returns achieved by investors in the UK over the last five years.

Some of the companies in which the Trust has invested have also received grants (before and after investment) and two have been through a Carbon Trust Incubator.

In 2006 the Trust planned to expand its activities by seeking investment from private sector investors with an AIM listed fund of up to £75 million. However market conditions were not favourable and the Trust is now examining the opportunity to raise a private fund.

The Trust, via a subsidiary, has set up a limited liability partnership Carbon Trust Investment Partners LLP (CTIP) which now employs the Trust's investment team and which is FSA regulated. This separates the investment advice activities from the Trust's provision of grants and other publicly funded support. CTIP occupies a separate part of the Trust's offices, although senior staff from both sides sit on various committees.

CTIP has a formal due diligence process, described by one successful applicant as more rigorous than most venture capital firms, even though the sums invested historically have been small.

In addition the Trust has set up a £2 million Seed Fund together with the Shell Foundation, managed by Imperial Innovations. This will invest smaller sums in very early stage businesses and is intended to be the first of several such funds.

- **The Trust is making investments following a well-designed process.**
    - There is close control over expenditure on due diligence at a level appropriate to project size; the Trust makes its judgements on the advice received and doesn't just back a hunch. It has learned from its initial experience and has been much more successful with recent investments.
    - The Trust keeps its investments under review and has developed policies and procedures to assist decisions on the disposal of investments, which is intended to occur as soon as possible after their flotation.
- **The participation of the Trust is likely to encourage more investment in low carbon technologies.**
  Other investors appreciate not just the funds invested by the Trust, but also access to the expertise of the Trust in the sector. Additionality is secured by encouraging appropriate levels of the investment early stage companies need for their development.
- **The Trust recognises the need to evolve its approach in a market that is changing rapidly.** As the sector grows, the Trust can play a highly important role at the leading edge of technology, continuing to encourage co-investment, maintaining a distinct position. But if it were to move away from this and become just another investment source it would lose its distinct position, and the additionality of its investment activities would become questionable.

- **The Carbon Trust should continue to review the relationship between its investment arm and its other activities.** The Trust wishes to expand its presence in the venture capital sector**;** because it also deals with public money, it needs to evolve procedures, structures and relationships that demonstrate very clearly that the two types of activity are separately managed, and that any conflicts of interest are recorded and managed. The Management of the Trust is aware of the issues in this area and takes seriously the need not only to separate decisions relating to grants and decisions relating to investment but to be seen to do so.
- **CTIP has to comply with FSA regulations which are changing.** The European Union directive on Markets in Financial Instruments Directive (MiFID) introduces new provisions governing conduct of business and internal organisation. A number of changes will be required in the area of decision making, documentation of procedures, independence of compliance, conflict of interest and data security. The changes will strengthen the operation of CTIP.

1.4. Organisation

The Carbon Trust is still a young, expanding organisation that has attracted high calibre staff. As an independent company it is also able to gain the confidence of private sector organisations with which it deals.

It is very noticeable that the management of the Trust learns from experience and adapts its organisation, operations, and objectives much more rapidly compared with what might be expected in a public sector organisation. Given the opportunity, the Trust has the infrastructure to deliver services on a much-enhanced scale; addition of more resources would enhance this even further.

The Carbon Trust has been highly innovative in its approach and its programmes. This is a major factor in the delivery of its innovation and investment activities.

1.5. Additionality

Adding Value through Applied Research

The management of the Trust recognises that it is not enough to back research groups to achieve exploitation of technologies. Its aims are geared to exploitation and the Trust seeks to ensure that its funding is likely to make a difference to what can be achieved. Significant additionality is achieved in this part of the programme.

Equipping Companies to Create Value

The idea that in general new companies derive benefit from incubation is not universally shared; incubators typically offer serviced offices, some laboratory or engineering space, and some advisory services. The Trust is different in that it provides a virtual incubation service which offers expert advice and analysis, but not physical space. This virtual incubation approach is delivering a flow of new low carbon companies that are attracting investment both from the trust and from other investors.

Though its investment activities are on a small scale, the Trust plays an important role as a co-investor by bringing its expertise to bear on investment in early stage companies, and through its extensive networks which help it to secure co-investors. Co-investors have contributed almost ten times the amount invested by the Trust itself.

Incubator and venture capital activity in private markets is increasing, and the Trust will need to keep an eye on developments. In particular, on investment, continued additionality is likely to depend on its retaining its interest in backing early stage companies at the forefront of applied technology.

Acceleration of Research and Technology

There is an opportunity, given adequate additional resources for more extensive Technology and Research Accelerator programmes, to make a significant impact. These programmes are significant innovations, and it is anticipated that the results, when realised, will be additional. The development of a range of support, particularly with the accelerator programmes will mean fewer gaps in support for research in a chosen sector. In addressing a range of potential constraints, the Technology Accelerator programmes are realistic about the complexity of exploiting the technology concerned.

1.6. The Value of the Trust

A number of those interviewed have suggested that the Carbon Trust is unique in the world and as such is a model that other countries may emulate. As larger funds are committed for the development of a low carbon economy, the Trust has to find a way of retaining and developing its distinct role in a field increasingly populated by larger entities with big budgets – and for this it needs to retain its independence.

In addition to financial support, those benefiting from grants or investment from the Trust greatly value its endorsement. From its expertise the Trust has created a “brand” and a set of capabilities that can contribute very greatly to the development of the UK low carbon economy.

2. Structure of the Report

This report is divided into chapters which address the original activities of Pillar 2 of the Carbon Trust, but aligned with the latest structure presented as **Carbon Trust Innovations** and **Carbon Trust Investments**.

Chapter 3 briefly covers the background to the activities, how they fit into the strategic priorities of the Trust, how the Trust operates and the effect of State Aid rules.

Chapters 4 to 7 examine the activities of Carbon Trust Innovations including Applied Research, Incubation, Carbon Vision and Technology Acceleration. The chapters focus on how the Trust decides on projects to support, how the projects are administered and the supporting processes. Key findings are listed at the end of each chapter.

Chapter 8 covers the investment activity of the Trust, including some aspects of the relationship between the investment arm and the rest of the organisation.

In Chapter 9 the report examines a range of case examples and shows how projects have progressed from initial contact with the Trust in some cases as far as investment.

Chapter 10 seeks to compare the Trust with other organisations and awards.

Chapter 11 contains the conclusions of the report.

3. Background to Innovation and Investment

3.1. Background

The Carbon Trust is an independent company primarily funded by DEFRA, the DTI and the UK Devolved Administrations. Its aim is to accelerate the transition of the UK to a "Low Carbon" economy. The Trust seeks to help the UK organisations in both the public and private sectors to reduce carbon and develop commercial low carbon technologies.

The Trust originally identified three "Pillars" to define its objectives:

- **Pillar 1**
  Maximise the reduction of carbon emissions through existing measures
- **Pillar 2**
  Maximise potential carbon reduction by accelerating the commercial deployment of new low carbon technologies
- **Pillar 3**
  Increase business drivers of climate change mitigation

These Pillars have been reflected by the divisional activity of the Trust. In 2005/6, out of total expenditure (excluding VAT) of £70 million, £68 million was spent on these three pillars. £17.5 million was spent on Pillar 2.

Through Pillar 2 the Trust supports a number of programmes funding research, development and enterprise programmes. This support is delivered by:

- Support for Applied Research
  Grants typically of less than £250,000.
- Carbon Vision
  £7 million towards university research funded jointly with EPSRC.
- Incubators
  The provision of advice to companies in incubation from selected consultants (up to a maximum value of £60,000).
- Technology Acceleration Projects
  To accelerate the application of promising technologies.
- Research Acceleration Projects
  To overcome technical barriers at an early stage

The Carbon Trust has a **Venture Capital** arm (Carbon Trust Investment Ltd) which acts as a co-investor in the low carbon technology field and, in addition, it develops low carbon business itself through **Carbon Trust Enterprises Ltd** (CTEL)[6].

The potential market for carbon reducing technologies is complex, with a wide range of contenders for development including carbon capture and storage, wind on- and off-shore, tidal power, energy saving initiatives, bio-fuels, solar panels and nuclear energy.

[6] CTEL is not included in the report, and is being reviewed separately by the National Audit Office.

The raison d'être of Pillar 2 has been to work with universities, businesses at an early stage of their development, research in small and medium sized enterprises and investors to identify and help accelerate the development and use of innovative low carbon technologies. The objective is to overcome barriers to the development and adoption of technology; this is particularly the case where the Trust works with industry to overcome market and regulatory barriers.

As the organisation has developed the Carbon Trust has continuously refined its approach; the way it now characterises the organisation is to split the functions of Pillar 2 into three areas:

- **Carbon Trust Innovations**
  This includes publicly funded technology development.
- **Carbon Trust Investments**
  This works alongside the publicly funded "Innovations" activity to take forward the development of low carbon technologies.
- **Carbon Trust Enterprises**[7]
  Carbon Trust Enterprises Limited (CTEL) develops low carbon businesses to support the Trust's objective of making the business case for climate change.

The table below, provided by the Trust, sets out where the Pillar 2 activities fit into the current scheme.

Accelerate the transition to a low carbon economy

Develop low carbon technologies	**Adopt low carbon technologies and practices**
Carbon Trust Innovations (Public £ with private sector in-kind support) **Research (Applied & Procured)** **Technology accelerators** - Marine Energy Challenge and EMEC - Micro-CHP & smart metering trials - Low Carbon Buildings - Biomass for heat **Business incubators**	**Carbon Trust Solutions** (Public £ with some co-funding) **Advisory services** - Carbon Management, Energy efficiency advice - Buildings Design Advice - Advice lines, publications and training events - Supply chain **Financial products** - SME interest-free loans - Local Authority financing (Salix)
Carbon Trust Enterprises (Private £ with public sector seed funding) **Development of new businesses** - Connective Energy, Partnerships for Renewable, Waste 4 Energy	
Carbon Trust Investments (Private £ with public sector seed funding) **Early stage investing** In-house investment portfolio, Venture capital fund creation,3rd party investment funds	
Carbon Trust Insights (Public £ with some co-funding) **Policy, strategy and market insights work** Informs policy makers, business decision makers and investors	

Source: Carbon Trust

[7] CTEL activities are not covered by this report.

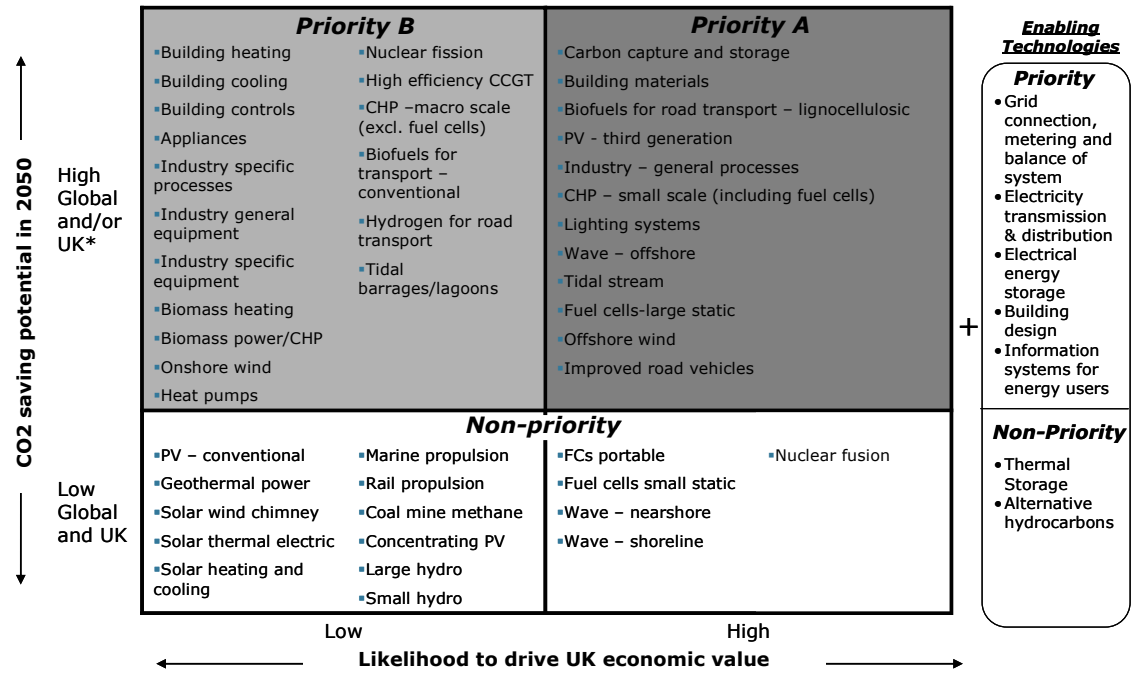
3.2. Strategic Priorities

The Carbon Trust developed a view of where its priorities should be, based on its available intelligence and following an initial background research by consultants FES (done in 2002 and updated by the Trust in 2007). In this Low Carbon Technology Assessment (LCTA) the Trust categorised the areas of research and the particular enabling technologies considered to be most relevant, categorised as "Focus", "Consider", "Monitor" and "Review Periodically". The first two categories ("'Focus" and "Consider") have accounted for the large majority of grants made by the Trust. The latest iteration of the LCTA is used to explain the Trust's priorities to those applying for grants, is attached as Appendix IV.

The Trust continues to evolve its criteria and a recent strategic review incorporated the categorisation shown in Figure 1 below, which will inform the direction of future projects initiated in house. The LCTA remains the selection criteria for external applications.

The emphasis has shifted now towards carbon saving potential on a global scale, rather than only in the UK, and it also looks at the economic value of new technology for the UK. The priority technologies are those with potential to deliver high carbon savings globally and/or in the UK; and the difference between Priorities A and B is that the UK is seen as having a comparative advantage in Priority A.

FIGURE 1 PRIORITY LOW CARBON TECHNOLOGIES



Source: Carbon Trust

3.3. Operations

Organisation

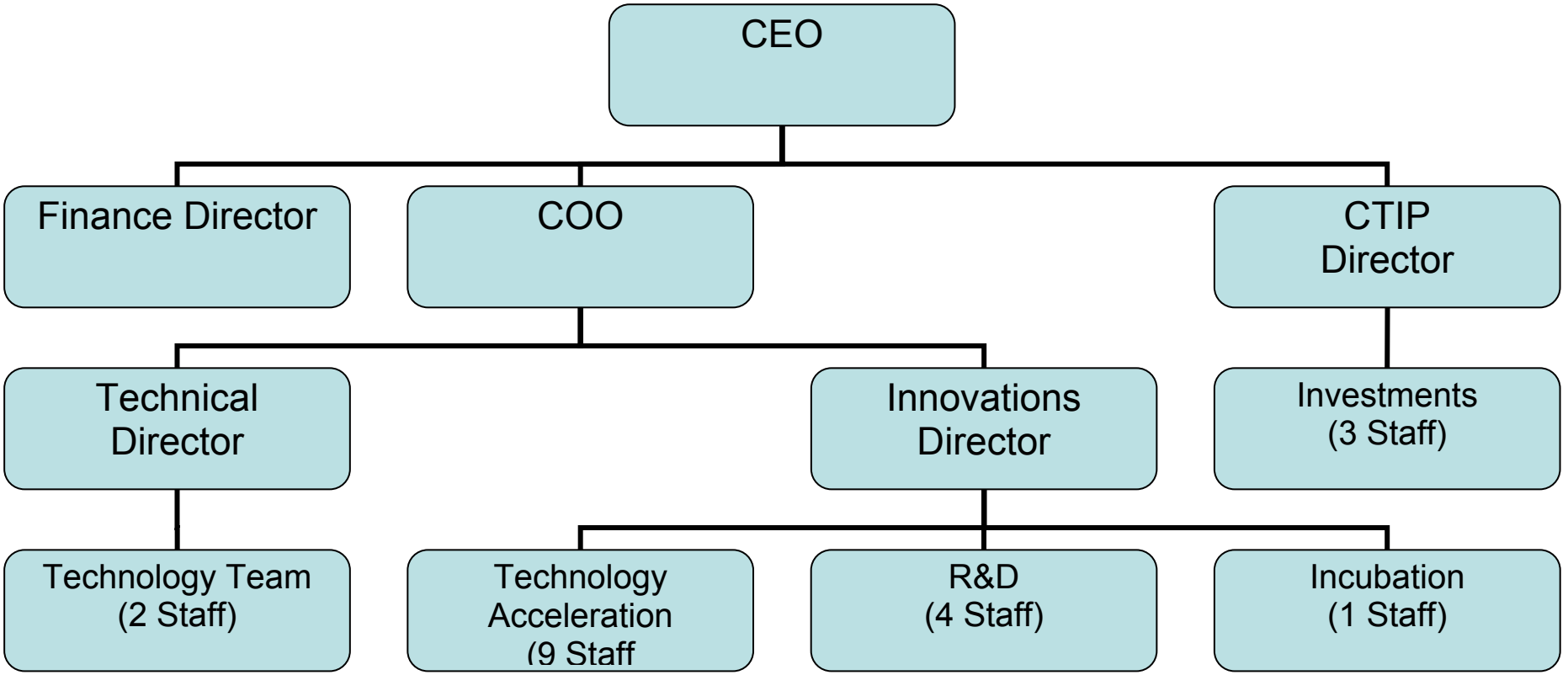
The overall organisation of the Trust is described in the main National Audit Office report. The numbers *directly* involved are shown in Figure 2 below. Excluding directors each includes:

- 4 staff in R&D, dealing with Applied Research Grants, Carbon Vision and Research Acceleration
- 6 Staff in Technology Acceleration and four contractors
- 1 staff member managing Incubation
- 3 staff in Investment
- 2 staff supporting the Technical Director

These represent about 12% of the total Carbon Trust Staff. However staff right across the organisation are involved in activities related to Innovations and Investment (for example Finance, Strategy, Publicity and Legal).Communication across departments and with outside contacts is important for the development of the organisation, its intelligence about the markets it serves and its network. Key external relationships include:

- External Expert Assessors of Applied Research Grants
- Consultants administering Applied Research Grants
- Companies engaged to operate Incubators
- The EPSRC in relation to the Carbon Vision Programme
- Co-investors in early stage companies
- Companies collaborating in Technology Acceleration
- Those undertaking grant funded research

FIGURE 2 Carbon Trust Staff Directly Involved in Innovation and Investment (as of 30th April 2007)



3.4. State Aid Rules

The Carbon Trust is mostly funded by public money, and therefore has to comply with the European Communities' "State Aid" and procurement rules. These are designed to avoid the distortion of competition when such bodies intervene in markets or exert their power as purchasers.

While State Aid rules generally address public support for the private sector, there can be cases in which public sector organisations provide services which compete with the private sector, in which case any support given for those services may also be treated as State Aid.

Support, for instance in the form of grants, that might confer advantage beyond de minimis levels must be notified to the European Commission, and support-giving bodies must operate within its decisions. These specify the purposes for which State Aid might be granted, define costs that might be eligible for support, and set limiting rates of support, or intensity of aid, that might be given. The Commission also has clear policies about areas within such support might be given that coincide with its other policy objectives, for instance regional development and, as in the case of the Trust, contributions to the reduction of greenhouse gases.

Complementary procurement rules require bodies in the communities that benefit from public funds to procure competitively, again above relatively low de minimis levels, and there is a defined threshold above which opportunities must be advertised at European levels. It is important for the Carbon Trust that competitive tendering within the procurement rules can operate outside State Aid rules, so long as any support would be available on the same terms to all competing parties.

Applied R&D and Carbon Vision

Elements in the Trust's Innovation Programme were notified to the Commission in 2002 and 2003 for grant support that fell within the Communities' R&D Framework, covering initial prototypes, demonstration and pilot projects with intensity-of-aid limits of 25% for grants and 40% for refundable grants, and 100% grants for fundamental research under Carbon Vision.

The Commission's decisions agreeing these proposals generally extended to June 2008, although one notification was due to expire at the end of 2006. In October 2006 the UK Authorities notified their wish to merge and extend these earlier notifications to apply from 1 January 2007 to 31 December 2012. This was within a programme limit of £50 million over the six-year period, a figure reflecting the Trust's budget expectations, and its priorities within it, rather than any limit guided by the Commission.

Under the new notification entitled "The Carbon Trust Applied Research Open Call", refundable grants are no longer included since the Trust has found them less convenient for demonstration than operating under the procurement rules beyond the stage of applied R&D.

Aid intensities of up to 100% are available for fundamental research, including in the remainder of the Carbon Vision programme, with limits of

50% for industrial research, and 25% for pre-competitive development, which can include the development of equipment for pre-competitive demonstration purposes.

Incubation

'De minimis' limits of Euro 200,000 now apply to eligible support for small firms. Recently raised from Euro 100,000, the Trust's incubation services for individual start-up companies have not been notified to the Commission as they are below this threshold. In practice, the earlier limit has proved sufficient, but greater flexibility may prove helpful.

In other areas, the Trust has structured its activities to place them outside the State Aid framework.

Technology Acceleration

Much of the Trust's expenditure on Technology Acceleration has involved the provision of services by third parties to work with industry in order to understand and develop products and services and to produce case studies and reports on the performance of technologies in practical circumstances. The Trust commissions work by third parties which are selected by open tender within the Commission's public procurement rules. As above, private sector contractors are not subsidised on a selective basis and State Aid rules do not apply.

Demonstration activities are a difficult area as they can only be supported within the State Aid framework for R&D with a 25% grant[8], which the Trust has found to be insufficient in some circumstances. This is one reason for undertaking Technology Accelerator work on a procured basis, although there are some other reasons:

- Demonstration based on grant support is likely to result in equipment being developed; however simply developing equipment doesn't necessarily prove anything (what is being demonstrated and to whom?)

  The Trust's approach under the procurement rules is therefore to complement the simple development or installation of equipment embracing new technologies with carefully designed programmes to monitor performance in practice, and in different environments, so that the results of thorough analysis can be made available to potential users. This important innovation increases the likelihood that new technologies will be deployed appropriately, and the availability of the data is also likely to encourage the rate at which it is adopted by third parties.

- By procuring services from the market the Trust has greater control and is contractually able to secure benefits from the project for the Trust and the UK as a whole. This has proved valuable in ensuring that monitoring data is collected correctly, and to time, since contractors are aware that competitors may be available to step in if they breach their contractual obligations.

[8] In some circumstances a higher rate may be available under the Environmental Protections Guidelines

The structure of each of the Trust's Technology Accelerators has been substantially determined by the needs of each project, but they have also taken State Aid constraints into account. In future the Trust may seek State Aid approval for aspects of acceleration activity should these prove to be better suited to grant support rather than competitive procurement.

Research Acceleration

The constraints on Research Acceleration are similar to those of Technology Acceleration. For the forthcoming Solar PV Research Accelerator, the first in a possible series, the Trust is considering setting up a joint venture with the selected partner. This vehicle would be used to procure the research, and it would also take ownership of Intellectual Property generated. However, this is still under discussion, as is any aspect that might require notification.

Investment

Interventions that have not been notified can be challenged if competitors believe that State Aid has been given. If any such support, for instance investment capital, is found to be illegal by the Commission, the recipient can be required to repay the Aid. This encourages a cautious approach to investing in early stage companies, even if the assurance of third party investigators has been secured to the effect that an investment has been made on fully commercial terms; any challenge could damage the reputation of the Trust, and the repayment of any element of an investment that was found to be illegal Aid might damage, if not undermine, an early stage company.

The clearest safeguard from potential challenge under the State Aid rules is for the Trust to co-invest on exactly the same terms as other private investors in the same company[9]. However the need to have a co-investor means that the Trust has to find at least one commercial partner willing to invest and to split the deal.

Trust staff have pointed out that this approach is not without its disadvantages. There has been a handful of opportunities in which it has not invested because it has not been able to find a willing co-investor, in spite of the wide network it has been developing among individuals and companies with whom it might co-invest. Sometimes this has been because others have not shared the Trust's view about the technology, or because the amounts being sought are too small to be of interest.

However, the Trust has been very careful to satisfy itself about its view of the quality of the technology, and about the quality of the management of the companies in which it might invest.

It is also possible that discussions about co-investing might lead to a single private sector investor investing in a company without further involvement from the Trust. Although this might have an effect on the eventual performance of the Trust's portfolio, the Trust's effort will not have been wasted since it will have contributed towards its mission of reducing

[9] This is a specific exemption call the "Market Economy Investor Principle" and shows that real commercial returns are made.

carbon however a successful investment with such potential might be funded

Conclusions

In practice, the State Aid and procurement rules have shaped the way in which the Trust works and for this reason the State Aid rules are considered by the Trust to be an important constraint. Although the importance of limiting carbon in the atmosphere appears to have an increasing priority among European Commission policies, which in turn ought to encourage it to be as flexible as possible with regard to the notification of the Trust's activities, the time taken to get such decisions is unlikely always to match the pace at which the Trust wishes to work.

This study has found that the Trust generally takes a cautious approach to the State Aid and public procurement rules within which it operates.

An example where it would be necessary to seek to influence the application of the State Aid rules within which the Trust operates might be where the scope of Research or Technology Acceleration would benefit from substantial grant support for demonstration at higher rates of support than are presently allowed.

In these circumstances, the appropriate route would be via DEFRA (as the Trust's sponsoring Department) to the DTI as guardian of contacts with the Commission on competition.

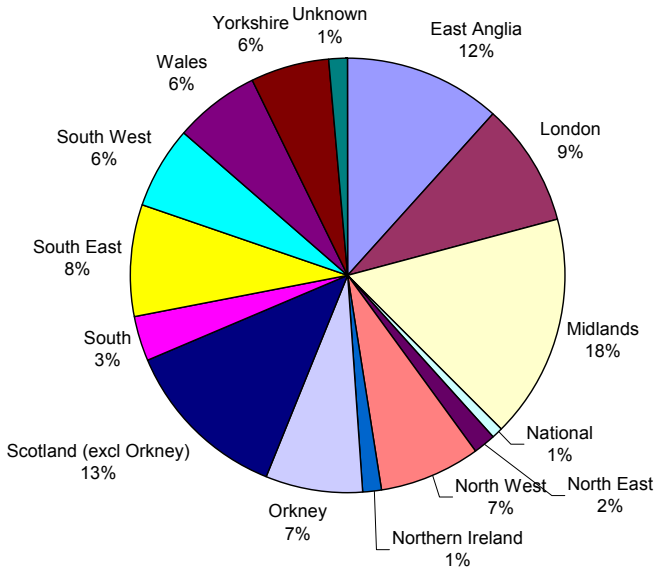
It is recognised by Trust staff that informal soundings with the DTI State Aids team have already been very helpful in developing their thinking, including that on the future development of both Technology and Research Accelerators. They also recognise that influencing the State Aid rules is a political process, in which, should this prove necessary, the Trust's Board members might have a role to play.

4. Applied Research

4.1. Dimensions

The applied research programme was started in 2002 and makes grants, normally up to a maximum of £250,000. The grants support development and commercialisation of technology to reduce UK carbon dioxide emissions, supporting the progress of low carbon technologies towards large scale deployment.

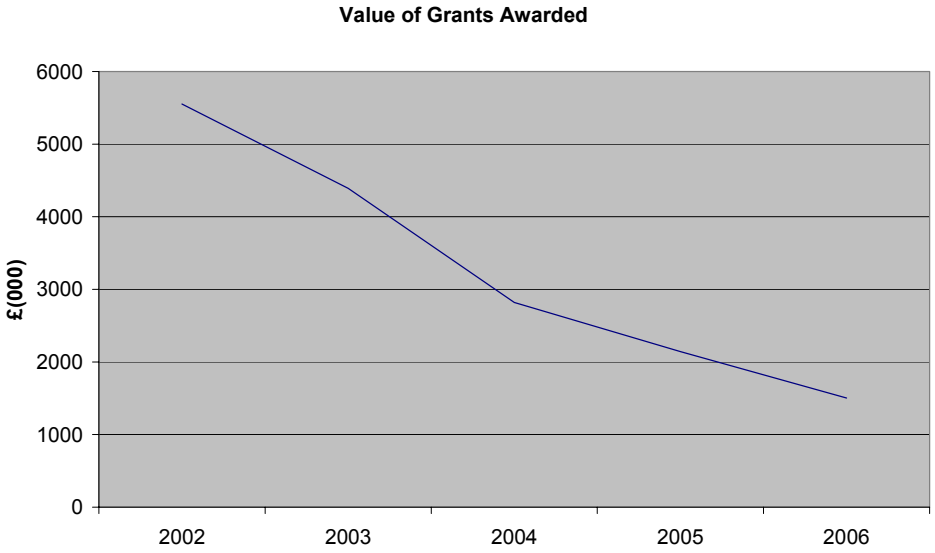
Up to the end of 2006 the Carbon Trust had awarded grants totalling approximately £16 million on 126 awards. The grants are distributed throughout the UK with an overall 20% going to Scotland, although a significant proportion of this is to support The European Marine Energy Centre in Orkney, which has received grants to the end of 2006 of £1.2 million in applied research grants and substantial additional funding support for its operations.



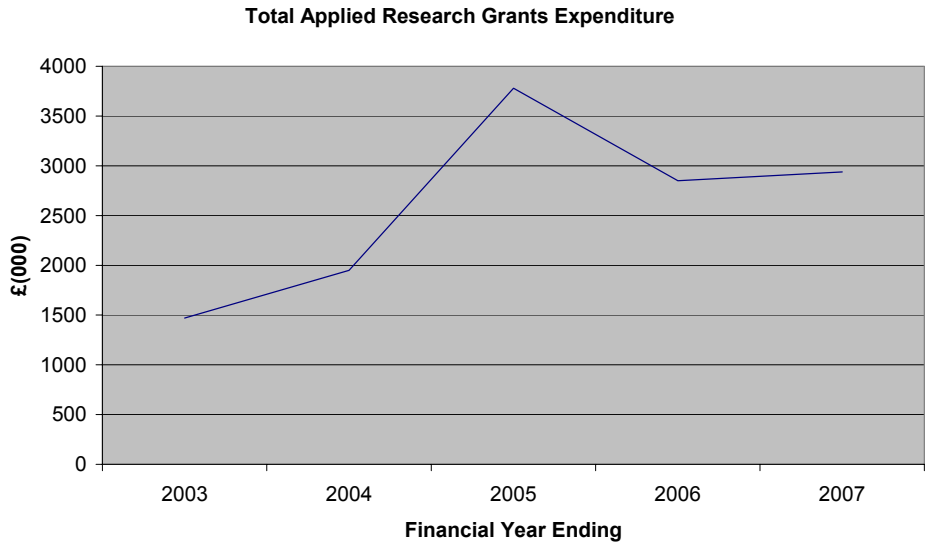
The grants have been split between Small and Medium Sized Enterprise (SME), Universities and the public sector, although some of the participants co-funding or sponsoring the work have been multinational companies.

Sector	£(000)	Percent
Industry	6,157	38%
University	8,400	51%
Public Sector	1,850	11%
	16,408	

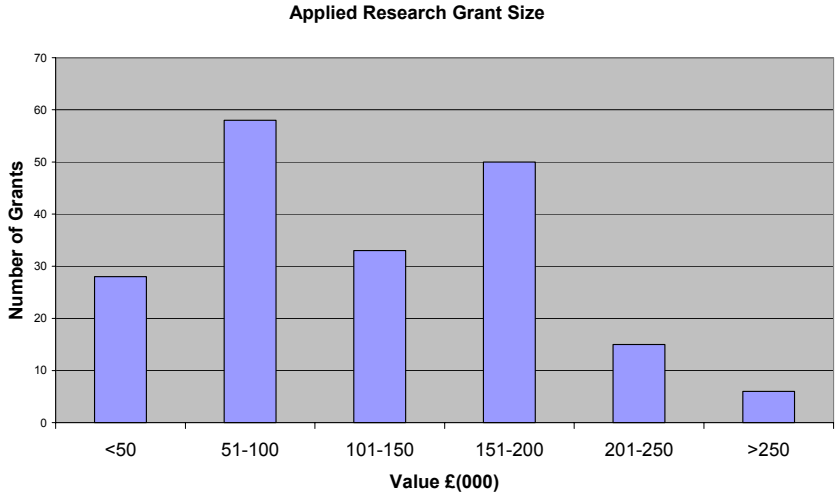
The value of grants awarded (as distinct from annual expenditure) has declined from a startup peak of £5.5 Million (which includes the major award to The European Marine Energy Centre in Orkney) to £2.2 million in 2005. The 2006 data does not reflect a complete year of awards.

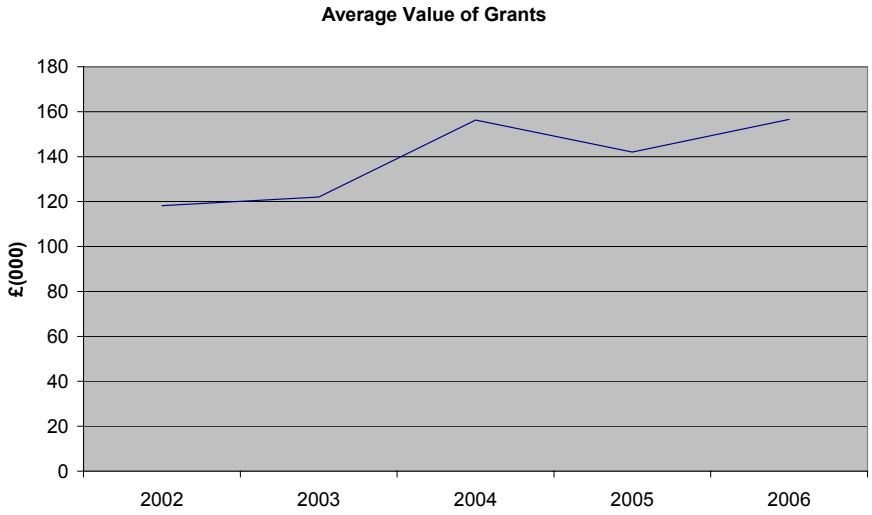


The total annual expenditure in support of the grants awarded peaked in 2004/5, but is now rising again towards £3 million per annum.



Most grants are for sums between £50,000 and £200,000, but in recent years the average size of grants has tended to increase.





The grants have been made within the following sectors:

	Value £(000)	No of Grants	
Conventional	231	1	
Demand side buildings	2,431	23	
Demand side industry	4,571	38	
Enabling technologies	809	8	
Fuel cells	204	1	
Industry – process control	150	1	
Industry -alternative	345	2	
Wind - on- and off-shore	244	1	
Other	650	9	
Supply - fossil/conventional	1,849	12	
Supply - renewables	4,772	29	Incl. Orkney Marine Energy Test Centre
Wave – offshore/nearshore	150	1	
	16,408	126	

The sectors used are consistent with the Low Carbon Technology Assessment shown in Appendix IV.

4.2. Process of Awarding Contracts

In essence the questions to be answered in the assessment of grant applications are:

- Is it legal?
- Is it a new idea?
- Is it a good idea?
- Can the applicants do it (technically and managerially)?
- Does it contribute to moving it closer to commercial deployment?
- Should the Carbon Trust fund it?
- Would Carbon Trust funding make a material difference?

These questions are explored using the detailed standard criteria, as laid out in the application form and defined in the Trust's State Aid notification.

The Carbon Trust has developed a comprehensive set of policies and procedures for the assessment and administration of its applied research grant programme.

The criteria and the way in which the programme works continue to evolve over time, and external views[10] have been sought on how the process might be improved.

The text which follows gives a brief description of the process.

4.2.1. Available Funding

Any UK business, university, public sector or voluntary organisation may apply for a grant up to a maximum of £250,000, but restricted to a percentage of eligible project costs:

- For industrial research the maximum is 50%
- For experimental demonstration the maximum is 25%
- SMEs can attract an additional 10%
- There can be an additional 15% if the project is in line with the Energy theme of the European Union programme for research, technological development and demonstration.

4.2.2. Selection Criteria

Projects are selected that fall within the priority areas of the Trust's activities as set out above.

In addition, to meet the selection criteria all projects must:

- Demonstrate credibly the potential savings in emissions and how the project will lead to these savings being achieved.
- Involve technology that either is itself innovative or where there is innovation in its application and which can lead to substantial advantages compared with the current practice.
- Present a proposal that shows how the work will contribute directly towards large scale deployment of the technology.

[10] ECOTEC consulting report

- Propose a programme of work that is well structured and thought through.

Some projects will not be eligible and these include:

- Duplicate activities - those that are already well supported by the Research Councils and other grant-giving organisations.
- 'Blue sky' research.
- Where the demonstrable benefit is outside the EU.
- Where work has been carried out prior to the contract.
- Where the project is insufficiently innovative.

The maximum duration of a Carbon Trust Applied Research grant is 3 years.

4.2.3. Assessment Process

The Carbon Trust makes at least three open calls per annum for Applied Research, that is, calls that are not restricted to any one technology. From a high point of more than 150 proposals, many of them exploratory, the Trust now expects 50-75 proposals per call in a huge range of technologies. The process is shown schematically in Figure 3 below.

Stage 1: Initial On-Line Application

Research calls are published on-line and in appropriate journals. Applicants are asked to make an initial proposal using a prescribed format via the Carbon Trust web site. After the call is made, applicants have five weeks to make an initial application. Once the proposals are received they are divided among the Carbon Trust review team and expert external assessors, selected from a panel of consulting firms according to the technologies in the applications.

The Carbon Trust then holds a two day meeting off-site (a "lock in") where all the initial proposals are first considered and marked against the assessment criteria by a member of the Carbon Trust Team and by a Technical Assessor. This first structured exercise enables the Trust to select projects worthy of further consideration.

Such applications are further examined by another external assessor, and then there is a review with all the assessors present at which the marginal or disputed cases are discussed. Where there is a discrepancy in view between these two opinions and where the proposal is likely to be close to the pass/fail border additional reviews are undertaken in which the Head of Low Carbon Research chairs a round table moderation discussion which normally reaches consensus on the recommendation to be made to the Preliminary Investment Committee (PIC).

The "lock in" assessment is considered very important by the Trust's managers. External Assessors from AEA Energy and Environment (industry and renewables), BRE (building), Entec (process and

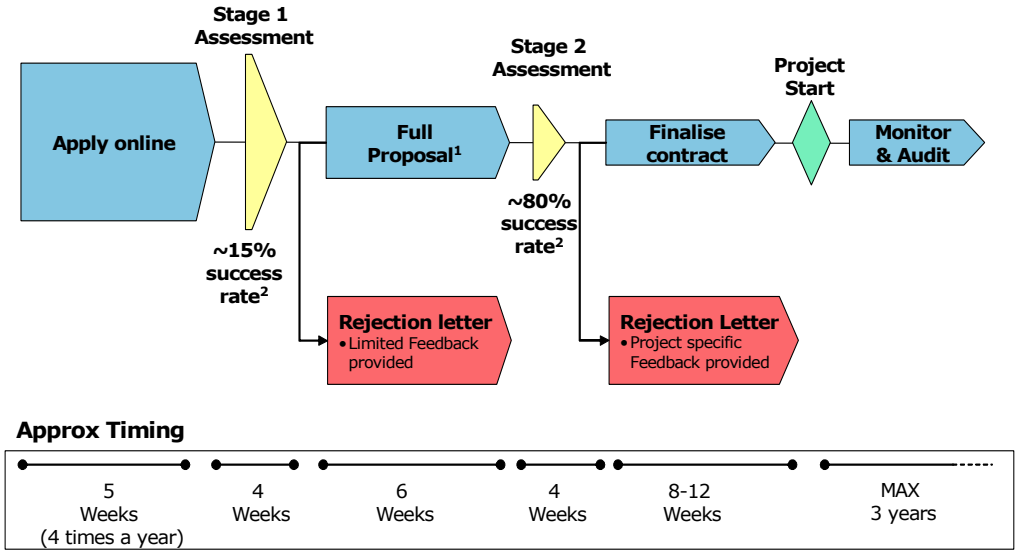
renewables), and Faber Maunsell (building) ensure that the Trust can bring to bear a high level of experience in a wide range of technologies. The outcomes are that:

- Some applications are excluded because they fail to make an effective case or fail on a number of the primary selection criteria, while others fail on specific points.
- Others are recommended for further consideration.

All applications and the recommended decisions are submitted to the PIC. The Trust ensures that this preliminary assessment does not take more than four weeks; all applicants are then informed of the outcome by letter within five working days of the decision.

Letters to unsuccessful applicants advise either that their application failed the primary selection criteria, or, where applicable, about the particular reasons for failure, and there are examples where this guidance has led to successful applications in later calls.

FIGURE 3 ASSESSMENT PROCESS



[1]Applicants are offered the opportunity to talk through their application with the Carbon Trust at the start of this stage
[2]Success rate is based on historic data and is dependent on programme budget and receipt of sufficient high quality proposals

Note: For those applications to be taken forward for a full proposal there is a mentoring process to assist applicants in preparing their full submission

Source: Carbon Trust Procedures Manual

Stage 2: Full Proposal

Successful applicants are invited, within one month of notification, to submit a draft full proposal, in line with the format specified by the Carbon Trust[11]. They are offered a "mentoring meeting" to review the draft proposal, answer any queries they may have and advise on what needs to be changed or added.

The mentoring meeting does not form part of the review process, although it may assist some applicants in deciding whether they really want to proceed. The meeting is attended by a Trust representative and a project supervisor from AEA Energy and Environment (AEA E&E) who will supervise the project if it is funded.

Those attending this meeting do not form part of the assessment team for any project for which they provide mentoring. Neither they nor the Carbon Trust R&D manager can make recommendations to the applicants concerning technical aspects of the project. The Carbon Trust sets out the issues to be addressed based on a standard agenda designed to ensure all relevant information is provided in full proposals. AEA E&E says that its supervisory staff welcome an opportunity to get to know applicants whose projects they may supervise.

Following the mentoring meeting, applicants have three weeks to submit full proposals electronically.

Each full proposal submitted is carefully examined by two external technical reviewers and one Carbon Trust reviewer. This is a thorough process which may involve web research on technical issues. There is then a "round table" discussion, as a result of which recommendations are made to the PIC. One representative of expert consultants will attend the round table meeting and will cover up to six applications[12].

Successful applications approved by the PIC are signed off by the Chief Operating Officer, the Technical Director and either the Finance Director or the Chief Executive; those over £250,000 are also signed off by the Finance Director and the Chief Executive. Grant offers are made within five working days of the PIC decision.

4.2.4. Selective Review of Calls

Two calls made over the last two years have been examined for this report, which together cover 136 applications.

Call "Y"	Number of Applications			
£0.8 million awarded	Initial Application		Full Application	
	Assessors	PIC	Assessors	PIC
Progress	8	10	3	4
Reject	62	64	3	4
Other	4	0	4	2
	74	74	10	10

"Other" includes a query, deferral, referral or where there is no data

[11] Full proposal format in Appendix VII

[12] The senior manager of AEA E&E, in charge of the supervisors who are involved in mentoring, advises that he also attends.

In Call "Y" the PIC made decisions in cases where there was a query, but did not go against any firm recommendation of the Assessors.

Call "Z"	Number of Applications			
£0.7 million awarded	Initial Application		Full Application	
	Assessors	PIC	Assessors	PIC
Progress	8	10	5	4
Reject	47	52	3	5
Other	7	0	1	
	62	62	9	9

"Other" includes a query, deferral, referral or where there is no data

In Call "Z", at the Initial stage the PIC made decisions on applications about which there was a query, but also overturned a decision to reject one application.

At the full proposal stage one of the ten applicants invited to submit a full proposal had dropped out. Of those that remained, the proposal where the PIC had overridden the *initial* rejection was now rejected, as was one other recommendation to progress.

Over these two calls 10 out of 136 applications were progressed or referred for further submission, and 93% of applications failed.

During the first stage of the assessment, the process requires proposals that are marginal, or those where there is a major difference of view between Assessors, to be examined by an additional Assessor, and the records indicate that this procedure was followed. Examination of the initial proposals for both calls shows the extent of review for high scoring successful applications, a band of applications ("marginal") most of which failed, and the lower scoring remainder almost all of which failed.

	Number of Applications			
	Call Y		Call Z	
	Applications	Percent	Applications	Percent
High score Applications	7		14	
No. with three assessments	3	43%	7	50%
No. progressed	7	100%	13	93%
Marginal Applications[13]	11		6	
No. with three assessments	10[14]	91%	5	83%
No. progressed	2	18%	2	33%
Low Score Applications	56		42	
No. with three assessments	2	4%	9	21%
No. progressed	1[15]	2%	0	0%

This demonstrates that the Trust is following its policy of ensuring that applications where there is some uncertainty are given additional attention. This is important when considering the level of risk being taken, and will be commented on further later in this report.

[13] Applications with a score in a band of about 5% below the score of those which were generally selected

[14] One item not assessed as it did not constitute research

[15] The application progressed here was for a company receiving incubation support; the full proposal was deferred, and then rejected on later review as part of the next call.

4.3. Contracts

Contracts between the Trust and each successful applicant follow a standard framework within which specific details will be negotiated by a supervisor from AEA E&E. All amendments have to be approved by the Trust, and the signatories are the recipient of the grant and the Trust.

The research contract currently in operation, available from the Trust's website, clearly has undergone modifications over the years. The terms and conditions cover all essential points with regard to safeguarding public expenditure – for example, the liability of each collaborator to refund a grant made if State Aid rules are broken is clearly shown.

Some of the terms and conditions appear to be loaded in favour of the Trust – for example, the term "Collaborator" appears to apply not only to the company receiving the grant, but also to the company providing the rest of the project funds. This second funder may also be liable to refund Grant. To date this provision has not been exercised, but it could be, and whilst the "Collaborator" would have to accept the provision agreed, there could be adverse publicity generated against the Trust.

The standard Agreement does allow the Trust to monitor carbon savings resulting from the collaboration for six years following the termination of the Agreement. To date few companies have been followed up, mainly because the projects funded have been at too early a stage to result in carbon savings as yet.

The research Agreement does have anomalies, for example, grants can only be guaranteed for a three year period. This was a requirement imposed by DEFRA which is not required by the Regional Development Agencies and could be removed so that projects can run to their natural conclusion.

In one of the clauses the recipient is required to agree to "grant to Us [i.e. the Trust] a perpetual, irrevocable, worldwide and royalty-free licence to use the Project and the Project Intellectual Property for Our Internal Business Purposes in line with Our memorandum and articles of association, with a right to sub-license to the Government Department to use for its Internal Business Purposes. Such licence and sub-licence rights shall not extend to exploitation with third parties (except in the circumstances set out in Clause 6.4). We shall be permitted to publish the Project and any of the Reports provided to it under this Agreement, subject to Your prior written consent, such consent not to be unreasonably withheld or delayed, provided always that We shall on Your request delay publication for a reasonable period to allow for a patent application to be made in respect of the Project Intellectual Property."

This is a wide-ranging demand from the Carbon Trust, and will necessarily involve the transfer of confidential know-how and commercially sensitive information, although it has never been invoked for any Project and would be difficult to police to protect the interests of the Collaborator.

Overall the contract does protect the interest of the Trust but it could be made less aggressive.

4.4. Process of Managing Contracts

Once a grant has been awarded it is contracted out to an external project supervisor (AEA Energy and Environment) who will supervise the project for the Carbon Trust.

Carbon Trust staff are present at an initial project "kick-off" meeting between the supervisor and the grant recipient. Subsequently project supervisors stay in contact with the grant recipient through monthly telephone calls. The call is usually for about ten minutes and can include:

- Ensuring that the applicant is following the contract.
- Highlighting issues (changes in the projects or changes necessary on the contract).
- Determining whether a technical review/audit is needed.
- Deciding whether the quarterly report is approved (on target for milestones).
- Making an up-to-date forecast on expenditure.
- Identifying whether the Trust needs to be more involved with the project

The progress of the project is updated on the Database ("Sharepoint"), held by the Trust to which AEA E&E also has access.

The grant recipient is required to produce quarterly reports on progress against the project plan. At this stage, if the project is not going to plan, the supervisor will report this to the Carbon Trust. The Trust may ask the supervisor together with an expert to visit the project team and determine whether and how the project can be brought back in line. If this is not possible there will then be a technical audit meeting, involving a member of the Carbon Trust Staff in about 60% of cases, depending on the seriousness of the situation; in some cases this results in a decision to close the contract. At any one time there will be in the order of 50 contracts being managed and about 20% of these will require some intervention.

An agreed proportion of the grant is paid against completion of each milestone for following the required quarterly report. The report is requested in an agreed format and, notwithstanding a suggestion from the R&D Manager that the Carbon Trust is flexible in its reporting requirements, cases examined mostly follow this format for reporting. Grant recipients interviewed all reported it as somewhat time-consuming and inflexible bearing in mind the relatively small amounts involved.

As well as "kick-off" meetings at the start of each contract, technical audit meetings, and any meetings at natural and contractually agreed breakpoints, Carbon Trust staff will only attend the closure meetings at the end of all contracts. The Carbon Trust also has a range of policies and procedures in place to manage changes to projects, including at breakpoints, which may relate to timing, scope and support requirements.

4.4.1. Post-Completion Monitoring

Only a proportion of applied research grants has been completed and early grants were mainly for projects at a very early development stage.

The Carbon Trust summary statistics show out of 96 projects started 85 were completed – 25-30 per annum over the last three years.

The Carbon Trust provided details of its assessment of 75 completed projects against its performance. These stem from the administrative review by AEA E&E. These ratings were as follows:

	Achievement of contract objectives	Performance of lead organisation	Performance of partners	Quality of reporting and results
Good or Exceptional	21%	16%	17%	28%
Satisfactory	57%	43%	32%	45%
Inconsistent or poor	8%	28%	7%	13%
Terminated	13%	13%	13%	13%
Not Applicable			31%	
	100%	100%	100%	100%

Source: Carbon Trust Summary
Note: the Trust does not have a formal definition for each of these labels, they are the subjective view of the AEA E&E supervisor

In spite of the poor performance of a significant number of lead organisations, 90% of projects completed were considered at least satisfactory in achieving their objectives.

The Trust's own review assesses the impact of the work against plan and examines project objectives, key technical achievements, impact on commercialisation (measured in terms of patents and other intellectual property produced, whether or not further development funding was obtained, whether external investment has been made into the company, visibility of commercial sales and/or contribution to knowledge) and next steps. This is reported back to the investment committee.

4.4.2. Carbon Savings

Each project has an initial view of the potential carbon savings which is supposed to be updated as the project progresses. However these projects are at a very early stage and in most cases, understandably, there is not sufficient data to make any modification as they progress.

4.5. Risk

Examination of the R&D scheme demonstrates that significant attention is given to all applications; those that fail to meet the Trust's criteria are quickly eliminated. Outstanding projects are also identified quickly and are funded provided that Stage 2 of the Assessment process confirms that they meet the Trust's criteria. From the evidence examined, there does not appear to be a significant number of proposals that should have been supported on the grounds that the Trust is taking insufficient risk.

In any event, the small size of most of these grants means that the overall risk in R&D support is small.

4.6. Additionality

The additionality of individual projects is likely to be strong, given the thoroughness of the assessment process, which includes "will our support

make a difference?" as one of its tests. An experienced assessor has pointed out that the thoroughness of the Trust's processes for assessment and monitoring means that companies that are not early stage and cash poor, and do not really need support, are unlikely to apply.

At Programme level, there are other sources of grant support, for instance the Regional Development Agencies for SMEs and DTI for larger applications and research councils for universities, but the Carbon Trust with its focus on applied research and development rather than pure research, and on market potential rather than academic publication, has different criteria, and supports a different range of projects. The process is not driven by the Research Assessment Exercise or by the need to publish papers in learned journals, which is the way in which academia tends to attract funding from the Higher Education Funding Council and the Research Councils.

The Trust's R&D programme would contribute even more to its overall additionality if its staff were more closely involved in the monitoring aspect of project management so that they were more aware before closure meetings about what might happen next, to ensure the practical exploitation of potentially promising and successful R&D.

4.7. Findings

- **There is a robust process for assessing grant applications which in most cases quickly produces a clear decision**
    - The selection process is detailed and organised; it has been shown to work effectively in the assessment of a wide range of applications, and attracts many more applications than it funds because of its exacting criteria.
    - Although some applicants find the formality of the application process irksome, it is effective in assessing a substantial number of applications in a short time.
    - In assessing cases, although the Preliminary Investment Committee includes managers with a scientific or engineering background it would be useful to include more practicing scientists as members.
- **The selection process is not "Risk Averse", although in practice the risk taken is small**
    - Whilst the selection process is stringent, the focus on marginal applications helps to ensure that valuable projects that would meet the Trust's criteria are not lost.
    - According to an experienced Assessor, the rejection rate is far higher than in other schemes for which Government Departments and the European Commission have been responsible. The focus of the assessment process on borderline applications helps to minimise the extent to which valuable projects are lost and by doing so avoids the use of public money and research resources on projects to which some might give

'the benefit of the doubt', but which on a more exacting assessment were better not supported.

- However, the use of general calls for applications, rather than calls focusing on specific technologies, may mean that some important potential projects are not attracted.
- The limited size of the grants reduces the range of projects that can be supported and the level of risk that is taken.

- **The use of expert Assessors in the initial application might be reduced**
  - The extensive reliance on experienced external Assessors was a very sensible approach when the Trust was set up, but its staff should now have the necessary expertise to handle initial applications with less external support. This should be considered, bearing in mind the importance of retaining a robust filter.
- **Technical aspects of application should be discussed at the mentoring stage**
  - The mentoring process should encompass an examination of technical issues and the scale and scope of proposals. At present the process misses this opportunity to improve projects and possibly to improve their prospects for success and of bringing new and improved technology to market.
  - Inclusion of outside experts in mentoring might improve this potential, and the mentoring meeting could be made a part of the assessment process, not simply a means of improving the presentation of full proposals and giving AEA E&E supervisors an opportunity to get to know applicants.

    Another approach might be to go for project improvement at the mentoring stage, but not to make this part of the assessment process, and to have the role performed by persons other than technical assessors.
- **The project management process could provide the Trust with more intelligence and continuity**
  - The use of consultants to supervise projects was necessary at startup but it has meant that Trust staff have had infrequent contact with the projects and the people running them.
  - This has had the effect of keeping Trust staff away from the cutting edge, and the steady flow of projects on which the applied research programme relies would be enhanced by better intelligence that closer contact with scientists in their working environment would bring.
  - There is therefore an argument, for example, that responsibility for project management should be clarified and brought in-house such that regular visits are made to all projects with a view to collecting intelligence and avoiding a loss of continuity in

progress to market whatever supervisory role is retained by the Trust's contractor (this need not mean major additional resources).

- The collection of intelligence should be the responsibility of all employees, and a separate intelligence database should be established. More contact with researchers could have the added benefit of discussions with the Trust about what might happen next after completion but before closure meetings, perhaps facilitating progress to market and avoiding the dispersal of research personnel.

- **The Trust could do more if it had a strong international approach**
  - All R&D grants are made for the benefit of the UK and generally made only to companies with headquarters in the UK. This means a loss of technology opportunities which could benefit the UK.
  - International intelligence is important to the Trust; without it new technologies are likely to be brought into the UK less quickly. Not all patents are developed; it is possible that an invention made abroad, with little potential benefit in its own market could be of benefit to the UK.
  - In its recent strategy document it was clear that the priorities of the Trust in selecting technologies for support are evolving towards a more international approach.

5. Incubation

5.1. Description

The role of the business incubator is to provide strategic and business development advice to start-up companies and to prepare management teams for further investment.

The Carbon Trust has engaged four contracting organisations to manage incubators for new businesses developing low carbon technology. These are virtual incubators and should not be confused with physical incubators, such as that also operated by Imperial Innovations, which offer premises as well as assistance.

The help provided through the Trust is restricted to advice aimed at increasing the likelihood of successful commercialisation of technologies with carbon saving potential. In addition, those providing incubation services for the Trust are also contracted to identify company opportunities for incubation which are in the low carbon area and which have the potential to attract investment and may be paid a finders fee.

The scheme was originally established with three incubators (plus one added later) and this first phase in effect acted as a pilot for the current scheme. Following this, there was a re-tendering process and in November 2006 four organisations were appointed to run incubators, two associated with universities (Imperial Innovations Ltd, an Aim listed company related to Imperial College, London and ISIS Innovation Ltd at Oxford), and two that are independent (Angle Technology and TTP, The Technology Partnership plc). Angle and Imperial were part of the original scheme.

To qualify for incubation support from the Trust, a company has to be incorporated in the UK, to own intellectual property from its research and either to have a UK patent or convince the Trust that the idea can successfully be protected. Some, but not all, of the teams forming a company successfully apply for an Applied Research Grant. This would normally happen before incubation, but in some cases has occurred afterwards.

The Incubators develop a proposal for support, and this is subject to examination by the Trust: not all proposals are successful.

Thirty Three companies have now completed incubation; of these:

- Twenty have raised investment, and of these,
- Four have received investment from the Carbon Trust[16]
- Eleven also received Applied Research Funding

As at April 2007, fifteen companies were being incubated, or about to be incubated; of these:

- One has already raised investment
- Three also received Applied Research Funding

[16] In all cases the Trust is a co-investor

5.2. The Cost of the Incubation Programme

To date, the total expenditure on incubation is estimated at £2.9 million of which £2.3 million will have been paid to the companies providing incubation services (the remainder being adminstration cost). Current annual expenditure is in the order of £1 million.

The Carbon Trust makes a package of payments to organisations providing incubation services.

- Each organisation receives a retainer of £60,000 per annum.
- When a candidate company is identified, it may be approved by the Carbon Trust, but if appropriate a concept validation is undertaken for which a payment of up to £15,000 is made to the incubator provider concerned[17].
- For a successful applicant, the Carbon Trust will pay up to £60,000 for incubation services (in the form of advice)[18].

At least one of the incubators has been paid a finder's fee (£5,000) for identifying companies that qualify successfully for incubation[19]. For incubator providers that also have incubation premises and/or have funds to invest in new companies there is also the opportunity for:

- Rental income from the company (for example in a University's own Incubator).
- Subsequent work for the company on a direct commercial basis.
- The opportunity to acquire a shareholding, possibly with the reassurance of the Carbon Trust as a Co-investor.

5.3. Comparisons from the Original Scheme

The Trust established a first "pilot" scheme for incubators that was completed in November 2006. By then, the numbers of companies that had completed incubation was as follows:

Incubator run by	Total Companies No[20].	Successful Fundraising		Investment from Carbon Trust	
		No.	Percent	No.	Percent
Angle Technology	11	10	91%	3	27%
Imperial Innovations	7	5	71%	1	14%
Previous Incubator	12	4	25%	1	8%
Previous Incubator	4	2	50%	0	

[17] Concept Validation: this is not an automatic step. Some companies may be admitted directly to the incubator. Although the trust will pay up to £15,000, typically this has been nearer to £10,000.

[18] The concept validation payment does not contribute to this £60,000: the company being incubated does not benefit from the concept validation phase, which is for the Trust only.

[19] The finder's fee is only paid for companies that are completely new to the Carbon Trust and that qualify for full incubation (no fee paid at the Concept Validation phase).

[20] NB one company was incubated at two different incubators, and is therefore included twice.

Of the companies incubated at Imperial Innovations, most are from an academic base, many from within Imperial College. Of those incubated by Angle Technology, an organisation with no close ties to a single university, more than half trace their origins in a range of universities.

In early 2007, the number of companies either in incubation or about to start is as follows:

	Total Companies No.	Successful Fundraising No.	Percent	Investment from Carbon Trust No.	Percent
Angle Technology	6	1	17%		
Imperial Innovations	6	0			
Isis Innovation (appointed 11/06)	0				
TTP (appointed 11/06)	3	0			

These companies are at a very early stage, and would not normally be expected to have raised significant funds during the incubation process.

Taking expenditure up to the end of the 2005/2006 financial year and comparing it with the number of companies that have attracted investment, the figures for the first phase of the incubators are as follows:

Average Incubation expenditure per company attracting investment	£(000)
Angle	41
Imperial	161
Others	98

On the face of it, Angle Technology gave superior value for money in this first phase. However, in examining performance it must be recognised that the type of contract varied according to the type of partner organisation selected.

For example:

- Funding for Imperial Innovations, which had its own carbon "deal flow", was based on a combination of retainer and service charges, rolled up into a quarterly milestone schedule[21]; whereas
- Angle Technology, which had no clear low carbon "deal flow" of its own, contracted to provide a virtual service and consultancy to the Trust paid on a consultancy basis for agreed work.

As the scheme progressed it became clear to the Trust that there were advantages and disadvantages in each approach.

[21] Milestones for Imperial Innovations included metrics on: recruitment of staff and kick-off phase, number of reviews of applications, number of CT approved candidates, number of signed licence agreements, number of optimised business plans, number of investment-ready companies (i.e. with term sheet of over £250,000), university spin-outs at stage of generating revenues, positive audit reports, and appropriate reporting

For the first approach, the Trust reports benefits of

- A clear focus on outputs.
- The opportunity to learn from an existing incubation approach.
- Low management overhead for the Trust.

However the Trust has found it difficult to establish a definite link between the incubator approach and the success in raising funds (which may have raised funding even if the incubator did an average job), and it required reliance on the viability of an incubator model with only limited control from the Trust.

Following an evaluation of the scheme, the latest programme is based on two types of charge:

- A retainer fee (which covers project management, proposal preparation, finding dealflow).
- Payment for services on a task by task basis.

A full time Carbon Trust incubator manager has been appointed and the Trust funds the incubator services itself rather than following the co-funding approach used in the first programme (which may have resulted in two funding agendas for some incubators).

5.4. Development

As mentioned above, the Carbon Trust has recently appointed a full-time manager for its incubation programme. Monthly meetings with each incubator have been introduced to review progress, to gather intelligence, and to collect information that will be useful in raising awareness of the Trust's incubator programme. This is being complemented by visits to the companies being incubated.

The process is generating a stream of information into the Trust improving its intelligence and monitoring progress in bringing technology to market.

The Trust is now also seeking to extend its range of activities in this area including provision of interim management for companies in incubation, identification of industrial partners as well as investors, assistance in finding trial sites for technology, and assistance in business development.

5.5. Legal Agreements

Any company which goes into the Incubator must sign three Agreements:

With the Incubator company

- A notional fee of £1 is paid to the Incubator for the services rendered.
- The Carbon Trust is covered by the Agreement but is not a party to the Agreement.
- It would be preferable for the text to make it clear that the data provided to the company being incubated will remain the property of the Trust, whilst ownership of any new patents resulting from the incubation may be shared.

- There is an obligation on the company to "execute the Call Option Deed or such other documentation as the Carbon Trust may require, to enable Carbon Trust Investments Limited (a wholly owned subsidiary of the Carbon Trust) or any other Group Company or member of a Fund Group to co-invest in the future". This ensures that the Trust is allowed to consider investing in any company which it funds in the incubator.

A Confidentiality Agreement with the Incubator and the Carbon Trust

This keeps everything confidential, including details of the assistance provided through the Incubator.

Call Option Deed with Carbon Trust Investments Ltd (CTIL)

This covers how long the CTIL has to consider investing in the company on the same terms as other investors.

5.6. Additionality

There has been significant investment in incubators in the UK often linked to universities or sponsored by RDAs; for example, in London, the LDA has identified nineteen incubators, of which it has funded five. In most cases this involves physical incubator space, together with some support (e.g. networking events, training sessions, payroll or administrative support, negotiated professional services fees). These are quite different from what the Carbon Trust incubators do: none is specialised in carbon saving, and incubation is an essential element in the Trust's capacity to take technology from the research stage into effective exploitation. Supported by evidence of effectiveness, these circumstances provide a defensible additionality case for the Trust's involvement in this area.

Firms receiving incubation are selected by through applying of their own volition, via a website or thorough a contact at conference or being approached by the incubator. Angle Technology in particular goes looking for opportunities by visiting individual universities.

5.7. Findings

- The Carbon Trust incubation process has shown itself capable of delivering a significant number of successful candidates for investment by the wider market and in some cases by the Carbon Trust. The selection process plays an important part in ensuring that only opportunities with a good chance of success are included.
- Both of the two established incubators for which statistics are available have succeeded in this; however Angle Technology, with no university connection, was particularly successful in the initial pilot[22]. Aspects of the approach developed with Angle are now being applied across all the incubators supported by the Trust.
- With the appointment of a full-time Incubator Manager, there is close contact with the providers of incubator services and the companies in

[22] No statistics are available yet for TTP or ISIS Innovation

the programme. It is noticeable that the quality of intelligence resulting from the closeness of management is of a different order compared with the Trust's research team.

- As in other areas, the Carbon Trust has shown that it is prepared to try new programmes and learn from them, improving its operations in the light of its experience.
- As low carbon technology achieves greater acceptance and attention, the need for specialist incubators supported by the Trust could decline. This should be kept under review, for instance when the present contracts with incubators expire.

6. Carbon Vision

6.1. Role of Carbon Vision

Carbon Vision is a programme of academic research co-funded with relevant Research Councils. It was an early initiative of the Carbon Trust to which its Board made a once-for-all commitment of £7m paid over a number of years.

The Trust had three broad aims in developing Carbon Vision with the Research Councils:

- to encourage more top quality research related to carbon saving;
- to promote greater cooperation between the academic research community and industry to assist in the exploitation of results;
- to help the newly formed Carbon Trust to get to know key university research groups, and to say "we are open for business", thereby encouraging interest in the other programmes it was planning to develop.

The selection of areas of research the Trust wanted to pursue was made with reference to priorities in its original Low Carbon Technology Assessment matrix (Appendix IV). As described by the Trust, the focus has been on:

- Energy Supply – enhancing the Engineering and Physical Sciences Research Council's (EPSRC's) existing 'SuperGen' programme to research low carbon methods of generating electricity, initially from £23m to £29m to increase its emphasis on fuel cells and photovoltaics in particular. More recently SuperGen has been further enhanced, and is now likely to cost some £33m.
- Energy Efficiency – low carbon buildings and footprint methodology for industry, costing some £6.5m in all, and
- Capacity Building – seeking to identify and support key researchers with the additional skills to become leading advocates for the importance of carbon reducing research, where one award of around £1m has been made.

6.2. Process of Selection

Proposals in the Carbon Vision programme have been generated following established Research Council processes, and selection has been informed by academic peer review.

Carbon Vision is a joint venture with the Research Councils where the Trust does not control the main application process, but does approve funding and sets the strategic direction and the framework for outcome management. Most of the procedures are not internal to the Trust. The terms of engagement with Carbon Vision are governed by a Memorandum of Understanding between the Trust and Research Councils.

As a newly formed organisation, contributing only a modest fraction of one percent of the Councils' annual expenditure, the Trust was not in a position to change this process significantly. However, it did have some influence over the membership of the selection panels and steering groups which the Research Councils establish to select and supervise each of the research consortia they support, and of the higher-level groups that are similarly established to oversee each of the programmes. These included:

- A Carbon Vision Advisory Group
  This group had two members each appointed by EPSRC and the Carbon Trust; it acted as a selection panel for the buildings and Industry Projects and made recommendations on funding.
- For the Leadership Award a Panel was agreed by the Trust and the EPSRC.
- For the SuperGen project the governance was in place before the Trust's involvement. Each consortium has a management/steering committee and this was supplemented by a "High Level Group" which looks across the entire Supergen programme and comments on performance and balance of the programme (membership included the Trust's Head of Low Carbon Research as well as a mixture of academic and industrial members with EPSRC).

6.3. Monitoring of the Carbon Vision Programme

The Carbon Vision programme is undertaken via the EPSRC under the Research Councils' UK framework. There is the normal EPSRC requirement of an Annual report, but in addition, the Trust required quarterly reporting as a condition of its support. These report progress against milestones and "deliverables" and cover specific issues. The Carbon Trust is the primary recipient of these.

In addition, to encourage the early adoption of results emerging from the building programme, the Trust has encouraged the creation of 'Engagement Groups', including potential users of results. The mechanism for these ensures that its members have early sight of emerging findings.

The quarterly monitoring reports are primarily for the funders but the Trust also passes the annual reports to the Engagement Groups, and also asks the teams to present against these at Engagement Group meetings.

The Trust and the EPSRC have also agreed to visiting panels to review projects at the mid term and on completion.

6.4. Additionality

On the Trust's aim to encourage more top quality research related to carbon saving, from the interviews undertaken it is evident that the amount research on carbon saving work has been increased. In assessing projects to support the Trust has always posed the question:

- "What is happening in this area?
- "Will our contribution make a difference?
- "Are we likely to get carbon saving out of this?"

In addition, the involvement of the Trust and its appointees in the processes of assessment and decision has had had a 'steering effect' on the content of work that might lead to carbon saving.

It is concluded that the Trust's involvement in Carbon Vision has secured a good degree of additionality in the volume and direction of research with little displacement of Research Council funding to other areas.

Value for money is likely to have been at least as good as that normally expected from Research Council spending, with an added benefit from the Trust's point of view that it succeeded in meeting its particular objectives of ensuring as much carbon saving as possible.

6.5. Getting to Know Academic Groups

Working with the relevant Research Councils was almost certainly the most cost-effective route open to the Trust to realise the third of its aims, that of quickly getting to know key academic research groups interested in low carbon work. This is because the Research Councils' process of addressing new (as opposed to established) areas is to invite all those interested in securing its funds to a workshop in which the issues are identified and discussed.

The Trust's presence at workshops where this method has been used has put its staff in an excellent position to observe, as well as meet and talk to, interested groups in the areas in which it is interested, for instance in the building programme. In this respect, Carbon Vision has served the Trust's purposes very well.

6.6. The Carbon Trust and the EPSRC

Almost all funds of the Carbon Vision programme have now been committed, and both the Trust and the EPSRC (the lead Council in this programme) say that they do not expect to cooperate in quite the same way again.

Carbon Vision has been conducted within an agreed Memorandum of Understanding between the Research Councils and the Trust. However, it is clear from the interviews carried out there are different interests and priorities. These lie between the interest of the Research Councils in the excellence of research as judged by academic peers, and the Trust's wish that the Carbon Vision programmes should be practically oriented and have an impact on carbon saving by commercialisation of low carbon technology.

Academics interviewed have commented on the different priorities between the Research Councils and the Trust. This has been particularly apparent in relation to monitoring where, as above, having satisfied themselves by academic peer review that excellent research is to be expected, the Research Councils normally appear to rely on annual monitoring and go back to peer review only if major changes in course have to be reassessed.

In contrast, given its interest in carbon saving, the Trust has sought to 'project manage' Carbon Vision programmes to promote exploitation of the results; this has entailed more frequent and onerous reporting than Research Council funded groups would be used to, and meetings with researchers when slippage has become apparent.

6.7. Dissemination

The Trust is significantly involved in the Carbon Vision programme which is generating results which are shared between consortium members and the Trust, feeding into the overall dissemination of the Trust's activities. For example, the consortium has quantified the energy saving which would be produced if all homes switched to energy-saving light bulbs.

6.8. Findings

Carbon Vision is a once-for-all programme conducted in collaboration with the Research Councils in which, in addition to the scientific targets, the Trust's other objectives have been satisfactorily achieved. These were:

- Getting to know key university research groups;
- Promoting greater cooperation between the academic research community and industry to assist in the exploitation of results; and
- Encouraging more top quality research related to carbon saving.

The Trust's expenditure for Carbon Vision appears to have achieved a good degree of additionality.

This approach has involved more frequent monitoring, the introduction of project management and the involvement of Engagement Groups of individuals who are well connected to encourage use of emerging results.

7. Research and Technology Accelerators

7.1. Background

The Carbon Trust has identified specific areas where its intervention by funding, coordination and expertise could have the greatest impact in accelerating the exploitation of technology aimed at carbon saving through overcoming market barriers. This is the principle of its **Technology Accelerator** programme. In addition the technology programme has the potential to fund demonstration projects which, although expensive, can be a major step in getting overcoming technical and market barriers.

The concept of the **Research Accelerator** is to focus attention and support on the development of particular areas of technology at an earlier stage, offering support as necessary for research before the applied stage; the research stage can also fund proof of concept work and, where appropriate, some demonstration work (although the latter will mostly be within the Technology Accelerator programme).

7.2. Technology Accelerators

Technology Accelerators aim to address market barriers to the development of new low-carbon technologies, such as marine energy, and the adoption of existing low-carbon technologies, such as advanced metering.

Selection Process

The Carbon Trust Innovations and Insights teams have regular meetings to review the full range of low-carbon technologies and identify priority areas for future Carbon Trust projects – based on prioritisation framework and LCTA analysis. As part of this process a particular low-carbon technology sector may be identified as a potential candidate for a Technology Accelerator. A scoping study is then initiated to carry out a review of the sector – encompassing both UK and international developments. This includes quantifying the carbon savings potential, identifying the key barriers to progress, identifying existing activity in the sector and talking to key stakeholders. In particular, the study will:

- Assess the selected area in great detail, identifying relevant markets, and what might be required to get a technology to market if that stage has not already been reached.
- Identify the constraints that seem to hinder progress in the exploitation of established technology in the market, whatever these might be – to do with a lack of awareness, mistaken perceptions about the technology or the true value of financial savings it might represent, the conservative behaviour of people, the stance of regulators and the absence of effective incentives.

Once this “deep dive” study has been completed, a senior team will review whether the case for intervention by the Trust is strong enough.

Sometimes the conclusion is that the problems would be better solved by other groups outside the Trust.

The results of the scoping study are presented to a wide range of Carbon Trust staff to ensure that the findings are shared across relevant teams. A Technology Accelerator will be considered appropriate if the scoping study identifies significant potential carbon savings and that Carbon Trust funding and support can be material and distinctive from existing activities in the sector. If the scoping study identifies a relevant opportunity a draft proposal is then taken to the Preliminary Investment Committee (PIC) for discussion. The Technology Accelerator team is charged to provide preliminary timescales and costings - and generally add flesh to the proposals.

A detailed Investment Paper is then written which defines the objectives of the Accelerator in detail, including the carbon case, management/delivery approach, costs, timescales and risks. This paper is reviewed by the Carbon Trust Investment Committee and may be accepted, passed back for amendments or rejected outright.

Scope

Each Technology Accelerator addresses one or more barriers to progress, for example:

- **Evidence to support the Technology**
  For many pre-commercial low carbon technologies there are claims about the potential benefits and performance but a lack of robust supporting data. The Trust may address this by running large-scale field trials and demonstration programmes.
- **Economics**
  Low-carbon technologies tend to be expensive compared with existing conventional technologies. Whilst some have the potential to become economically viable as a result of major cost reduction, others may not. In many cases the cost saving potential is not known. In these cases the Trust may undertake or commission detailed technical and economic assessments or run projects to demonstrate major cost reductions.
- **Policy**
  Low-carbon technologies often require incentives to encourage early market take-up. In many cases policy support may not exist or may be inappropriate. The Trust may address these problems by using its independent data and analysis to inform government officials and support policy development.
- **Awareness**
  Some low-carbon technologies have already been proven in other markets but face barriers in the UK, often due to a lack of end user awareness of the potential benefits. The Trust may address this through wide dissemination of its findings and also produce targeted and relevant advice for potential end users.

Project Management

Each Technology Accelerator has a dedicated Carbon Trust manager, who sets the overall strategic direction, manages the overall contractual relationships and those with key stakeholders, ensuring delivery against plan.

External consultants are used extensively[23]. An energy metering trial, for example, involved 500 small businesses all of which installed metering connected to the Trust database. AEA Technology analysed the data and managed the data collection. Technology accelerators each involve a range of different activities, typically delivered via a variety of contractors, however all projects include:

- A contracted **Project Manager** who is responsible for managing the detailed project plan, status reporting and tracking of risks and issues.
- One or more **technical contractors** who provide the functional, technical and industry-specific expertise to shape and deliver the project.
- Contracted **"participants"**, typically including technology developers, installation companies, service providers and end user companies.

Standard competitive tendering processes are employed in the selection of all contractors used to deliver the projects.

Current Technology Sectors

The Technology Accelerator group is at present working across seven areas (detail in Figure 5 below):

- European Marine Energy Centre (EMEC)[24]
- Small Scale CHP Pilot Field Trials
- Advanced Metering
- Low-Carbon Building Accelerator (LCBA)
- Biomass Heat Accelerator
- Marine Energy Accelerator
- The DTI's Low Carbon Buildings Programme[25]

£28 million has been committed to this Technology Acceleration programme, with current projects going through to 2011. (See also Figure 4 below).

[23] Delivery by the seven consortia involved was managed so far by the Trust and consultants (Hama). In addition TEAM (a specialist metering company) provided a database to host metering information collected from the sites.
[24] A separate note on EMEC is included as Appendix VIII
[25] This is not strictly a technology accelerator, but which is managed by the technology acceleration team. In support of the wider DTI programme

FIGURE 4: Technology Acceleration Programme

Project	Start	End	Committed £m	Purpose	Comments
Micro-CHP	2003	2008	3.7	Technology: Micro-CHP systems to generate both electricity as well as heat for domestic and small commercial applications Barriers: technology performance unproven and optimum target markets unknown Scope: large scale field trial of Micro-CHP units covering range of different technologies, manufacturers and end users Key aims: understand carbon saving potential and ideal target markets for Micro-HP	85 installed Micro-CHP units. 25 condensing boilers
Advanced Metering	2003	2007	1.2	Technology: advanced meters to provide SMEs with visibility of their energy use Barriers: potential benefits for unknown, suppliers not currently offering this service Scope: large scale field trial of advanced meters across UK SMEs from all sectors Key aims: demonstrate benefits, understand barriers and identify key policy actions Outcome: stimulated sector demonstrated benefits and influenced government policy. 5% carbon savings demonstrated.	582 SME sites across the UK.
EMEC	2003	2009	2.0	See Appendix VII	
Marine Energy Challenge (MEC)	2004	2005	3.4	Technology: devices to generate electricity from waves and tidal streams Barriers: current cost unknown and unclear path to potential cost reduction Scope: review of device technologies with range of different developers, including detailed engineering analysis and design optimisation Key aims: understand UK potential, costs and scope for future cost reductions Outcome: quantified UK potential, provided clear view on current costs and identified potential routes to future cost competitiveness. 20% cost reductions achieved.	Worked with 8 device developers in partnership with academic groups
Buildings (LCBA)	2004	2010	4.5	Technology: low-carbon measures in refurbishment of non-domestic buildings Barriers: lack of focus on energy impact during refurbishment and limited understanding of which low-carbon measures are most cost-effective Scope: major refurbishment projects from hospitality, retail and government sectors. Key aims: achieve lower carbon buildings, understand cost effective opportunities and key barriers to lower-carbon refurbishment	10 buildings involved
DTI LCBP	2006	2011	5.0	Context: support for the DTI's Low Carbon Buildings Programme stream 2B Technology: low-carbon buildings: energy efficiency and on-site renewables Barriers: current building regulations do not encourage building to go as far as they could, lack of demonstration of on-site renewables Scope: provide low-carbon expertise to buildings project teams (alongside DTI providing grant funding for on-site renewables) Key aims: demonstrate low carbon buildings, understand cost effective opportunities/ key barriers	25 buildings involved (new and existing)
Biomass (BHA)	2006	2011	5.0	Technology: biomass heating for small to medium scale commercial applications Barriers: high costs, fuel supply chain risks and lack of end user awareness Scope: understand current baseline, run cost-reduction projects with installers, demonstrate supply chain best practice and raise awareness with end users Key aims: reduce costs, reduce supply chain risk, accelerate adoption	65 existing biomass sites
Marine Energy Accelerator (MEA)	2006	2009	3.5	Technology: devices to generate electricity from waves and tidal streams Barriers: costs too high (based on evidence from Marine Energy Challenge) and lack of required focus on cost reduction in industry Scope: A) new low-cost device concepts B) common low-cost components and C) installation, operations and maintenance strategies Key aims: demonstrate potential for step change cost reduction and accelerate progress towards this cost reduction	Interest from 200+ organisations New device concepts from 3 device developers
			28.3		

7.3. The Effect of State Aid Rules

Because of the constraints of the State Aid rules, which limit the grant funding that the Trust might award, the Trust instead commissions work from third parties though a formal and competitive procurement process. While this has a number of disadvantages in terms of a cumbersome selection and project management process, it has at least the advantage that the Trust can hold contractors to their agreed milestones.

In such a project, the Trust might envisage working with up to 20 companies, using a template which describes what the Trust is looking for in terms of cost reduction, and what the individual company will do.

7.4. Technology Acceleration Examples

Marine Energy Challenge

This Acceleration Project was undertaken in 2004 and 2005. The Low Carbon Technology Assessment (2002) originally identified the potential for marine energy. However it was also apparent that for marine energy technologies to be considered economically viable, better knowledge would be needed on costs, engineering and durability.

The objectives of the Marine Energy Challenge were to undertake detailed engineering design and performance analysis of existing technologies, and identify how substantial savings in generation costs might be made.

The project enabled developers of marine energy devices to work with consultants expert in offshore engineering and power generation. Several offshore wave energy devices were assessed and through engineering re-design work, their costs of energy were reduced. Additional detailed studies were made into the costs of shoreline/near-shore wave energy and tidal stream energy.

- The Carbon Trust gained a view of the current costs of marine energy across a breadth of technologies.
- Several devices had their costs reduced by more than 20%.
- Development progress was significantly accelerated.

Following detailed studies it was concluded that:

- Marine energy can become cost-competitive, but is likely to be more expensive until substantial capacity is installed.
- Offshore wave energy will only be competitive if a substantial cost reduction is achieved.
- Tidal stream energy could become cost-competitive within the limits of the UK resource.

Advanced Metering

Advanced Metering has been used successfully by energy intensive users to drive down costs. Over recent years, the cost of the technology has reduced significantly and the approach now offers a good return on investment in managing energy and water usage. Despite this it has not

been adopted widely. The overall aim of the Carbon Trust was to understand, quantify and demonstrate the potential of Advanced Metering to deliver both significant cost and carbon emission reductions in less energy intensive organisations.

The trial was initiated in 2003 with a request for tender to meter data suppliers. Tenders were invited from consortia made up of specialist companies with a lead partner acting as the contractor to the Carbon Trust. By early 2004, seven consortia had signed contracts to provide almost 600 sites to the field trial.

The trial is now complete and the Trust reports that almost all of the recommendations in the final report have been adopted in "Meeting the Energy Challenge: A white Paper on Energy" (CM7124 May 2007)

Biomass Heating

Another example of a Technology Accelerator is the use of biomass for heating, where the Trust undertook a thorough sector review of the production of both electricity and biofuels above the domestic level but below large scale application. It found that the costs for all of these applications are currently too high to be commercially attractive, that there was little confidence that there could be continuity of supply in the market and a lack of customer awareness of the potential benefits. On the basis of this review, the Trust launched the Biomass Heating Accelerator which is seeking to address supply chain and awareness barriers.

7.5. Research Acceleration

In concept, Research Acceleration is likely to consist of large, focused projects on topics selected by the Trust, typically working with universities, with small innovative companies and large manufacturers in collaborative commercial ventures to develop low-carbon technologies.

For each Research Accelerator, the Trust will review areas of potential interest and:

- Identify the current centres of excellence.
- Make a judgement on their capability to deliver a programme of research.
- Assess the UK position in the sector against the rest of the world.
- Determine what should be done.

As with the Technology Accelerator, a "deep dive" study will be undertaken and, following review, a case for expenditure will be presented. Also as with the Technology Accelerator, because of the constraints of the State Aid rules which limit the grant funding that the Trust might award, the Trust proposes to commission work from third parties through a formal and competitive procurement process.

Research Acceleration is a new initiative. The first topic, third generation photovoltaics (PV), is still at the development stage – potential participants are being lined up to participate.

The Advanced PV Research Accelerator is designed to exploit emerging novel photovoltaic materials for large-scale applications. The first phase of

activity has been successfully completed and the Trust has received 16 Expressions of Interest, describing programmes of research worth over £70m, from consortia including over 60 different organisations. The Trust has short-listed the proposals from consortia built around: Corus Colors, Applied Multilayers/Loughborough University, a NaREC/Cenamps cluster in the North East, Imperial College and the Technology Partnership/Cambridge University. The Trust considers that the short-listed proposals represent opportunities to capture world-class intellectual property in the rapidly emerging technology of advanced PV materials and that together the short-listed proposals offer a balanced portfolio for detailed assessment, covering competing PV materials technologies, as well as different levels of maturity and risk. There is a clear strength in the UK in processing of organic and polymer PV, and the Trust is working with the consortia to develop the case for investment through market assessment and technical feasibility studies.

Other technologies that have been or are being been considered are:

- Bio-hydrogen, the development of the means to produce hydrogen without using electrolysis. This proposal was not pursued because it was considered that the science base is not ready to warrant a move to exploitation.
- Offshore wind.
- Low energy lighting.

It is anticipated that one or two bids will be chosen for the Advanced PV Accelerator and that the expenditure will be between £3.5 and £20 million in total.

The proposal is for the establishment of a joint venture with external partners in which the Trust will provide funding and the partners will provide co-funding, intellectual property or other valuable contribution that would count as investment. This should enable the Trust to participate in the future earnings stream resulting from the intellectual property contributed to, and developed, by the joint venture.

7.6. Findings

- **Additionality: The Accelerators are particularly valuable innovations**
    - From interviews carried within and outside the Trust, it is clear that the basic requirement for any intervention by the Trust is a benefit in the form of carbon saving for the UK.
    - The Technology Accelerator is a novel approach which attempts to identify and address all the constraints that may hinder the effective exploitation and adoption of particular technologies across the community.
    - It is too often taken for granted that all that is necessary is for new technology to be developed, and that its exploitation will follow naturally and effortlessly to the benefit of all. This is not

the view taken by the Trust; the Technology Acceleration model is relevant, and deserves to be copied elsewhere.

  - One aspect of this is the Trust's recognition, contrary to much received opinion, that simply supporting the development or installation of demonstration equipment is not enough to secure optimal prospects for adoption and diffusion in the market place. Instead the Trust places great store on monitoring the performance of demonstration equipment in practice and in a range of circumstances so that potential users are in a much better position to recognise and secure potential benefits in terms of carbon saving.
  - The Research Accelerator supports the early stage proof of principle which is the essential step between applied research and effective exploitation.

- **The Trust has an effective process**
  - It is clear that the Trust is thorough in the background work which it undertakes before a project gets approved by the Board.
  - It has not been possible within the time limit of this report to examine a whole Accelerator in detail, but what is done appears to be thorough and proportionate.
- **In this area the Trust is properly geared up for knowledge transfer**
  - Unlike the Applied Research programme, all the knowledge gathered in the development of Technology and Research Accelerators is stored within the Trust, and not among its external consultants, so the benefits can be shared and built on as appropriate.
  - However, external consultants manage the day-to-day aspects of the contracts as well as ensuring the technical content standards required by the Trust are maintained. Without their assistance, it would be impossible for the Trust to field enquiries on the scale being tackled in its Technology Accelerators.
- **Better intelligence** (as discussed in the earlier section on Applied Research) would greatly assist the selection of projects for support by the Research Acceleration Group.
- **It is relevant that results from Technology Accelerator work will provide further material to commend to users in Carbon Trust Solutions**
- **Decisions within this area of the Trust are taken at a senior level;** some of these could be devolved to manager level**.**
- **There is an opportunity to scale up activity in this area,** provided the necessary funding is available.
  - The Technology Accelerator model is already demonstrating its potential, and the concept of the Research Accelerator, while still in initial development, is also promising.

- There is scope to extend the application of both concepts to other technologies. The Trust has included further activities in these areas should it attract enhanced funding in the forthcoming Comprehensive Spending Review 2007.
- This study has found that the Trust generally takes a cautious approach to the State Aid and public procurement rules within which it operates. However, it is recognised by Trust staff that informal soundings with the DTI State Aids team have already been very helpful in developing their thinking, including that on the future development of both Technology and Research Accelerators. They also recognise that influencing the State Aid rules is a political process, in which, should this prove necessary, the Trust's Board members might have a role to play
- In addition, since the DTI has funding and State Aid clearance for the support of large demonstration projects, there may be scope to explore collaboration on this point.

8. Investment

8.1. History

The Carbon Trust has two commercial arms, Carbon Trust Enterprises Ltd, which develops new businesses (not within the scope of this report) and Carbon Trust Investments[26].

In its investment activity, the Trust is one of a very small number of organisations investing in early-stage companies in the clean energy sector. Like the Trust most of the organisations have public sector funding.

The Trust is seeking to invest in companies with low carbon technology that has the potential to deliver a significant return on investment. By doing this the Trust adds a relatively small amount to the sector, however, by declaring its support as an investor and showing that financial returns are available, its activities may also attract new investors.

Through its range of activities the Trust has developed an understanding of the technology and market knowledge and is able to bring together parties who may use or invest in the technology. Co-investors have contributed several times the amount invested by the Trust.

Over last five years the Trust has received approximately 325 business plans or executive summaries. Following meetings, visits and/or initial due diligence, 31 have been progressed to detailed due diligence stage, and to date investment have been made in nine companies.

The Trust made its first investment in 2002 and up to June 2006 had invested in eight companies[27]:

2002	Bowman Power
2003	Natural Buildings Technologies
2003	Exus Energy Ltd
2003	Ceres Power Holdings (AIM listed)
2004	CMR Fuel Cells Ltd (AIM listed)
2004	Ocean Power Delivery
2005	Whitfield Solar Power Ltd
2005	Heliswirl Technologies Ltd

Co-investment

Although technically it is possible for the Trust to be sole investor without breaking State Aid rules, provided it has a third party opinion, valuation of early stage companies is particularly difficult and it is the policy of the Trust only to be a co-investor (on pari passu terms), typically with three or four other organisations.

Valuation and Return on Investment

Although the initial investments did not generate a return (Bowman Power and Exus are in liquidation), later investments have been much more successful. The Trust made a profit of £1.8 million on the sale of its shares

[26] Investments are managed through a subsidiary company (CTIL).
[27] The ninth investment was in ACAL Energy (February 2007)

in Ceres Power following that company's successful AIM listing and the overall portfolio valuation is in the order of £10 million.

Using a process that the CTIP reports was examined by the reporting accountants, and which conforms with the International Private Equity and Venture Capital Valuation Guidelines[28] for the planned AIM flotation (see section 8.6 below), Internal Rate of Return (IRR) on the Trust's investments is approaching 19%, and CTIP estimates that this would translate into a 9% IRR net of management and administration costs. This compares with the BVCA 2006 Performance Measurement Survey which shows negative internal rates of return for both venture and technology funds over a five year period to 2006[29] (although as the survey makes clear, emphasis should be placed on long term returns).

CTIP advises that the Trust's portfolio is valued in conformance with the International Private Equity and Venture Capital Valuation Guidelines where quoted investments are included at closing mid-market price and unquoted investments are valued at the lower of cost or diminished value (unless there has been a material third party transaction that would set a value).

With one exception the total amounts initially invested have been £1 million or less.

Research Grants

Several of the companies in which investment has been made have received research grants from the Carbon Trust; this may have occurred before or after the equity investment was received.

The total amounts of grants awarded were:

	£(000)
Ceres Power	593
Heliswirl	100
CMR Fuel Cells	300

All of these grant awards went through the formal application process, and the Trust takes the view that its decision processes are separate, and that it would be unjust to exclude companies in which it has invested, or may invest, always as a co-investor, from Applied Research Grants that fully meet its exacting criteria.

In the case of Heliswirl, the timing overlapped with the investment and, as far as can be deduced from the files, this was coincidental. The Management of the Trust seeks to address grant and investment decisions as independent of each other, however, senior managers are involved in both decisions (see also Section 8.9).

[28] Theses were developed by the Association Française des Investisseurs en Capital (AFIC), the British Venture Capital Association (BVCA) and a wider range of other national Venture Capital bodies.
[29] PriceWaterhouseCoopers BVCA Private Equity and Venture Capital Performance Measurement Survey 2006.

Sources of Funds

To date, all of the sums invested have been either Government money or surplus resulting from profit on previous investments made. In all cases co-investors have accounted for at least 50% of the investment; and co-investors have included:

- 3i
- Cascade Fund, IC Innovations
- Conduit Partners
- Esmée Fairbairn Trust
- FF&P
- Foursome Investments
- Herald Ventures
- Hydro Ventures
- Impax
- Lehman Bros
- Nikko Ventures
- NStar Co-investment fund
- Partnerships UK
- Rising Stars Ventures
- SAM
- Schneider Ventures
- Synergis Ventures

In addition, a wide range of business angels have been co-investors with the Trust. The reasons why the Trust invariably invests as a co-investor are explained in Section 3.4 above.

8.2. Organisation Structure

All investments are made through Carbon Trust Investments Ltd (CTIL), a 100% owned subsidiary of the Carbon Trust. In 2006 the Trust decided to raise funds from the market for investment in low carbon businesses and this fund would be listed on AIM (see below).

At the same time a limited liability partnership was set up (Carbon Trust Investment Partners LLP, ("CTIP") to advise the fund.

Senior members of staff have transferred from being Carbon Trust Employees to being employed by CTIP which advises the Trust on all its investments. CTIP charges the Carbon Trust for its advice and services. The comparative costs have been independently examined and the Trust will make the report available to the National Audit Office.

CTIP is registered with the Financial Services Authority to undertake investment business. The FSA registration includes employees of CTIP.

The management committee of CTIP includes the Carbon Trust CEO, Finance Director and two of the above senior members of staff.

In is understood that CTIP was set up with advice from PriceWaterhouseCoopers. and KPMG was further used to provide advice on the fundraising.

8.3. Process of Selection

In order to obtain FSA approval, CTIP has had to demonstrate a comprehensive set of procedures to cover each step in the assessment of investment proposals and authorisation of expenditure (the Venture Capital Investments Procedures Manual). It is understood that the procedures applied for earlier investments undertaken by the Trust were similar in nature but with a lower degree of formality.

The procedures where the Trust is considering an investment are set out below. For an investment made by a separate fund, the procedures would

be similar except that the investment approval would of course be from the Fund and not from the Trust.

- Candidates for investment are asked to submit an executive summary for screening by the CTIP Investment Manager to assess whether it meets the Fund's Criteria. Investments are logged onto the investment management system. Each investment proposition is discussed at weekly team meetings[30]. If the proposal passes this filter, the company seeking investment is invited to submit a business plan which is reviewed by the Investment Manager.
- The investment is assessed by the Investment Manager against the fund's specific investment criteria. At the initial stage CTIP will consider whether there is an element of additionality asking "whether their investment will make a difference to the success of the company?".

  CTIP is also concerned to encourage the exploitation of new technology asking "What is distinct about the proposal?" and CTIL staff have said that they will not do "Me too" technology. CTIP will also do more detailed managerial and market appraisal. At this preliminary stage it may rely on its own internal specialists. No other external due diligence is funded at this stage.
- Successful plans are then subjected to an internal "Peer Review" and at the same time the nature of the due diligence requirements is considered following which the proposal is presented to the fund sub-committee which decides whether to fund due diligence. At this point due diligence costs for a small transaction should be less than 10% of the investment requirement for CT and 5% for a larger transaction.
- Full due diligence will include those technical, commercial, financial, management and legal aspects which require independent assessment. It is understood that the extent of the due diligence will depend on the size of the investment. In some cases it has been possible to share the cost of due diligence with other investors.
- Following successful due diligence the legal team is instructed and heads of terms are negotiated. A term sheet is then signed by the Investment Manager.
- Once completed, the due diligence is reviewed to confirm the commercial potential of the investment proposition.

[30] No discussions take place unless all deals are logged on the investment management system, and the same procedure is mandatory at each stage of the process.

- CTIP will then recommend a successful investment proposition for investment approval.
    - For investment of less than £1 million decisions are by the PIC.
    - £1 million to £5 million decisions are by the Investment Committee – a sub-set of the Trust's Board.
    - Decisions for more than £5 million decisions are by the whole of the Carbon Trust Board.

To date no initial investment has exceeded £1 million. The limiting factor on the total amount invested is that few companies seeking investment support meet the requirement of standards of technology, opportunity and management, and the trust has to balance the need to provide investment where it might not otherwise be available against the need to demonstrate that low carbon technologies can generate good returns and safeguard the Trust's reputation and value as a "brand".

8.4. Post Investment

The Carbon Trust acts as observer and retains the right to appoint a non-executive director on any company in which it invests. It also has rights to see all board papers and key internal documents.

After investment has taken place, there are quarterly evaluations and a report to the board; the evaluation includes carbon use modelling. These post–evaluations will not affect the Balance Sheet of the Trust unless there has been a realisation of the gain or a decision to write-off the investment.

CTIP undertakes continuous monitoring of investment performance including:

- Deciding whether to appoint a non-executive investment director.
- Review of project milestones.
- Creation of diary for key events (for example board meeting cycle, company reporting cycle, loan interest preference due dates, capital repayment dates, review of project milestones and any other dates).
- Quarterly revaluation.
- Review of sale terms and exit options.
- Preparation of exit case.

8.5. Divestment

CTIP staff keep all investments under continuous review and run their own financial model of future cash flow of the company in which the investment has been made and the potential dividend stream.

On quoted companies the policy is to sell as soon as possible after any period of restriction on the sale of shares post flotation (a "lock-in") has expired. However the decision will be qualified by the picture indicated by CTIP's future cash flow model; in some cases the team may consider a share to be undervalued and not sell for a period – as happened with Ceres Power.

For unquoted investment s the model will inform any decision on a trade sale or listing.

8.6. AIM Listed Fund

The market for investment in low carbon technologies has evolved substantially. Carbon Trust staff report that low carbon technologies are beginning to be seen as potentially attractive by investors who are committing significant funds to this area; however, the sector remains small compared with conventional energy technology.

During 2006, the Carbon Trust sought to establish an AIM listed fund, Carbon Trust Investments Clean Energy Fund Ltd, the purpose of which would be to invest in low carbon technology opportunities being developed by small and medium-sized companies. The objective was to raise £75 million.

The Carbon Trust got insufficient commitment and, in the circumstances, it was decided not to proceed with its AIM listing. The Trust is now considering the possibility of raising a smaller private fund.

8.7. Carbon Trust Investment Partners

As part of the process of setting up a listed fund, Carbon Trust Investment Partners LLP (CTIP) was set up as advisors to Carbon Trust Investments Clean Energy Fund Ltd.

The pathfinder prospectus for Carbon Trust Investments Clean Energy Fund Ltd indicated that the Carbon Trust and the CTIP would have an Agreement for Supply of Services, under which, for a consideration, CTIP would be entitled to access the Carbon Trust's personnel giving it significant resource, technical expertise and access to information. The prospectus suggested benefits to CTIP from access to the following Carbon Trust Activities:

- Business incubator and investor readiness
- Technology-specific initiatives giving broad sector-level insights into key emerging clean energy technologies
- Links to universities and research centres enabling potential access to intellectual property sources
- Investment opportunities in companies arising from the Low Carbon Seed Fund LLP (see below)
- Investment opportunities in commercial low carbon businesses arising from CTEL
- Carbon Trust sponsored conferences, seminars and networking events
- Over 100 Carbon Trust applied research projects either live or completed
- A proprietary database and screening methodology tracking deal flow throughout Europe.

8.8. Seed Fund

The Carbon Trust recognised that it needed an investment vehicle to provide small sums for technologies at an earlier stage than could sensibly be funded via current investment programmes. It is therefore seeking to establish a number of seed funds in the UK.

The first fund was set up in 2006 with Imperial Innovations Group plc. The Low Carbon Seed Fund LLP has £1 million from Imperial Innovations funded by a grant from Shell Foundation and £1 million from The Carbon Trust. Each investor has a 50% interest in the Fund. The board includes Chris West of the Shell Foundation and Peter Shortt of CTIP and a representative of Imperial Innovations. All calls are open and not restricted to Imperial College. No investments have been made yet.

The fund intends to invest its funds in early stage UK companies which aim to develop clean energy technologies, including wind power, solar power, tidal power, fuel cells, biofuels and new materials.

As part of the agreement, the Imperial Innovations' Fund Manager will select opportunities that fulfil the fund's investment criteria and will prepare investment proposals for the fund's selection. Investments will range between £50,000 and £250,000 and will usually be made at the seed or first stage financing rounds. Proposals will be put by Imperial to CTIP and the Shell Foundation.

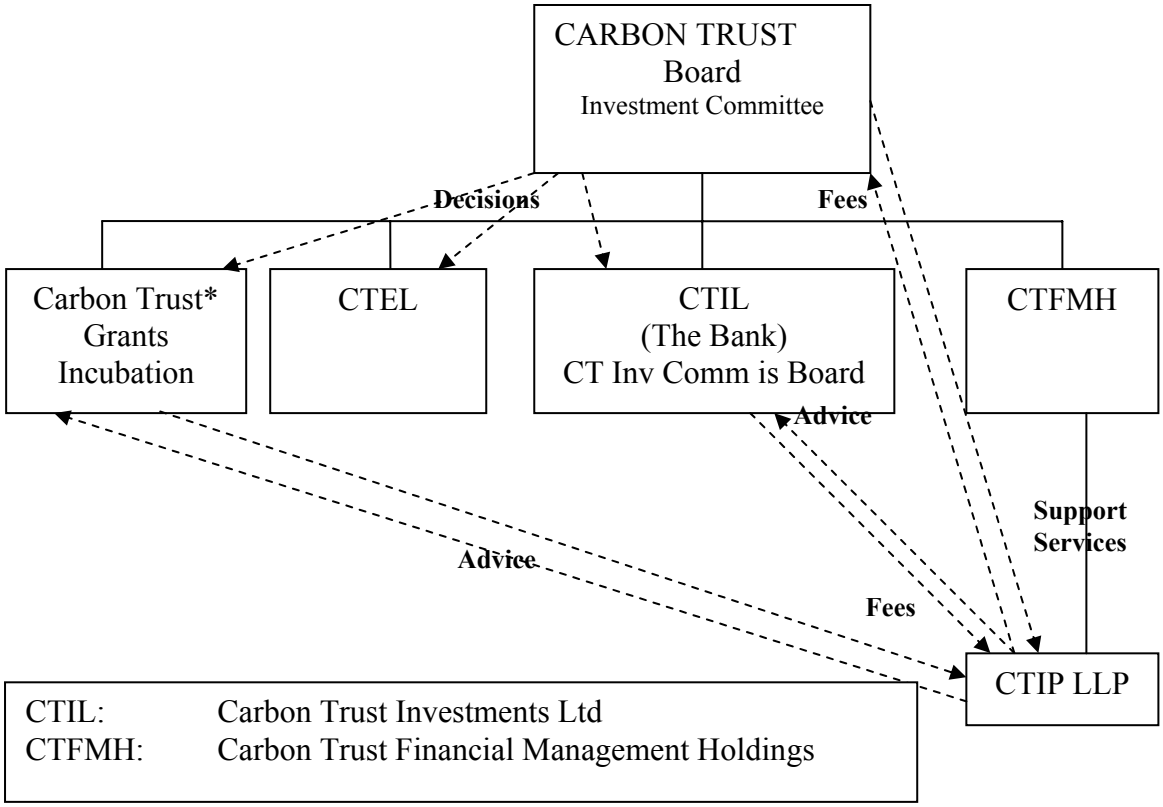
Companies for investment will be at the post incubator stage, but not ready for Series A funding.

8.9. The Relationship between the Trust and CTIP

It is not within the terms of reference of this report to conduct a detailed review of the Governance of the Carbon Trust. However, the relationship between that part of the Trust that deals with research grants and the investment activities involving CTIP is important not least because the Trust is a majority owner of its own advisor.

Figure 5 below shows the relationship between the various components of the Trust. The Trust seeks to operate with "Chinese Walls" (for example the physical separation of offices within the same building) placing emphasis on separating investment and grant decisions. However in the current structure it is inevitable that approval by management for one type of support (such as a research grant) is made in the knowledge that another type of support is likely to be available (for example investment).

Figure 5 Structure of the Carbon Trust



*This function is part of the Trust and not a subsidiary

8.10. Compliance

The European Union directive on Markets in Financial Instruments Directive (MiFID) replaces the current Investment Services Directive (ISD) in November 2007. MiFID introduces some new provisions governing conduct of business and internal organisation.

As an FSA regulated firm CTIP has been subject to a review by an independent firm of consultants[31] which reports the planning process within CTIP as being very considered and detailed, and that the investment and valuation processes are adequately defined to best practice.

MiFiD regulations will require a number of changes in the area of decision making, documentation of procedures, independence of compliance, conflict of interest and data security, together with the implementation of MiFiD compliance manuals. The report makes some recommendations relating to compliance monitoring and the recording and management of any conflicts of interest. At present those responsible for compliance also have responsibilities relating to the investment process.

8.11. Risk

Venture Capitalists generally expect the number of failures in technology portfolios to exceed the number of successes, but that the value of their successes will outweigh failures by a large margin. This is therefore an inherently risky area, but without risk taking, potentially valuable technologies would not be brought to market. What matters is the approach that is taken to minimise undue losses.

After a difficult start, the Trust can say that its recent investments have overall been successful and that, as a co-investor, its risk is limited by the level of risk acceptable to other investors, even though they in turn may be reassured by its expertise in technologies relevant to carbon saving.

While its investments might not go ahead, at least not at an appropriate level without its involvement, it is difficult to argue that the Trust is taking excessive risk if others can be persuaded to share the risk, and therefore spread the risk exposure of its portfolio.

Where the Trust decides to invest, or declines to take a risk by not investing, it will do so this having been through a thorough due diligence process, making its judgement on the advice received and not just backing a hunch.

This subject is linked to that of additionality, discussed next.

8.12. Additionality

One recent investment is a good illustration of the degree of additionality the Trust can achieve from its investment activities. A start-up company was formed to try to develop and exploit a new fuel cell technology using established principles but, with a novel electrolyte, had received an initial

[31] The MHB team had sight of a draft report by IMS consulting at the CTIP offices.

investment of £50,000 from a private sector seed corn fund of a kind that is comparatively rare. To prepare the company for further investment, it was encouraged to go through an incubator supported by the Trust. As a result, the Trust became aware of its existence and its technology.

The initial investor believed that some £1.6m of new investment would be needed by the company to take it successfully through the next phase of its development. The investor interested another in the opportunity, but together they were only prepared to risk some £750,000. They sought to interest the Trust, which was initially cautious but, once persuaded about the potential of the technology and the company, energetically took the lead in financing. The Trust decided to invest, and found a fourth investor through its networks.

Reassured by the Trust's judgement in this specialist area, the three external co-investors each agreed to put in up to £400,000, matching up to £400,000 from the Trust, and paid a pro rata share for the due diligence, which the Trust arranged. Without the Trust's involvement, it is unlikely that this company would have been adequately funded.

There is a general financial market failure in the supply of risk finance for early stage companies; this failure is recognised by HM Treasury and the DTI in amounts especially below £2m and in some circumstances more. This is because, especially in high technology, it is unlikely that companies needing investment will have demonstrated the potential of their technology in the market place sufficiently well to be able to offer investors confident rates of return that many tend to look for.

Overall, co-investors have contributed almost ten times the amount invested by the Trust itself.

8.13. Findings

- **The Trust is making investments following a formal process**
    - There is close control over expenditure on due diligence appropriate to project size.
    - The Trust makes its judgements on the advice received and doesn't just back a hunch.
    - The Trust has learned rapidly from its initial experience and has been much more successful with recent investments.
- **The participation of the Trust is likely to encourage more investment in low carbon technologies**
    - Other investors appreciate not just the funds put in by the Trust, but also the expertise of the Trust in the sector. Additionality is secured by encouraging appropriate levels of the investment early stage companies need for their development.
    - As the sector grows, the Trust can play a highly important role at the leading edge of technology, continuing to encourage additional co-investment, and maintaining a distinct position. If it were to move away from this and become just another

investment source it would lose its distinct position, and the additionality of its activities would become questionable.

- Without a distinct position it could be more difficult to compete with larger funds that are likely to participate in the sector.

- **The Carbon Trust should review the relationship between the investment arm and its other activities**
  - In providing both research grant support and investment, the Trust has a difficult task in meeting requirements for information to be exchanged between its Innovation and Investment arms while at the same time separating the activities to minimise any conflict of interest. On the one hand the Trust has to:
    - Try to meet the objective of providing seamless support, of which investment is one component.
    - Ensure that the Investment process is properly overseen by senior staff and the Executive.

    On the other hand, given that the its expertise has been funded by public expenditure, the Trust has to be seen to ensure that neither employees nor investors receive any excessive benefit from returns on investment or a carried interest (that might arise, for example, if a private fund were set up).
  - This report does not deal with governance issues, and it is understood that the Trust has taken expert advice in this area. However, given the ever-increasing value of the Carbon Trust's "brand" and reputation, the Trust should review its organisation, structure and physical location of its investment arm in order to eliminate the possibility of the arrangements being misconstrued.

9. Case Examples

A selection of eighteen case files was examined to look at the process of application, management and measurement of outcomes; they include three cases where the application failed, or where the project was not started for financial reasons (the company concerned went into administration).
The applications:

- Accounted for approximately 15% of the total value of Applied Research Grants.
- Represented many different regions of the UK.
- Included examples from all years from 2002 to 2006.
- Included five examples which have been through a Carbon Trust Incubator.
- Included two examples which have received investment from the Carbon Trust; others have received investment from other sources.
- Included one example from a local authority and five from SMEs; the remainder were university-related.
- Included one example that went into administration.
- Included one example that had its grant terminated because of non-compliance.
- Included four cases from the interview programme conducted for this report.

The case studies demonstrate a range of circumstances, including:

- Both successful and unsuccessful applications for support, and cases where the application was referred back for improvement.
- Projects and organisations that receive more than one type of support, including Applied Research Grants, Incubation, Investment and the possibility of Research Acceleration.
- Cases which were successful without investment by the Carbon Trust.
- A case where a grant was terminated.

The Carbon Trust has recently introduced a process whereby on commitment of new funding the potential future additional carbon savings resulting from the Trust's support are estimated using the 'Future Impact Estimation' tool. These estimates are further updated if there are material changes in circumstances for the project and on project completion based on an analysis of the projects success and achievement of relevant milestones. This analysis is separate to that undertaken by the applicant and represents the Carbon Trust's independent view of carbon saving potential.

9.1.Research Grants

Selection Process

While the papers are incomplete for one of the early examples, the files examined mostly provide evidence of the implementation of the selection process, and the Carbon Trust's analysis in computer files show the progress of each application.

The files support the analysis in Section 4.2.4 above that marginal applications receive specific attention. The PIC is active in the decision process, if necessary overriding the recommendations of the assessors.

It is also clear that the assessors and Carbon Trust staff are prepared to challenge applicants' assumptions on costs (for example, "padded" university overheads) and are not overawed by applications from august institutions.

Administration of Grants

Most of the progress reports in the files are to the standard format specified by the Trust. They are clearly subject to review, but are received via the project supervisors.

In the two cases examined where something has gone wrong (in one the company going into administration and in one not complying with the terms of the grant) it is clear that Trust staff have acted rapidly to contain the situation and minimise losses.

Carbon Savings

The Trust considers applications in relation to its Low Carbon Technology Assessment (LCTA). Applicants are required to indicate potential carbon savings and those receiving grants have to include carbon savings estimates in their reports. However there is little evidence of any follow-up after the completion of a research project; this may be because the technologies qualifying for research grants have not yet reached a stage where their carbon saving potential can really be measured.

In 2007 the Trust has developed and refined its approach to the estimation of future carbon savings. The future, additional, carbon savings likely to result from all projects are estimated based on the level of success achieved in the project and the attainment of relevant milestones

Assessment on Completion

AEA E&E which supervise the projects grades each one on completion. The figures below are taken from six completed projects among the selection of fifteen successful applications analysed for this section of the report. The scoring system evolved with inclusion of greater detail in cases D-F:

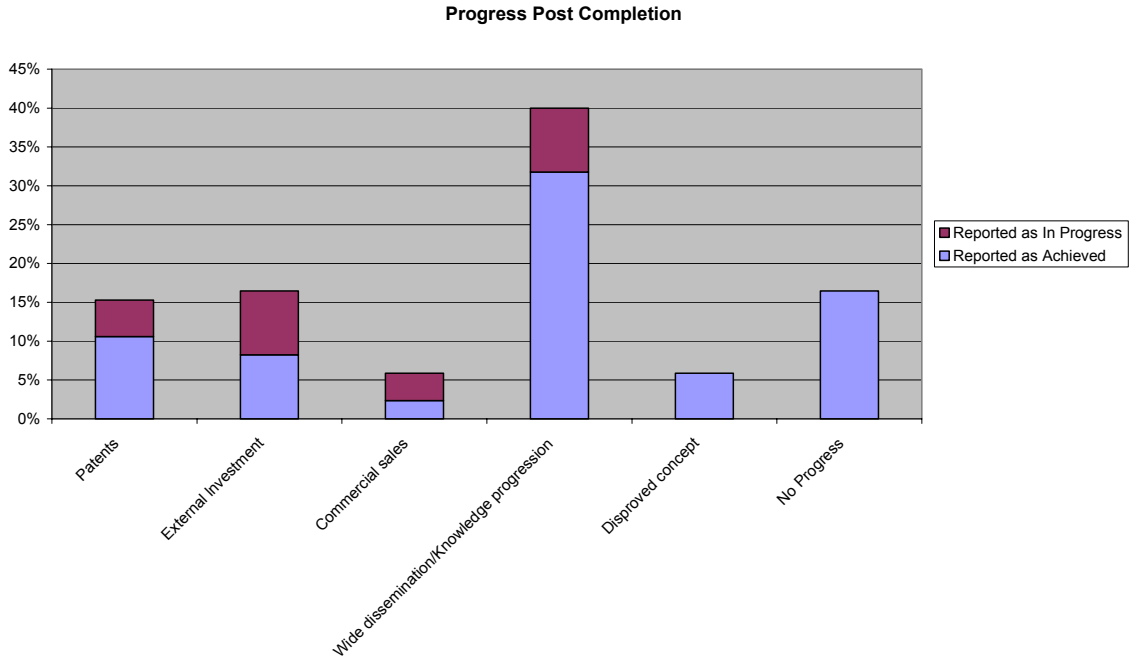
Closure report	A	B	C	D	E	F
Achievement of Contract Objectives	3	4	4	3	4	4
Performance of lead company	2	3	3			
Project management				3	3	4
Regularity of Progress Information				3	4	3
Ability to manage other partners				3	3	3
Performance of project Partners		3	3	3		
Reporting	3	3	4	2	3	4
Analysis and conclusions				3	4	4
Clarity of results				3	3	3

The scoring represents the following standards:

- 4 Exceptional
- 3 Satisfactory
- 2 Inconsistent
- 1 Poor

These are judgement-based assessment, and are not subject to any formal criteria.

AEA E&E will advise the Trust on projects where they might wish to have further meetings, and these occur in about 20% of cases. In the past year the R&D department has recruited additional staff and is now able to monitor outcomes on a systematic basis. The chart below sets out progress post completion on 85 projects.



The R&D Department is now tracking progress of completed projects, and in addition short reports are produced for dissemination of projects outcomes within the Trust.

Of the six closure reports A-E two example reports were supplied in addition to the brief comments within the spreadsheet database showing the technical achievement, impact on commercialisation and next steps.

9.2.Incubation

Of the five examples that had been supported through the Carbon Trust Incubation Programme four raised funding, including the example attached (Case V) where a grant had been withdrawn.

9.3.Investment

Of the two companies that received investment from the Carbon Trust one received funding from the Trust in a second round and went on to a flotation. The other received what was in effect seed capital at a much earlier stage of its development.

Due Diligence

The CEO of the first company characterised the investment team of the Trust as being exceptionally rigorous in their assessment of proposals, more than most venture capital firms and with the added dimension of carbon saving. He thought that this rigour may have something to do with the use of public money and public accountability but wondered whether the process is “too gold plated”. However he also felt that due diligence by the Trust can help to make a startup credible to other potential investors.

The CEO of the second company said that the Trust didn’t do much due diligence on his company, because of the small amount of investment (less than many research grants) and because the company had already been through the incubation process.

Both of these companies had received research grants at about the same time as the investment and at the time both the Research and Investment arms of the Trust knew that both transactions were under consideration.

Carbon Saving

Both of the chief executives interviewed were just as focussed on delivering shareholder value as in any other field. Carbon savings were seen as a means to generate sustainable earnings. They also see the Carbon Trust investment team as very hard nosed - about making money, but within the criteria of carbon saving. (“The technology is a necessary evil to make money”.) In the whole process they have been generally happy to let the Carbon Trust make the running on the calculation of carbon reduction.

9.4.Findings

- From the selection of cases the Trust appears to be following its own procedures in assessing applications for research grants; where a project team cannot deliver the research, the grant is quickly terminated.
- The Preliminary Investment Committee (PIC) takes an active part in decision making.
- Historically there has been limited follow up at the end of a project, although this is being addressed to and extent in that results are tracked and reported, and progress is disseminated within the Trust; However this still remains an area where the Trust has a major opportunity to gather intelligence about its technologies; this will require meetings with a much higher percentage of grant recipients and should not be on the basis of issues raised by AEA E&E.
- It has not been possible to come to robust conclusions about the carbon savings the programmes will deliver, but this is due to the early stage of the technologies.
- The Applied Research Grant and Investment arms of the Trust are alive to the need to be aware of each other's activities in awarding grants or making investments even though the decisions are separate.

The companies emerging from the process do not see carbon reduction as an end in itself, but rather as a means for them to make returns for their shareholders. This is understandable since carbon saving is an externality in addition to the companies' interest in making returns for their shareholders. It is this wider benefit that justifies the involvement of the Trust in helping to create the conditions for their success.

10. Comparison with other organisations

The CEO of a company which had received support from the Carbon Trust, and which now operates in international markets, and who was interviewed as part of this study, has commented that the Trust is probably unique in the world, and a model that other countries may wish to emulate. However there is a wide range of organisations in the UK that undertake activities and have processes that have some elements in common with those of the Carbon Trusts, although none is very similar overall.

This section looks at some examples in the UK and one the USA where comparison can be made. Because of the wide range of sources of funds it is not presented as a definitive list.

10.1. Massachusetts Renewable Energy Trust

The Carbon Trust suggested The Massachusetts Renewable Energy Trust (MRET) as an organisation, albeit at State level rather than at USA national level, that had some similarities with the Carbon Trust. Reduction in carbon emissions has so far received little attention at a federal level under the present US administration.

MRET was formed following the deregulation of the electric industry in Massachusetts. The State Legislature created the fund to help increase renewable energy sources available in Massachusetts, funded by a small levy on domestic electric bills. The fund is administered by the Massachusetts Technology Collaborative (MTC), an independent economic development agency.

MRET oversees a $150 million state fund for renewable development. It has established incentives to attract business start-ups and renewable-energy business transfers from other states and a university consortium to provide research and development.

The published MRET Strategic Plan indicates a budget of $43 million for the 2007/8 financial year, summarised as follows:

Financial year 2008	$ Million Projected
Green Buildings	15.2
Clean Energy	12.8
Industry Support	4.5
Policy Total	0.5
Multi-Programme	
Low Income	0.8
Office of Commonwealth Development	3.0
Offshore Wind	2.0
Special Opportunities	4.0
Total Programme Allocation	42.8

Examples of projects funded by MRET include:

- $2 million in grant funding from MRET to four emerging-technology demonstration projects:
    - $0.5 million to construct a hydroelectric plant utilizing Gorlov helical turbines;
    - $0.5 million to construct and demonstrate a CHP biomass gasification system;
    - $0.5 million to install a 500-kW ocean-wave demonstration facility (part of a multistate effort with Connecticut, Massachusetts, and Rhode Island);
    - $0.5 million to scale up, construct, and demonstrate a biomass technology at the Hubbard Forest Industries sawmill.
- $3.5 million grant programme for 100 new solar-electric installations and 21 recipients to develop new and renovated energy-efficient buildings.
- $5 million Premium Power Installation Grant programme that provides up to 25% of the total capital costs, with a maximum of $2 million per project for fuel cells.

The area for greatest concentration and success for MRET has been in disseminating intelligence and networking within the “renewables” industry cluster in Massachusetts. MRET has paid close attention to identifying the members of this cluster (this provides the opportunity for monitoring the growth in employment in this cluster as evidence of MRET’s success in its activities).

Although MRET has put efforts into identifying the organisations falling within the renewables cluster it has not at this stage engaged in any strategic modelling of the sector. It is not able, for example, to analyse the attributes of members of the cluster in terms of carbon emissions, generating capacity or employment; or to model/forecast future changes in these attributes for the cluster or members of sub-clusters either as a function of time or in consequence to policy development by MRET.

Future development of MRET will concentrate on addressing the issues of accountability – assessing what have been the outputs/outcomes of MRET’s activities/programmes – and in steering MRET to achieve some “big wins”, these latter being measured mainly in terms of public impact and jobs created or saved.

In terms of internationalisation of the whole renewables field, MRET has contact with some major organisations and sees the opportunities to build on these contacts to develop future activities. This will be of use in networking to advance the interests of members of Massachusetts-based organisations.

Activities equivalent to Carbon Innovations and Investment

MRET's greatest successes so far have been in influencing (via grants and incentives) the school building programme within the state to create Green schools. In doing this MRET has have drawn strongly on the example provided by California.

A second area in which MRET feels it has been successful is in building the networks and development within the renewables cluster. More precise measurement within this area of perceived success may be difficult.

Comparison with the Carbon Trust

The controlling body for MRET is the MTC board. Consequently and unsurprisingly there is a substantial emphasis within MRET on assessing its activities and progress in terms of jobs in the renewables field created or saved, secondarily in terms of MW of capacity installed. This latter item relates mostly to installation, which qualifies for a rebate on the levy paid by consumers.

MRET has to cover a very wide range of activities; many of these have their origin and raison d'être in historic events. It has not had the opportunity that the Carbon Trust had of starting from scratch, and there is understood to be considerable overlap between activities, with attendant coordination issues.

From discussion with MRET staff, the ingredients for success for this type of organisation must include:

- A focussed set of programmes and activities
- Definition of reachable target market(s)
- Strategic focus
- An easily comprehensible "story" (material not woolly)
- Trading on areas of expertise/strength
- Attention to fostering and stimulating "deal flow"
- "Smart" metrics to assess performance

And should avoid:

- Top heavy and cumbersome processes
- Multiple and/or contradictory missions
- Board membership/management tiers misaligned with mission and critical success factors

On the basis of the above, the Carbon Trust fits in very well with the ingredients for success and does not suffer from the attributes best avoided.

10.2. DTI Grants for Research and Development

There is a range of schemes angled at different stages of RD&D and different types of organisation.

Research and Development

The SMART award programme for research in SMEs, that was originally developed and administered by DTI, is being replaced by an R&D scheme for SMEs, day-to-day responsibility for which has been delegated to the Regional Development Agencies (RDAs) and Territorial Departments. These bodies follow locally determined procedures within broad guidance from DTI on selection criteria and arrangements to protect the public purse. This requires proportionate arrangements for project management and for monitoring, without specifying whether this should involve regular visits by project officers, though an audit is invariably required at the end of each project.

These grants can be up to £500,000, but most are considerably smaller. They can be contrasted with bigger applications, which the DTI continues to deal with centrally under the aegis of its Technology Strategy Board. These have to be collaborative between researchers and firms with a view to the results being exploited commercially, echoing the Trust's general approach.

Smaller grants for R&D to help individuals starting up businesses and SMEs already based in England to carry out research and development work on technologically innovative products and processes are distinct from University awards and do not fund academic research. They contribute towards the costs of research and development work and are intended to encourage businesses to carry out projects that they would not otherwise undertake at all, or in the same way, and companies are encouraged to seek matching finance from private sources for these projects.

The grants are discretionary and project proposals will be assessed against a Scorecard agreed between the DTI and Regional Development Agencies. The grants are aimed at a variety of stages of research, detailed in figure 4 below for a number of purposes.

Applications

There is a standard set of selection criteria and these include:

- Level of technological innovation
- Technical risks and R&D challenge
- Commercial potential and market need
- Exploitation prospects
- Management abilities and the project team
- Commercial and financial viability
- Intellectual property and patents
- Additionality
- Wider aspects

Over time, calls for applications will emphasise particular areas of technology. Each agency will develop its own process, but along the guidelines set out by the DTI.

Monitoring of Grants

Monitoring of grants will normally be carried out by the agency concerned, although in certain circumstances third parties can be asked to do this. It will include:

- Monitoring the technical and commercial progress of the project and claims for payment against the agreed work plan and set milestones.
- Checking financial viability of the project and business via audited or full management accounts and various databases.
- Assessing the effect of any changes to or within the project (for example, change of project direction and objectives) or business.
- Deciding whether any repayment of support might be requested, where compliance with the terms and conditions has not taken place.
- Checking and advising on the marketing/exploitation aspects of the project; and
- Notifying DTI Sector Directorates about projects and their progress, where they have requested such information.
- Thorough checking of claims for payment and related documentation.

FIGURE 4: Grant for Research and Development
(Source: Guidelines for Officials: DTI)

Grant Type	Maximum Value	Maximum Percentage of Costs	Maximum Duration	Description
Micro Projects	£20,000	50%	12 Months	Development of: • Simple, low-cost working prototype of a technologically innovative product or process, or • Pre-production technology that can be used in technologically innovative products or processes
Research Projects	£75,000	60%-75%	18 Months	Planned research or critical investigation aimed at producing new scientific or technical knowledge, the objective being that such knowledge will be useful in developing new products, processes or services. The output of a Research Project will typically be an early bench top or experimental model (but not a pre-production prototype). This type of model may be backed up by a Report on the technical and commercial feasibility of the concept to develop an innovative new product or process.
Development projects	£200,000	35%-45%	3 years	A Development Project will shape the results of a Research Project or industrial research into a plan or design for a new, altered or improved product, process or service for commercial use, including creating an initial prototype that could not be used commercially. It does not include the routine or general changes made to products, production lines, manufacturing processes, existing services and other operations in progress, even if those changes may represent improvements.
Exceptional Development Projects	£500000	35%		An Exceptional Development Project will have a major effect on the overall performance of UK industry (and, ideally, across industrial sectors) in terms of the way it works, increasing its productivity or its sustainable development. It is the strategic nature of these projects that distinguishes them from standard Development Projects. These grants will help SMEs to enter markets demanding particularly expensive research and development on leading edge technology, but in return must demonstrate the potential to generate a strategically exceptional value for money return on the public investment.

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The New and Renewable Energy R&D Programme

The DTI states that it has now "a more focussed programme that assists businesses with their technology development". The New and Renewable Energy R&D Programme is delivered through via two open calls per annum. Application is through a two-stage assessment process (outline proposals followed by full proposals) managed by an independent contractor, with independent assessors involved at each stage of the process. From the announcement of the call, it takes approximately six months for successful proposals to get consent.

To be eligible for support, all proposals must be of a collaborative nature. Eligible collaborations can be of two kinds: industry–industry or industry–academic.

Areas of focus include:

- Fuel cells
- Wave and tidal stream
- Wind
- Photovoltaics
- Biomass
- Embedded Generation

DTI Capital Grants Programme

The DTI's Capital Grants Scheme funds demonstration projects, under which funds have been allocated for:

- Offshore wind: (£117 million)
  This was to stimulate early development of offshore wind farms. The scheme is now closed.
- Biomass: (£66 million)
  To encourage the efficient use of biomass, particularly energy crops, for energy production by stimulating the early deployment of biomass-fuelled heat and electricity-generation projects. Of this £66 million, the New Opportunities Fund provided approximately £33 million for energy crops power generation and around £3 million for small-scale biomass/combined heat and power projects.

A number of other areas have already received additional or new funding:

- Solar photovoltaics: (£31 Million).
- The Clear Skies Programme (£12.5 million):
  grants for domestic and community schemes.

DTI Marine Renewables Deployment Fund

The £50 million 'Marine Renewables Deployment Fund' supports the continued development of the marine renewables sector. The EPSRC advised that this programme is about wave devices of which £42m is allocated towards capital and revenue support for wave device developments and £8m towards infrastructure projects.

The objective is to bridge the funding gap between research and deployment to enable demonstration projects to be undertaken.

10.3. Other Sources

The services of the Energy Saving Trust are excluded as its “footprint” of support, focussed on domestic building, has very little overlap with the Carbon Trust. However, as an example of collaboration, the Energy Saving Trust has a lead in DTI’s low carbon buildings programme, a part of which is contracted to the Carbon Trust to manage because of particular expertise in its Technology Accelerator team. Other sources of funding that might be available to those applying to the Trust include:

National Endowment for Science, Technology and the Arts

The NESTA Invention & Innovation Programme provides early stage funding to small businesses. Investments may be made at a proof of concept stage, by NESTA alone or at a later stage when NESTA may be a co-investor with a private sector investor. Investments may take the form of loans, pure equity, or contracts based on a return on income from the exploitation of IPR.

Knowledge Transfer Partnerships

The scheme is funded by the DTI, the Research Councils and Regional Development Agencies. Each partnership employs one or more high calibre Associates (recently qualified people) to work on a project, which is core to the strategic development of a business.

The partnerships can fund research or other aspects important to the development of a business providing funding of approximately £26 million per annum for approximately 500 partnerships.

Business Innovation Centre (BIC) funding

BICs offer services to inventors, entrepreneurs and SMEs. They are funded by the European Regional Development Fund (ERDF), the Government's Single Regeneration Budget (SRB) and by other local private and public sponsors.

Regional Venture Capital Funds (RVCFs)

RVCFs are a programme in England to provide risk capital via the Regional Development Agencies to SMEs who demonstrate growth potential. These funds are generally managed by venture capital companies under contract to the RDAs, though at least one of the RDAs retains fund managers with private sector experience in this area to manage its funds.

The rationale is an 'equity gap' in the provision of small-scale risk finance for SMEs with growth potential.

The stated objectives are to

- "Demonstrate to potential investors that commercial returns can be made by funds investing in the SME equity gap thus promoting the private sector venture capital industry".
- "Increase the supply of quality fund managers operating in the equity gap".

Funding is from Government, via the Small Business Service plus additional finding from the European Investment Fund (EIF). RVCFs can invest up to £250,000 in equity or debt into any qualifying business.

University Challenge Fund

The UCF is to support businesses at an earlier stage (when the university would be the majority shareholder) than would be eligible for a Grant for Research and Development. At the 'spin-out' stage, when Grant for Research and Development would be appropriate, UCF is not. Therefore, the two funding mechanisms are, in effect, mutually exclusive.

Environmental Transformation Fund

This joint DEFRA/DTI scheme was announced together with developments in emissions trading in June 2006 with funding to be announced in 2008 after the 2007 Spending Review. The aim will be to boost investment in renewable energies and other green technologies aimed at reducing carbon emissions.

In a Parliamentary answer of 25th April 2007, the Parliamentary Under-Secretary, Department for International Development said:

"Expenditure from the Environmental Transformation Fund (ETF) will cover the three years of the comprehensive spending review period from April 2008. Apart from £50 million earmarked for the Congo basin, which was announced in the Budget, detailed breakdown of allocations have not yet been decided.

"It is expected that the allocation will be used to fund multilateral activities, such as the World Bank and Regional Development Banks' clean energy investment framework and other initiatives, as well as bilateral projects with countries. It will also be used for purposes such as adaptation, promotion of clean energy and tackling unsustainable deforestation". (Hansard: 25 Apr 2007: Column 1169W).

The 2007 budget statement included a £800 million international "window" for the Environmental Transformation Fund to finance overseas development projects that deliver both poverty reduction and environmental benefits in developing countries.

Comparison with the Carbon Trust

The DTI has both grants of a similar size to those offered by the Carbon Trust, and grants which cover the same areas addressed by the Trust. It has a two stage call process for research grants, and it has total funding that greatly exceeds that available to the Carbon Trust.

Therefore to some extent the DTI can be seen as a competitor of the Trust in the delivery of support. However there are some key differences in approach in that:

- The DTI:
    - Can act on a bigger scale for larger projects, and
    - Is the most powerful voice in government support of new technology whereas the Trust, by comparison, is a tiny organisation.
- However the Trust:
    - Specialises all the time in applied research grants for a particular set of (low carbon) technologies.
    - The attitude to risk at the Carbon Trust is informed by a *rigorous,* objective and transparent assessment process which reduces the risk of unsatisfactory outcomes.
    - Has a degree of independence which enables it to adapt quickly to changing circumstances.
    - Has innovation and investment programmes which provide funding and services as part of the whole range of the Trust's activities.
    - Has innovation and investment programmes which seek to help the development of the technology at each stage from proof of principle to commercial product.
    - Engages with client organisations in a fundamentally different way with an unmatched range of expertise.
    - Through its assessment of and support of companies, the Trust is a key factor in persuading other organisations to participate or invest. It is a trusted, independent organisation. Those dealing with the Trust have commented that the process experience and the relationship is very different, as a result of the different nature of the organisation, its culture, structure and objectives.
    - Monitors technical and commercial progress more closely

10.4. SULIS Fund

The SULIS Fund provides funding to new ventures emanating from Bath, Bristol and Southampton Universities. Its purpose is to fund companies between the stage of Research funding and the raising of commercial Venture Capital. Sums of up to £0.25 million are made available to:

- Establish the potential of a project and identify areas of risk and uncertainty.
- Develop the concept and define market possibilities.
- Complete critical technical development needed to prove the concept.
- Help the process of Intellectual Property Protection.

- Ensure effective commercialisation.

The fund generally deals with sums at the lower end of the range of investment made by the Carbon Trust. The fund is managed by the venture capital firm Quester and Sulis Innovation Ltd (a joint venture between the participating universities.)

There is a formal process of approving projects; proposals for investment go through a number of stages. Initially they are screened by a University Technology Transfer office. Following support in the building of a business plan from Quester of an external consultant, the case for investment is presented to the SULIS executive which includes representatives from the Fund managers and the participating universities. If successful then a full proposal is made to the SULIS Board. Funding may be offered in tranches contingent on completing defined milestones. Successful applicants may receive further funding once a spinout is formed and this may involve both SULIS and co-investors.

SULIS will normally retain the right to observer status or the right to appoint a non-executive director, and there is a requirement for quarterly reporting of progress.

The criteria for investment which are for new companies at a “seed” stage of development are:

- A strong Technology or IP base.
- Potential products or services able to sustain competitive advantage over time in identified markets.
- A strong business leader/entrepreneur associated with the project.
- Clear opportunity for growth and business development.
- That formation of a company has significant advantages over other commercialisation routes.
- Ethical issues.
- Environmental and social impact.

Comparison with the Carbon Trust

The SULIS process is aimed at small investments in new companies of a size similar to the lower end of the range of investments made by the Carbon Trust and also those which might be made by the new Low Carbon Seed Fund LLP (see section 8.7 above). The Sulis Fund of course does not concentrate only on low carbon technologies.

The Carbon Trust investment appraisal process, described in Section 8, is at least as rigorous as this, even when operated to a less intensive extent for small investments.

11. Conclusions

This section complements the findings reported in the preceding sections and addresses some aspects of the Trust in the future.

11.1. Organisation

The Carbon Trust is still a young, expanding organisation that has attracted high calibre staff. As an independent company it is also able to gain the confidence of private sector organisations with which it deals.

It is very noticeable that the management of the Trust learns from experience and adapts its organisation, operations, and objectives much more rapidly compared with what might be expected in a public sector organisation. Given the opportunity, the Trust could deliver services on a much-enhanced scale.

The Carbon Trust has been highly innovative in its approach and its programmes. This is a major factor in the delivery of its innovation and investment activities.

11.2. Additionality

11.2.1. Adding Value through Applied Research

Relationship with basic/academic research

There is a significant difference in the objectives, timescale, approach and success criteria between research for discovery and applied research.

The aims of the Trust in applied research are more specific and more geared to exploitation than those of the Research Councils, justifying a rather different approach to ensure that as much as possible is being achieved of relevance, not just excellence in whatever is done.

The Trust is very clear that it is not enough simply to back research groups if one is interested in exploitation and deliverables, and its value lies in its being able to drive forward practical application of new technology.

A number of external organisations commented on the uncertainty surrounding the future of the proposed Energy Technology Institute. In deciding its approach to managing research, it would be worthwhile drawing on the experience gained in the Carbon Trust's programmes.

Scale and Coverage

It is inevitable that the scale of funding and State Aid rules have in some respects limited what the Trust has been able to achieve. There is an opportunity for larger accelerator programmes to make a significant impact; however to obtain the benefits the Trust may need to address the level of clearance it has under State Aid rules, and make the case for the value it can deliver through increased funding.

The Trust is developing a range of support that has fewer gaps either in support for research at a particular stage or in the time taken to move from one stage of support to another.

11.2.2. Equipping Companies to Create Value

The idea that new companies derive benefit from incubation is not universally shared; however the virtual incubation approach now taken by the Trust is delivering a flow of new companies that are attracting investment, not just by the Carbon Trust.

In the next step of raising money, the Trust plays an important role as a co-investor in bringing the Trust's expertise to bear on investment decisions relating to early stage companies, but in addition offering financial commitment. However, in delivering this, it has to be seen to have the right level of separation between publicly funded support and private investment.

11.3. Position in the "Market"

A number of those interviewed have suggested that the Carbon Trust is unique in the world and as such is a model that other countries may emulate. The Carbon Trust "Brand" and capability has gained a high reputation in both industry and academia; the value of this needs to be protected and enhanced.

As larger funds are committed for the development of a low carbon economy, the Trust has to find a way of retaining this distinct role while surrounded by larger entities – and for this it needs to retain its independence.

Becoming a bigger organisation is not the whole answer; rather it may lie in retaining a distinctive position at the leading edge of innovation.

11.4. Extracting the Value

The report has covered a number of areas which have the potential to add more value to the activities of the Trust.

- In the area of applied research, more contact with grant recipients would help to generate better intelligence of developments in technology and the market, especially if combined with greater follow-up on completion of projects.
- The focussed use of experts at the later rather than earlier stage of the grant application process could help to improve project scope and quality. Trust staff now has the ability to do the initial screening.
- The Trust should explore the means of gaining intellectual property rights and equity in exchange for support. Whilst one mechanism is via seed funding, there are others:
    - Universities provide funding for startups and in exchange have equity;

- The Wellcome Trust and other charities can receive equity in exchange for its grants.
- There is also the precedent in the social housing sector where Housing Associations are awarded grants while at the same time the Housing Corporation which awards the grants retains some rights to the value of properties built.

11.5. Contribution to Carbon Trust Solutions

Finally, through its range of activities and their dissemination, the innovation and investment activities support both the Carbon Trust Solutions and Carbon Trust Insights objectives.

APPENDIX I Glossary

Term	Description
Applied Research	Applied research is designed to solve practical problems of the modern world, rather than to acquire knowledge for its own sake.
Basic Research	Basic research (also called fundamental or pure research) is seeks to address a scientific question. The main motivation is to expand knowledge, not to create or invent something. There is no obvious commercial value to the discoveries that result from basic research.
Biomass	Living and recently living biological material which can be used as fuel or for industrial production.
Clean Energy Technology	The clean energy technology sector includes technologies such as wind, wave and tidal power; high efficiency energy conversion devices such as fuel cells; energy efficiency technologies which lower the energy consumption of existing materials or processes; bio energy, bio fuels and related technologies; waste to energy technologies and projects; and innovative business models deploying existing or emerging clean energy/low carbon technologies or processes which can exploit revenue streams offered by regulatory or support regimes.
Cleantech Venture Partners	A limited Liability Partnership, registered in Scotland which is a member of Carbon Trust Investment Partners (CTIP).
CTEL	Carbon Trust Enterprises Limited, a subsidiary of the Carbon Trust which develops commercial low carbon businesses.
CTIL	Carbon Trust Investments Limited, a subsidiary of the Carbon Trust which is a holding company for venture capital investments.
CTIP	CT Investment Partners LLP, a limited liability partnership incorporated in England and Wales and registered with number OC319987, whose registered office is at 8th Floor, 3 Clement's Inn, London WC2A 2AZ.
Deep Dive	A term used to describe a very thorough examination of barriers to change in a particular area of applied technology where the Trust may wish to extend its activity
EPSRC	The Engineering and Physical Sciences Research Council with which the Carbon Trust collaborates in Carbon Vision.
ETF	The proposed Environmental Transformation Fund, a project being run jointly by the Department for Environment, Food and Rural Affairs and the Department of Trade and Industry which will provide investment for renewable energy and energy-saving technologies.
Fuel Cells	A fuel cell is an electrochemical energy conversion device. It produces electricity from external supplies of fuel.
Greenhouse Gases	Gases that trap the heat of the sun in the Earth's atmosphere, producing the greenhouse effect. The two major greenhouse gases are water vapour and carbon dioxide.
Gtc	Billions of metric tonnes of carbon
GW	Gigawatt
Incubator/Incubation	Service, which may or may not include premises, to assist companies a an a early stage of their development to develop their business and organisation
LCTA	Low Carbon Technology Assessment. An exe4rcise carried out by the Carbon Trust to help determine its priorities.
LDA	The London Development Agency
Lock-in	An off-site meeting lasting up to two days in which initial applications for Research Grants are assessed.
Low Carbon Seed Fund	An investment fund managed by Imperial Innovations Limited with capital provided by the Shell Foundation and CTIL investing up to £250,000 in early stage opportunities in the low carbon economy.
Photovoltaic	Photovoltaics (PV) is a solar power technology that uses solar cells or solar photovoltaic arrays to convert light from the sun into electricity.
PIC	Preliminary Investment Committee of the Carbon Trust. Subsidiary to the full Investment Committee.
Pillar 2	The name originally given to the innovation and investment activities of the Carbon Trust.
Project Managers	Employees of AEA Technology who manage applied research projects for which the Trust provides grants.
RD&D	Research, development and Deployment
RDA	Regional Development Agency
Seed Fund	An investment fund which supports fledgling businesses with early stage investment.
Series A funding	The first round of venture capital financing of the company.
SMART award	AN award from the DFT that supports development of new technology based business.
SME	Small or medium-sized enterprise
Sulis Fund	A seed f und managed by Quester, a venture capital firm in collaboration with the Universities of Southampton, Bristol and Bath.
The Carbon Trust	The Carbon Trust is a company limited by guarantee incorporated in England and Wales.
The Carbon Trust Investment Committee	A committee of the board of the Carbon Trust which is responsible for setting the portfolio objectives and approving the investment strategy of those activities of the Carbon Trust which help to develop low carbon technologies.

APPENDIX II Terms of Reference

As part of its Value for Money report on the Carbon Trust, the National Audit Office commissioned Morgan Harris Burrows to examine the effectiveness of the Trust's Pillar 2 programme. The aim of the report is to provide the NAO with a solid evidence base:

- To cover the benefits that the Trust is adding to the process of developing and commercialising new low carbon technologies, and
- For making recommendations on where there are gaps or barriers in the process which the Trust could address.

Morgan Harris Burrows was asked to address the following questions:

- Does the Trust have a robust process in place for deciding which technologies and organisations to fund?
- Is the Trust providing appropriate support to businesses and research projects to encourage the development and commercialisation of new low carbon technologies?
- Is the Trust raising awareness of its Pillar 2 programmes so as to effectively demonstrate the case for investment in low carbon technologies?
- Is the Trust filling a gap in the market for which private sector finance would not be available?
- Is the Trust taking an acceptable level of risk with public funds?
- Is the Trust taking sufficient risk to encourage the development and commercialisation of new technologies?

In addition to clear conclusions on the above questions, the NAO also requires:

- At least five case examples on organisations that the Trust has supported at different stages of the commercialisation process;
- If possible, a clear comparison of the financial performance of the Trust's investments with other investments in the low carbon sector;
- Realistic recommendations on how the Trust could accelerate the move to a low carbon economy within the UK by helping organisations develop commercial low carbon technologies.

The remit relates to operational aspects of Carbon Innovations and Carbon Investment (formerly Pillar 2 of the Carbon Trust's activities). While issues relating to other Pillars or Governance may be drawn to the attention of the NAO, they do not form part of this report.

APPENDIX III Methodology

The method of working was to examine the operations of Carbon Innovation and Carbon Investment (Pillar 2 of the Carbon Trust) in three ways:

(I) To review documents relating to Carbon Trust strategy and policy

(II) To examine the procedures by which projects are selected and support or investment decisions are made

(III) To undertake an interview programme to discover how the Trust works, how it has evolved and what issues it faces in its operations. Interviews were undertaken involving:

a. Carbon Trust Staff

b. Organisations that have received support

c. Organisations that have received investment

d. Organisations which provide services to the trust

e. Government agencies which make grants including the DTI and the Engineering and Physical Sciences Research Council.

f. Other organisations which provide financial support or investment

g. Comparable organisations in at least one other country

(IV) To examine a number of cases where support or investment has been given.

(V) To test findings with both the National Audit Office team and senior staff at the Carbon Trust.

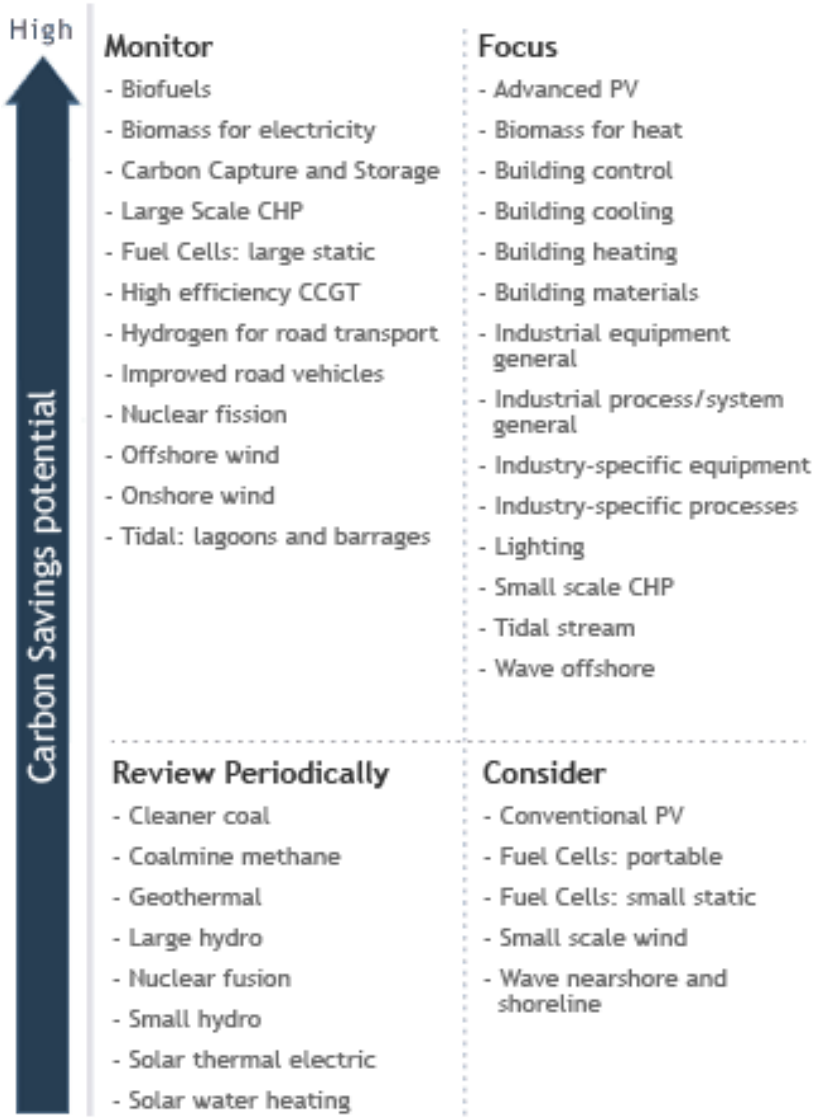
A team of four senior and experienced consultants undertook the assignment with at least two consultants (or one consultant and one representative of the NAO) attending each interview.

Limitation of Scope

The investigation was undertaken to a tight budget and timescale. The work does not include:

- Review of the corporate governance of the Carbon Trust
- A full systems review of Carbon Trust operations
- Tests of controls and transactions that would be undertaken in the course of a financial audit
- Any examination of Carbon Trust Enterprises Ltd (this area covered by the NAO team)

APPENDIX IV Low Carbon Technology Assessment



Enabling technologies

Alternative hydrocarbons

Buildings design

Electrical energy storage

Electricity transmission and distribution

Grid connection and balance of system

Hydrogen production

Hydrogen storage

Information systems for energy users

Thermal energy storage

Updated Feb 2007