Smarter Ways for Taxpayers' Dollars to Stimulate Innovation and Create Value

(the fuller version)

Asilomar Conference 2009

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Director, Projects
Carbon Trust

Contents

- **The Carbon Trust**
  - Who are we;
  - What do we do
- **Informed intervention to accelerate innovation:**
  - the low carbon innovation journeys;
  - smarter money;
  - smarter technology focused innovation.
- **We're with the innovators all the way:**
  - RD&D – we're active partners;
  - incubator mentoring - we help start ups become investor ready;
  - early stage investment – we invest for a carbon and commercial return.
- **We inform policy**

The Carbon Trust - a unique delivery model

Our mission is to accelerate the move to a low carbon economy by working with organisations to reduce their carbon emissions and develop commercial low carbon technologies.

- The Carbon Trust is an independent company set up in 2001 by the UK Government with support from business;
- Our funding (£190m this year) is set by the UK Government;
- Our Board approves our business plan and determines the allocation of funds to programmes; our governance structure determines allocations to projects without reference to Government;
- Our use of public funds is scrutinised by the Government's National Audit Office.

Our mission is delivered through five complementary low carbon business areas

Insights

Explains the opportunities & challenges surrounding climate change

Solutions

Delivers carbon & money savings via energy efficiency

Innovations

Develops low carbon technologies for future carbon savings

Enterprises

Creates low carbon businesses for a low carbon economy

Investments

Finances clean energy businesses for a green growth economy

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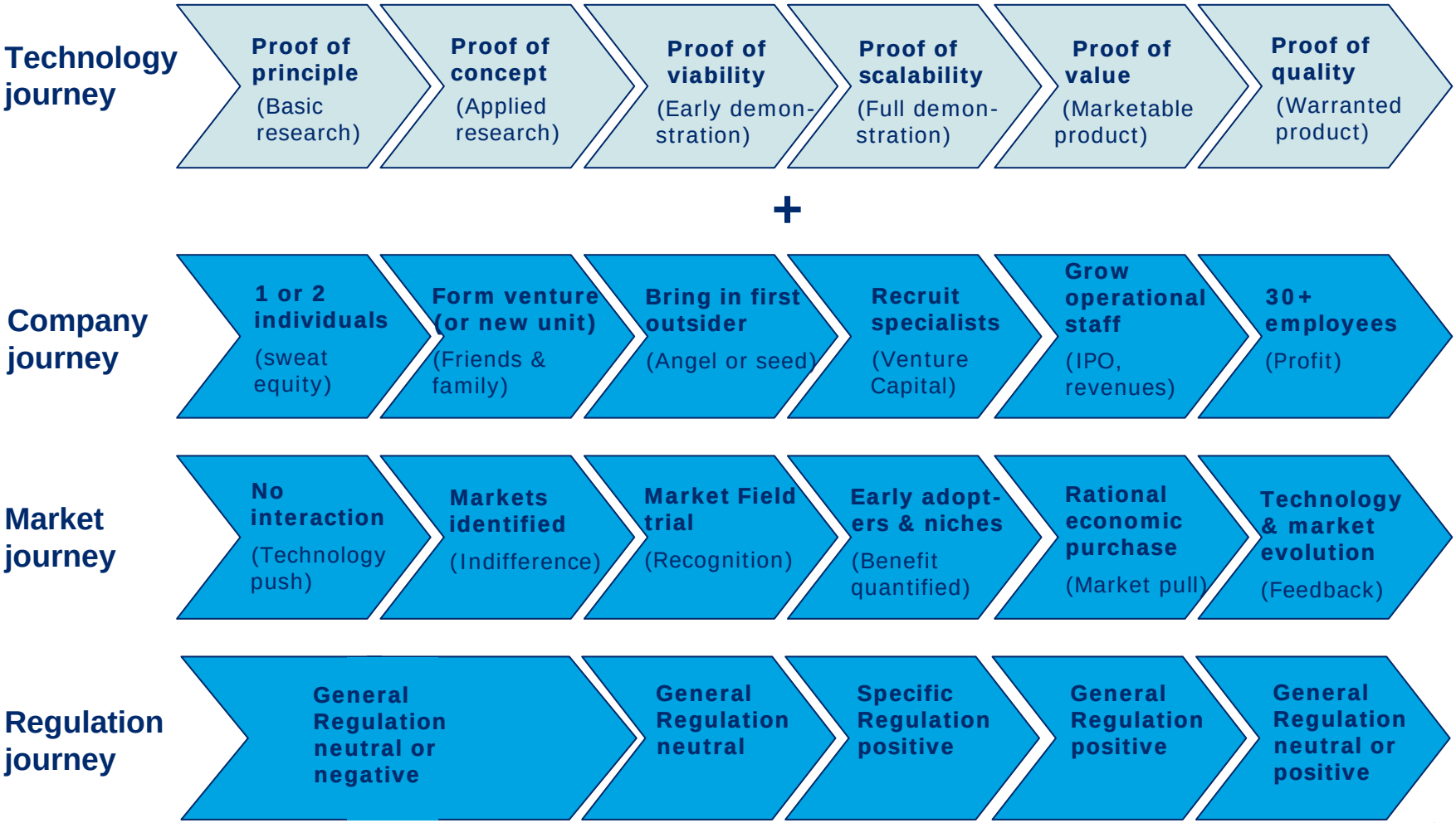
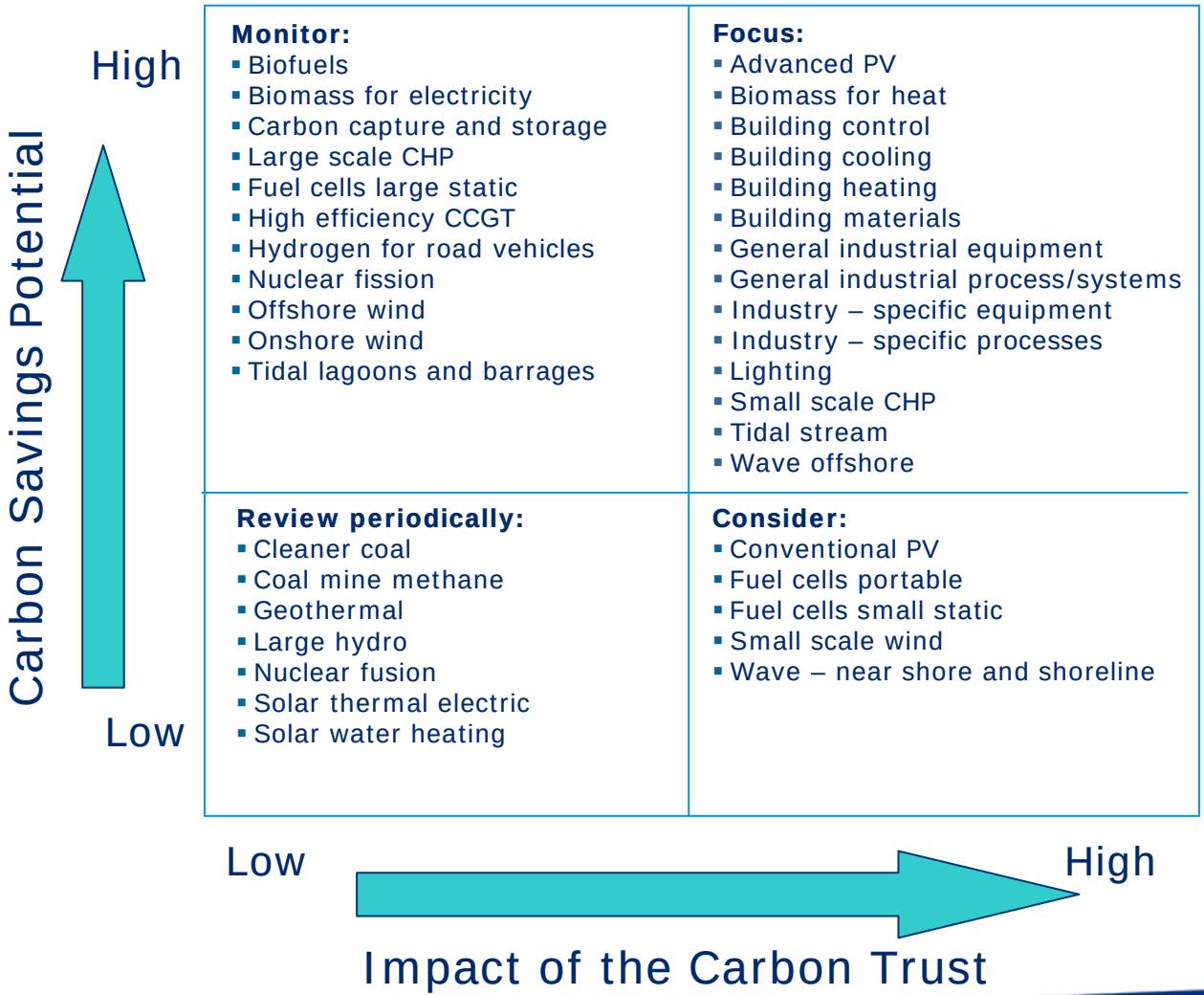
The low carbon innovation journeys



Smarter money where it's needed

- It's not the size of the cheque that makes our interventions effective - it's the knowledge, experience and commitment that goes with the money;
- We've invested £21m in over 180 applied R&D projects and leveraged a further £30m of other funding. Over 65% of completed projects are in the process of generating new patents, making commercial sales or receiving further investment into the development of the technology.
- We form clean energy research or business consortia with international partners (eg our £30m offshore partnership to reduce the cost of offshore wind power; our £6m novel algae transport fuels research accelerator – Phase 1);
- Our technology accelerators address market barriers to take up (eg micro-co-generation; low carbon buildings refurbishment; community biomass heat schemes).

Technology focus makes better use of our resources



Enabling:

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*

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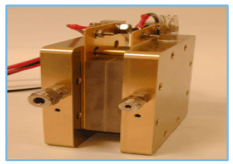
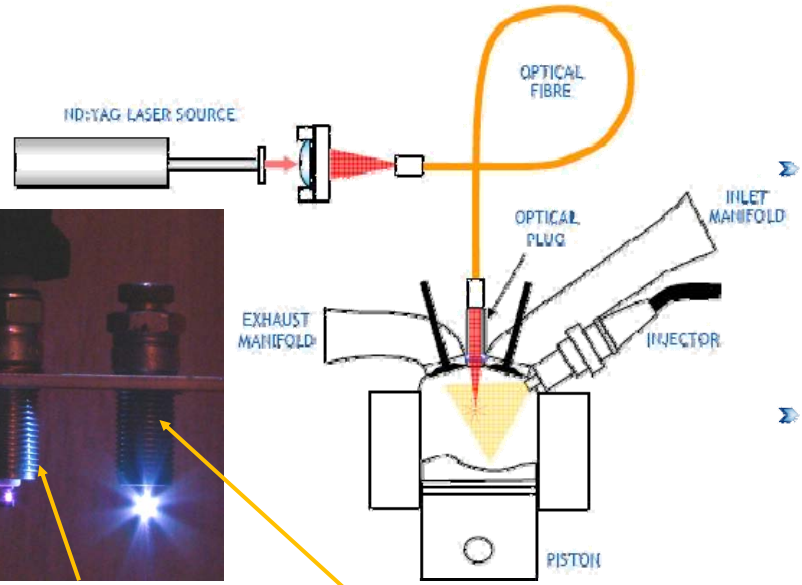
Research & Development – partnerships

Activity:	Comments
 **Applied Research Open Call**: commercially-focussed grant support for leading low carbon innovators. 175 projects to date; 70% success rate*	• Invested £21m in over 180 applied R&D projects and leveraged a further £30m.
 **Advanced PV directed research** : accelerating development and manufacture of cost effective organic solar PV technology	• Work now underway with Cambridge/TTP 2nd project planned with team from Imperial College
 **Advanced Bioenergy directed research – Bio-oil**: developing pyrolysis upgrading processes to turn waste biomass sources into conventional fuels	• Will launch at least one major >£5m project in 2009 Analysis indicates that bio-oil/pyrolysis has potential to be the lowest carbon of all biofuel routes
 **Advanced Bioenergy directed research - Algae:** developing the technology for low-cost, mass algal biofuel production in open ponds	• All the leading UK academic groups have applied; we are now taking over 20 proposals for applied R&D projects through to full due diligence
 **Breakthrough polymer fuel cell research:** harnessing recent UK materials science breakthroughs to make a step change in the cost of polymer fuel cells	• Recent stakeholder event confirmed appetite and capacity of UK polymer fuel cell and general materials base Initiative to be launched later this year

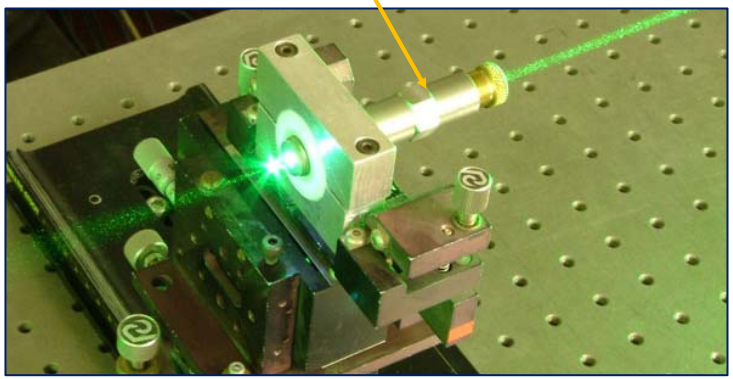
*additional finance raised, IP filings, and/or sales of new products

Applied Research: Laser Ignition project



Conventional spark plug

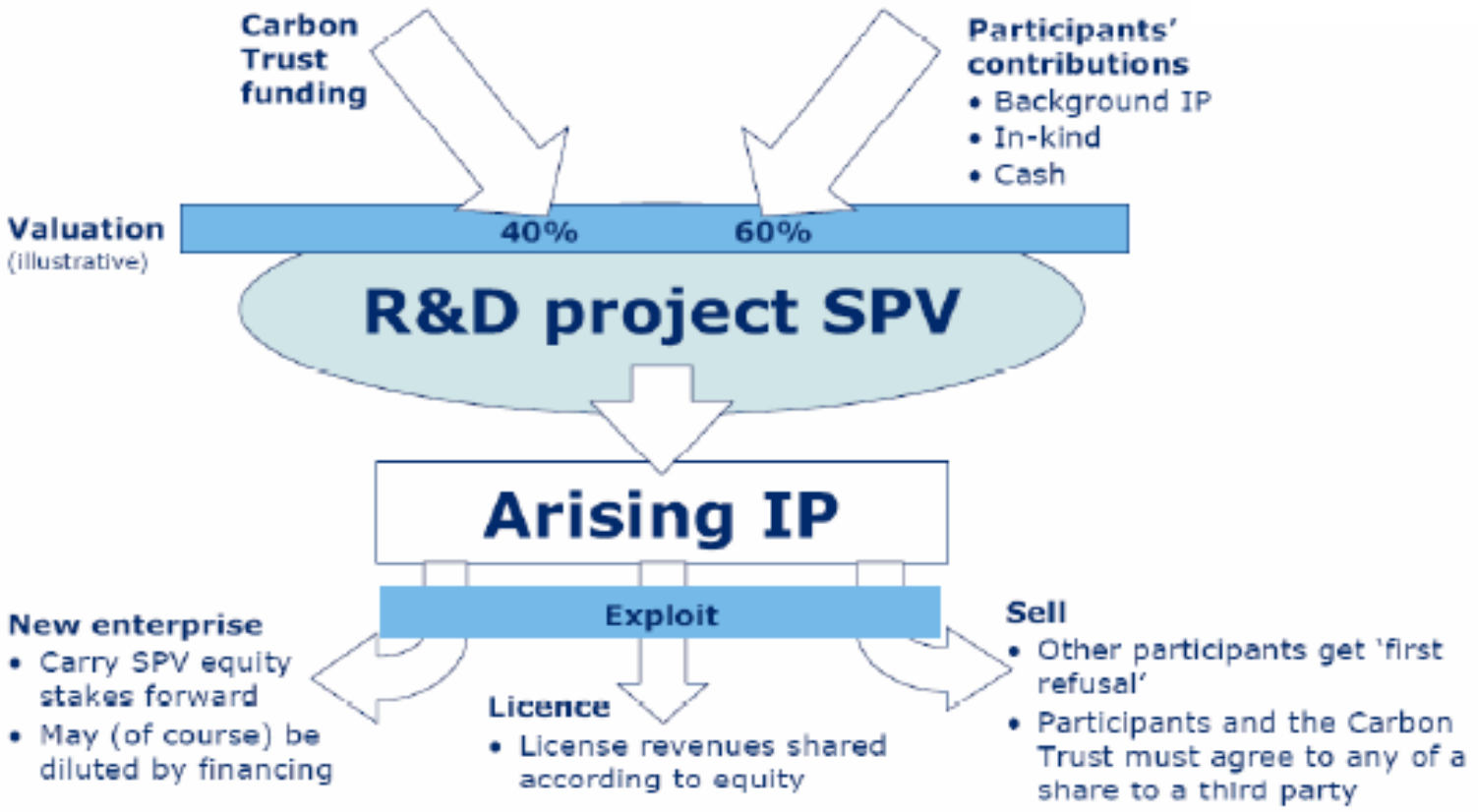
Laser optical plug



- Project features
  - £200k (~$320k) grant from the Carbon Trust
  - Partners:
    - University of Liverpool Engineering Dept
    - Ford Motor Co. ltd
- Technical objectives
  - Develop a Laser Ignition (LI) optical system for automotive engines: replace spark plugs with optical laser plugs
  - Ultimately LI system could be sold as class-1 laser system a comparable cost to conventional ignition
- LI yields significantly improved, leaner combustion:
  - increased combustion speed
  - controllable ignition location across whole cylinder
  - multiple ignition points possible
  - no cold start spark-plug fouling
  - no flow disturbance due to protruding plug
- Main benefits include
  - Improved efficiency & CO_2 reduction
  - Reduction of regulated pollutant emissions
  - Lighter weight
  - Improved cold start capability…
  - … enabling wider uptake of biofuels

Directed research: creates a special purpose vehicle which converts grants to equity in the event of success

SPV model



Bio-energy Directed Research Programme

- Urgent need for next generation biofuel
  - sustainable feedstocks, lower lifecycle GHG emissions;
  - improved fuel chain efficiency, improved end-use performance).
- Key objectives:
  - develop transport fuel replacements;
  - compatibility with existing transport fuels infrastructure.
- Landscaping study in 2007 identified 3 areas where the Carbon Trust could be material & additional over next 3-6yrs:
  - Strand A: Pyrolysis to Transport Oils - underway
  - Strand B: Algal Bioenergy Systems - underway
  - Strand C: Novel Biofuels

Directed research: the Pyrolysis Challenge - waste biomass to conventional transport fuels

Opportunity of pyrolysis biofuels

- A thermo-chemical process that produces a liquid "bio-oil" from biomass
- Can use various and variable feedstocks, including waste (MSW, waste wood, agricultural waste)
- Potential lowest carbon biofuel in terms of energy delivered (at least 80% savings relative to fossil fuels)
- Can produce fuels similar to gasoline, diesel and jet
- Will maximise use of existing infrastructure

BUT

- Need to develop a new process for "upgrading" bio-oil to make it suitable for transport fuels

The Pyrolysis Challenge

- Based on UK excellence in chemical engineering, catalysis and fuels chemistry
- £5-7m projects to design, develop and demonstrate a novel upgrading process
- Launched February 2008 – 24 consortia applied
- Significant engagement from
  - leading academic centres (Imperial College, York, Aston)
  - world class fuels technology companies (BP, ConocoPhillips, Johnson Matthey)

Directed research: the Algae Biofuels Challenge – environmentally sustainable feedstock for transport fuels

Opportunity of algae for biofuels

- Potential to produce 6-10 times more biomass per hectare than palm oil (current highest-yielding crop)
- Does not require fresh water
- Can use unproductive land
- Algae produce an oil that is particularly suitable for conversion to diesel and jet

BUT

- Costs of algae production currently X10 too high
- Need to develop new technology for mass cultivation of algae at large scale

The Algae Biofuels Challenge

- Phase 1 will invest £3-6m in applied R&D to improve understanding of the fundamentals of mass algae cultivation and high oil productivity
- Phase 2 (if Phase 1 is successful) will develop a large (up to 10 hectare) field site for further development of the technology in a real world environment
- Launched October 2008 – 81 applications for Phase 1 projects including all the leading UK centres (Cambridge, Plymouth, Southampton, Newcastle)

International offshore wind accelerator: driving costs down and reducing risk

£30m collaboration to cut the cost of energy from offshore wind by at least 10%

CARBON TRUST

RWE The energy to lead

Airtricity

SCOTTISHPOWER

DONG energy

StatoilHydro

Launched Oct 2008

- Collaborative structure with co-funders sharing costs and addressing sector-wide issues holding back progress
- Aims to deliver enhanced technical solutions which can be deployed at scale in future Round 3 offshore farms
- Timescale – 2 phases over 4 years

Areas of focus – cost reduction in medium to short term

- **Offshore foundations** – novel foundations with potential for lower costs
- **Wake effects** – improving the optimisation of offshore wind farm layouts
- **Access, logistics and transportation** –reducing access costs novel for wind farm construction and operation
- **Electrical systems** – improving efficiency of offshore wind farm electrical systems

Business Incubation: helping early stage companies become 'investment ready'

- **We have six low carbon incubator providers across UK**
  - Access to wide range of in-house and specialist skills
  - Provide help to clean energy university spin outs and business start ups
- **Incubation services**
  - Advising on company formation, business plan preparation, capacity building, intellectual property protection; marketing strategy;
  - Up to £70k of service provision per incubatee
- **Focus on taking company to 'next level'**
  - "Investment readiness": raise funding, secure licensing or joint ventures
- **82 companies supported so far**
  - 25 have raised private investment, 3 have listed on UK Alternative Investment Market
  - £84m of private funding raised
  - 3 licence agreements

Early stage low carbon investments

Carbon Trust Investment Partners finances early stage low carbon enterprises that have commercial potential but are too risky for private venture capital. By delivering commercial returns, we encourage others to invest, thereby accelerating the transition to a low carbon economy

- Low Carbon Seed Fund with Shell Foundation and Imperial Innovations to capture early stage opportunities;
- In 2006/07, CT Investment Partners LLP set up as a separate FSA regulated business;
- In November 2008, the Carbon Trust signed a Memorandum of Understanding with the Qatari Investment Authority to build a clean energy investment fund.

12 investments totalling over £9m have been made, leveraging a further £88m of private investment into low carbon companies, two of which are listed on the Alternative Investment Market.

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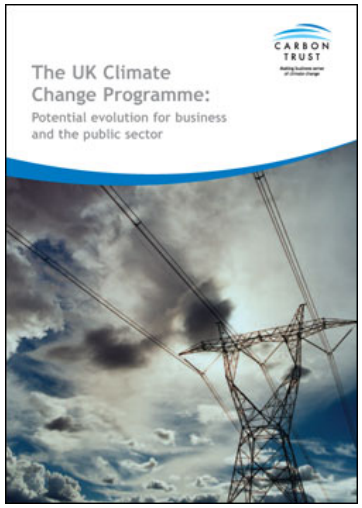
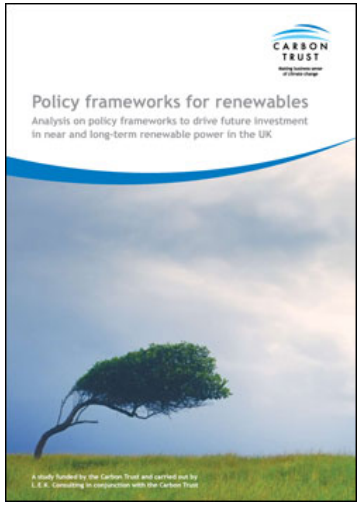
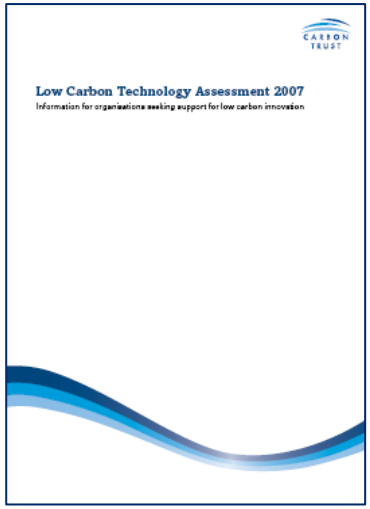
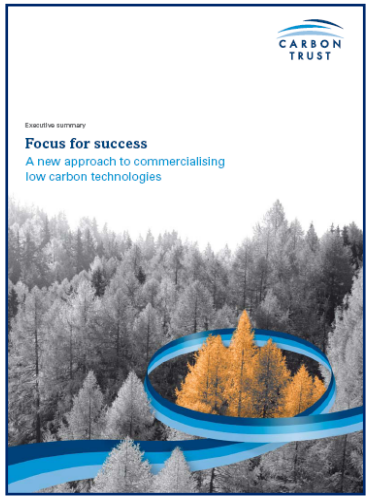
Carbon Trust Insights

Our teams of experts explain the opportunities & challenges surrounding climate change and carbon reduction. We use our independent insights to focus our own resources; to inform Government policy; and to help business prepare for tomorrow's low carbon world. We publish our work and share our knowledge.









Summary

- Moving to a low carbon sustainable economy is essential to respond to the threats of climate change and energy security. It requires unprecedented public policy interventions: to accelerate low carbon technology innovation and deployment; and to discourage investment in high carbon technology leading to lock-in;
- Emerging technologies need to progress along the ‘company’, ‘market’ and ‘regulatory’ journeys as well as the technology development journey;
- Accelerating low carbon innovation requires:
  - commercially-focused, independent and well informed support for early stage R&D activities to de-risk technology, attract private investors, and create compelling consumer products;
  - an impartial, well informed, credible entity to bring business and researchers together to address the barriers;
  - informed and bold policy making.

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Making Business Sense of Climate Change

www.carbontrust.com

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