THE LANDSCAPE OF CARBON DIOXIDE CAPTURE, STORAGE, AND MANAGEMENT (CCSM) EDUCATION IN THE UK

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THE LANDSCAPE OF CCSM EDUCATION IN THE UK

Executive Summary

This report was commissioned by the IEA Greenhouse Gas R&D Programme (IEA GHG) to assist the Carbon Sequestration Leadership Forum (CSLF) task force in the assessment of international graduate degrees at MSc and PhD level on Carbon Dioxide Capture, Storage, and Carbon Management (hereinafter CCSM) from universities. The scope of this report is to identify academic perspectives and programs in the areas of CCSM currently available in the United Kingdom (UK). The information assembled in this report was sought from the internet, email contacts and visiting key universities. This report addresses the major findings and discusses the current landscape of CCSM education in the UK.

The number of postgraduate degrees and short courses in CCSM in the UK is limited, and mainly focusing on carbon management. The University of Edinburgh offers a Masters of Carbon Capture and Storage led by the School of Geo Sciences, in which carbon storage is a major component. The degree has flexibilities for those with non-geoscientists qualifications, offering introductory subjects in geology and hydrocarbons. The Universities of Nottingham, Birmingham and Loughborough (hereinafter called UNBL) consortium offers an Engineering Doctorate (Industrial) in carbon dioxide capture as part of a large capacity building programme awarded by the British Government via the Engineering and Physical Sciences Research Council (EPSCR) with further sponsorship from Industrial and Energy Companies. The program entails the graduation of 50 Engineering Doctorates in the next 7 years. Of particular attention, the engineering doctorate involves 1 year training at one of the consortium universities followed by 3 years industrial research placement. The Imperial College Masters in Sustainable Energy Futures has a strong focus energy systems and sustainability, with a subject on CCS clean fossil fuels.

Another interesting alliance is the European consortium of the Universities of Edinburgh (UK), Versailles St-Quentin (France) and Bergen (Norway) which offer PERICLES (Postdoctoral European Masters Formation on Interactions between Climate, Environment and Society). This is mainly a research degree with emphasis on modelling environmental systems. The CCS postgraduate degrees surveyed have interdisciplinary contents including subjects in the areas of economics, social, political and environment. These subjects are also core in the carbon management degrees. For those working in CCS industry, it is likely that many problems will not be technical, therefore warranting the addition of these areas of studies.

It is expected that these programs will evolve, similarly to environmental management and energy sustainability degrees offered around the world for the last 20 years, while new alliances and new programs will be available from other universities in the near future. Nevertheless, it is observed that “Regulations and Law” and “Risk Analysis” were not covered in the surveyed programs. The implementation of CCS or the management of carbon will be regulated and those involved in the CCS industry will have to be trained to fully understand the applicable regulations and laws. This is particularly important in the European context, where there are a large number of considerable small territorial area countries with complex tier government levels. In addition, risk analysis plays a major role in any industry, and the CCS industry will

have to manage important technical risks (carbon dioxide capture engineering technologies, transportation and injection and CO_2 leakage from storage) and non-technical risk (political, public opinion, financial and long term liability) among many other potential risks. Those working in the CCS industry will have to fully understand how risk can be incorporated in their decision making analysis and managed accordingly.

There has been a good mobilisation from the private sector and universities in offering short courses in CCSM. In terms of carbon storage, the Scottish Centre for Carbon Capture and Storage has two short courses dealing with CO_2 injection and storage, and in particular focusing on the education of engineers on carbon storage. No short courses were found in carbon dioxide capture, and the majority of the other short courses available are mainly on carbon footprint, and potentially addressing new guidelines and standards (PA2050 and ISO 14067). The short courses offered by IFF, ICAP Plc and CEAG Ltd, include risks, regulation and carbon markets. These courses may be geared to training managers and financial traders.

The majority of the postgraduate programs surveyed include the conventional course delivery per semester and requiring a dissertation. This delivery mode may suit full time students. The Imperial College Masters in Sustainable Energy Features is more focused on intensive two week courses which include lecturing, tutorials and exercises. The Imperial College also has an interesting subject of 'Distinguished Speakers Seminars'. Students are required to attend 10 seminars to complete the subject. The University of Edinburgh allows for industrial projects as part of their masters of carbon capture and storage. The UNBL consortium has a program strongly focused on carbon dioxide capture industrial research. The UNBL consortium also offers Summer School programs as part of their curriculum, which includes a range of seminars by invited speakers and problem solving activities.

The important question in course delivery mode is 'what is the profile of the CCSM student'? Under the perspective of education in capacity building programs, there will be a need of a new generation of engineers, scientists, managers and analysts to be trained to attain the set of skills needed to deal with CCSM issues in the future. This new generation will be mainly full time students endeavouring to take conventional masters or doctorate degrees. By the same token, the current generation of professionals working in the energy industry may desire to upgrade their skills and CCSM knowledge. The current generation are more likely to be part time students opting for degrees with intensive courses (1 or 2 weeks), attending seminars and summer schools. In other words, current and future CCSM programs should cater for different segments of the educational market.

This report has concentrated on courses provided in the UK. In addition, mention should be made that from a base in the UK the IEA GHG organises an annual International CCS Summer School. This is hosted at different locations worldwide each time; Germany, Canada and Australia in the first three years. This course offers an intensive week in all aspects of CCS, from capture to storage, and non-technical topics such as economics, policy, regulation, safety and public communication.

Contents

List of Tables

1 Introduction

This report was commissioned by the IEA Greenhouse Gas R&D Programme (IEA GHG) to assist the Carbon Sequestration Leadership Forum (CSLF) task force in the assessment of international graduate degrees at MSc and PhD level on Carbon Capture Storage and Carbon Management for universities. The acronym CCSM is used hereinafter to Carbon Dioxide Capture, Storage, and Carbon Management while CCS is specifically used for Carbon Dioxide Capture and Storage only.

The scope of this report is to identify academic perspectives and programs in the areas of CCS and Carbon Management currently available in the United Kingdom (UK). The information assembled in this report was sought from the internet, email contacts and visiting key universities in CCSM in the UK. This report addresses the major findings and discusses the current landscape of CCSM education in the UK.

Disclaimer: The information assembled in this report was summarised and it does not serve the purpose of advertising any of the individual programs available in the UK. For all intents and purposes, this report neither provides an assessment of the quality of courses available nor does it serve as guidance for entry requirements in any of the institutions mentioned.

2 Methodology

The information assembled in this report was sought from the internet using search words such as ‘carbon’, ‘carbon capture’, ‘carbon sequestration’ and ‘carbon management’. Several leading universities in the UK were personally contacted via email, while meetings were held at the University of Nottingham and the Imperial College to discuss their academic programs in these areas.

3 CCSM Educational Programs

3.1 Mapping Postgraduate Degrees

In this session, postgraduate degrees are mapped according to their compulsory and elective subjects as listed in Table 1. Detailed information of these courses can be found in Appendix 1. In order to summarise the information in a relevant manner, the following criteria was followed:

- (C) Capture: Subjects in engineering and science of CO_2 capture from flue gas stream, incorporating transportation.
- (S) Storage: Subjects in geology and science of CO_2 storage
- (E) Environmental: Subjects in climate change, environmental sciences and management, including modelling, geography and town planning.
- (X) Economy, Social and Political: Subjects in CO_2 studies in these fields of Science.

Table 1 – Doctorate and Masters Course Mapping

		Compulsories				Electives			
Institution	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
U. of Edinburgh School of GeoSciences	Masters of Carbon Capture and Storage								
U. of Edinburgh Business School	Masters of Carbon Management								
EUROPEAN: U. of Edinburgh (UK), U. of Versailles St-Quentin (France), U. of Bergen (Norway)	PERICLES – Postdoctoral European Masters Formation on Interactions Between Climate, Environment and Society								
Imperial College Institute of Energy Futures	Masters in Sustainable Energy Futures								
U. of Nottingham, Birmingham and Loughborough Schools of Engineering	Engineering Doctorate (Industrial) and Masters in Carbon Capture								
U. of Glasgow Crichton Carbon Centre	Masters of Carbon Management								
U. of Lancaster School of Engineering	Masters of Low Carbon Emission								

3.2 Entry Requirements

The majority of the courses listed in Table 1 have a minimum entry requirement of class 2.1 in a relevant degree in Engineering, Science or the Arts, or an equivalent form of overseas qualification. In some cases, candidates with an adequate component of mathematics, or extensive relevant postgraduate experience will also be considered.

3.3 Carbon Dioxide Capture

The two leading institutions in carbon dioxide capture are the consortium of the Universities of Nottingham, Birmingham and Loughborough (hereinafter called UNBL), and the University of Edinburgh. The component of carbon dioxide capture appears to be minor in the Masters of Carbon Capture and Storage offered by the University of Edinburgh. The Imperial College has a Masters in Sustainable Energy Futures has a strong focus on engineering, energy systems and sustainability, with a subject on clean fossil fuels which incorporates CCS concepts.

The Engineering Doctorate (Industrial) and Masters of Carbon Capture offered by the UNBL consortium is part of a large capacity building programme awarded by the British Government via the Engineering and Physical Sciences Research Council (EPSRC). The UNBL consortium was awarded the EPSRC Engineering Doctorate Centre with further industrial sponsorship from Air Products Ltd, Alstom Power Ltd, E.ON, Rolls Royce Plc, RWE nPower, Welsh Power Ltd, Drax Power Ltd, Corus, CPL Ltd, Doosan Babcok and Innospec Inc. The program entails the graduation of 50 Engineering Doctorates in the next 7 years. It should be noted that the engineering doctorate involves 1 years training at one of the consortium universities followed by

a 3 year industrial research placement. Hence, the program has a strong focus on industrial carbon dioxide capture research.

3.4 Storage

The University of Edinburgh offers a Masters of Carbon Capture and Storage led by the School of GeoSciences, in which storage is a major component of the degree. The degree has flexibilities for those with non-geoscientists qualifications, with requirements in introductory subjects in geology and hydrocarbons in order to graduate. To date, this is the only masters program focusing on carbon storage in the UK.

3.5 Environmental

The majority of the programs offer environmental subjects. This is important as CCSM are part of the big picture concept, and their relations, interactions and impact upon the environment must be fully understood. Of particular attention, the European consortium of the Universities of Edinburgh (UK), Versailles St-Quentin (France) and Bergen (Norway) are offering the PERICLES (Postdoctoral European Masters Formation on Interactions between Climate, Environment and Society). This is mainly a research degree with emphasis on modelling environmental systems, particularly focused on climate change.

3.6 Economic, Social and Political

Economic, social and political issues are very important facets of CCSM, and this is rightly reflected by the inclusions of subjects in these areas in the majority of the courses surveyed. These are also core subjects in the carbon management degrees. It is generally the case that technically minded professionals also need further training in the management aspects relevant to their working positions. For those working in the CCS industry, it is likely that many issues will not be technical, therefore warranting the addition of economic, social and political training.

3.7 Other Programs

An example of other programs is the masters of low carbon emission offered by the University of Lancaster. Although this program has a strong engineering focus, mainly on nuclear power and renewable energies, the program has no carbon dioxide capture component. There are a large number of masters courses in the UK currently being offered in power engineering, energy systems, sustainable energy, low energy building etc. Perhaps the motivation of many of these courses is on reduction of carbon emissions, or the efficient production of fossil fuel energy. Based on our search, these courses were not specifically addressing CCS or carbon management, and therefore were not considered in this report.

3.8 Program Gaps

Although we have not been privy to the syllabuses for each of the subjects offered in the programs listed in Table 1, their titles gave us an indication of the potential contents of each subject. It is expected that these programs will evolve, similarly to environmental management

and energy sustainability masters degrees offered in the last 20 years, while new alliances and new programs will be available from other universities in the near future. Nevertheless, it is observed that “Regulations and Law” and “Risk Analysis” were not covered in these programs.

The implementation of CCS or the management of carbon will be regulated and those involved in CCS industry will have to be trained to fully understand the applicable regulations and laws. This is particularly important in the European context, where there are a large number of considerably small territorial area countries (as opposed to Australia, USA, Canada, China and Russia), with complex tier levels ranging from local government, to central governments in each country, and finally the European Union.

In addition, risk per se has many facets associated with non-technical risks (political, public opinion, financial risks and long term liability), and technical risks (carbon dioxide capture engineering technologies, transportation and injection, and CO_2 leakage for storage) among many other potential risks. Those working in the CCS industry will have to fully understand how risk can be incorporated in their decision making analysis. Our society has transient views and managing CCS risk appropriately will be a day to day activity in the industry.

4 CCSM Short Courses

The short courses in CCSM sought from our internet search and being offered by Universities and the private sector are listed in Tables 2 and 3, respectively. In this report, we only included those courses that were actually available in 2009, as several other courses were described, but no course delivery dates were given. Further information about these courses is included in Appendices 2 and 3.

In terms of carbon storage, the Scottish Centre for Carbon Capture and Storage has two short courses dealing with CO_2 injection and storage, focusing particularly on the education of engineers in CO_2 storage. The majority of the remaining short courses are mostly on carbon footprints, and potentially addressing new guidelines and standards (PA2050 and ISO 14067). These types of short courses follow the educational evolution of training courses which started in the 1980’s with quality control systems, waste management followed by environmental management systems, cleaner production, sustainability and eco labelling. The short courses offered by IFF, ICAP Plc and CEAG Ltd, include risks, regulation and carbon markets. These courses may be geared to training managers and financial traders.

Table 2 - University Short Courses

Institution	Title	C	S	E	X
Scottish Centre for and Storage - U. of Edinburgh	CO_2 Storage for Engineers				
Scottish Centre for Carbon Capture and Storage - U. of	CO_2 Injection and Enhanced Oil recovery (EOR)				

Edinburgh					
U. of Glasgow – Crichton Carbon Centre	Introduction to Carbon Management				
U. of Manchester Sustainable Consumption Institute	CPD Course in Carbon Footprint				
U. of Bath	On Line Course – Primer on Carbon Foot printing of Consumer Goods and Services				
U. of East Anglia Low Carbon Innovation Centre	Carbon Management Skills				

Table 3 – Private Sector Short Courses

Institution	**Title**	**C**	**S**	**E**	**X**
ICAP Plc and CEAG Ltd	Foundation Emissions Course: Regulation, Risk Management and Carbon Pricing				
IFF – International Faculty of Finance	Carbon Trading, Risk and Strategy				
GP Training Consultants	Introduction to the UK Carbon Reduction Commitment				
BSI Group	Calculating your Carbon Footprint Training Course				
Aspects International	IEMA Approved Carbon Footprint Management Course				

Although this report has concentrated on courses provided in the UK, in addition, from a base in the UK the IEA GHG organises an annual International CCS Summer School. This is hosted at different locations worldwide each time; Germany, Canada and Australia in the first three years. This course offers an intensive week in all aspects of CCS, from capture to storage, and non-technical topics such as economics, policy, regulation, safety and public communication. A feature of the course is the assignments given to the students for group work. Some 170 students have undertaken this course to date.

5 Course Delivery

In this section, postgraduate degrees are mapped according to their delivery mode as listed in Table 4. In order to summarise the information in a relevant manner, the following criteria was followed:

- (C) Conventional: The course is delivered during a full semester.
- (SS) Summer School: The course is part of a Summer School
- (I) Intensive: The course is delivered within a week or two week period, and may involve a series of lectures and tutorial sessions.
- (DS) Distinguished Speaker: The course includes a series of seminars from distinguished speakers in the area of CCSM
- (R) Research: The course requires a dissertation at Masters level or a major laboratory research project as part of a PhD degree.

- (IR) Industrial Research: The course allows students to take industrial projects as part of dissertation at Masters' level or a major industrial research project as part of an engineering doctorate degree.

Table 4 – Doctorate and Masters Delivery Mode

Institution	Degree	C	SS	I	DS	R	IR
U. of Edinburgh School of GeoSciences	Masters of Carbon Capture and Storage	■				■	■
U. of Edinburgh Business School	Masters of Carbon Management	■				■	
EUROPEAN: U. of Edinburgh (UK), U. of Versailles St-Quentin (France), U. of Bergen (Norway)	PERICLES – Postdoctoral European Masters Formation on Interactions Between Climate, Environment and Society	■				■	
Imperial College Institute of Energy Futures	Masters in Sustainable Energy Futures			■	■	■	
U. of Nottingham, Birmingham and Loughborough Schools of Engineering	Engineering Doctorate (Industrial) and Masters in Carbon Capture	■	■			■	■
U. of Glasgow Crichton Carbon Centre	Masters of Carbon Management	■				■	■
U. of Lancaster School of Engineering	Masters of Low Carbon Emission	■				■	

Table 4 shows that the majority of the programs include the conventional delivery of course per semester and require a dissertation. This delivery mode is suitable for full time students. The Imperial College Masters in Sustainable Energy Features delivers intensive two week courses which include lecturing, tutorials and exercises. The Imperial College also has an interesting subject of 'Distinguished Speakers Seminars'. Students are required to attend 10 seminars to complete the subject. The Imperial College delivery mode may suit professionals where time limitations and commitments do not allow for long absence from work while the seminar series adds value as students are exposed to CCSM views and visions from experts in the field.

The University of Edinburgh allows for industrial projects as part of their masters of carbon capture and storage. By the same token the UNBL consortium has a program strongly focused on carbon dioxide capture industrial research. This program caters to technically minded students interested in carbon dioxide capture technologies and their integration in energy systems for the purpose of improvements, optimisation and intensification, in addition to new discoveries. The UNBL consortium also offers Summer School programs as part of their curriculum, which includes a range of seminars by invited speakers and problem solving activities.

The important question in course delivery mode is 'what is the profile of the CCSM student'? Under the perspective of education in capacity building programs, there will be a need of a new generation of engineers, scientists, managers and analysts to be trained to attain the set of skills needed to deal with CCSM issues in the future. This new generation will be mainly full time

students endeavouring to take conventional masters or doctorate degrees. On the other hand, the current generation of professionals working in the energy industry may desire to upgrade their skills and CCSM knowledge. This current generation are more likely to be part time students opting for degrees with intensive courses (1 or 2 weeks), seminars and summer schools. In other words, current and future CCSM programs should cater for different segments of the educational market.

6 Postgraduate Degree Options

In this section, postgraduate degrees are mapped according to degree options as listed in Table 5. In order to summarise the information in a relevant manner, the following criteria was followed:

- (C) Postgraduate Certificate: Generally equivalent to 1/3 of masters degree.
- (D) Postgraduate Diploma: Generally equivalent to 2/3 of masters degree
- (M) Masters: Full coursework plus dissertation or industrial project leading to the award of MSc or equivalent Masters level degree.
- (ED) Engineering Doctorate: Industrial research theses leading to the award of Engineering Doctor degree.

Table 5 – Doctorate and Masters Degree Options

Institution	Degree	C	D	M	ED
U. of Edinburgh School of GeoSciences	Masters of Carbon Capture and Storage				
U. of Edinburgh Business School	Masters of Carbon Management				
EUROPEAN: U. of Edinburgh (UK), U. of Versailles St-Quentin (France), U. of Bergen (Norway)	PERICLES – Postdoctoral European Masters Formation on Interactions Between Climate, Environment and Society				
Imperial College Institute of Energy Futures	Masters in Sustainable Energy Futures				
U. of Nottingham, Birmingham and Loughborough Schools of Engineering	Engineering Doctorate (Industrial) and Masters in Carbon Capture				
U. of Glasgow Crichton Carbon Centre	Masters of Carbon Management				
U. of Lancaster School of Engineering	Masters of Low Carbon Emission				

Table 5 shows that CCSM degrees are offered as a Masters degree with an option for postgraduate diploma, except for the Imperial College and the European PERICLES programs. The UNBL consortium program allows an exit clause for the students enrolled in the Engineering Doctorate. If the number of courses and credits are deemed to comply with Masters regulations, students may complete their degree as a MSc in carbon capture instead, or are awarded a postgraduate certificate or diploma. The postgraduate degree options provide

flexibility in the education market, a practice found in other parts of the world for those constrained by financial or work limitations. There are also a large number of research works on CCSM being carried out in the UK that are funded by the Industry, EPSCR and European Community, and other agencies. These are generally offered at high research level (PhD) and are not part of the scope of this report.

7 Conclusions and Recommendations

The number of postgraduate degrees and short courses in CCSM in the UK is limited, and mainly focusing on carbon management. The University of Edinburgh offers a Masters of Carbon Capture and Storage led by the School of GeoSciences, in which carbon storage is a major component. The UNBL consortium offers an Engineering Doctorate (Industrial) in carbon dioxide capture aiming at graduating 50 Engineering Doctorates in the next 7 years. Another interesting alliance is the European consortium of the Universities of Edinburgh (UK), Versailles St-Quentin (France) and Bergen (Norway) which offers PERICLES (Postdoctoral European Masters Formation on Interactions between Climate, Environment and Society). The CCS postgraduate degrees surveyed have interdisciplinary contents including subjects in the areas of economics, social, political and environment. These subjects are also core in the carbon management degrees. Nevertheless, it is observed that "Regulations and Law" and "Risk Analysis" were not covered in the surveyed programs. It is recommended that these areas are considered for future Masters Curricula in CCSM.

The majority of the postgraduate programs surveyed include the conventional course delivery per semester and requiring a dissertation, which can be replaced by an industrial project or industrial research. This delivery mode may suit full time students. More flexible modes include intensive two week courses, attending seminars and summer schools, which are tailored to part time students. CCSM postgraduate degrees offered as a Masters or Doctorate levels have exit options for awards as postgraduate certificate or diploma.

There has been a good mobilisation from the private sector and universities in offering short courses in CCSM. In terms of carbon storage, the Scottish Centre for Carbon Capture has two short courses dealing with CO_2 injection and storage, and in particular focusing on the education of engineers on carbon storage. No short courses were found in carbon dioxide capture, and the majority of the other short courses available are mainly on carbon footprint, and potentially addressing new guidelines and standards (PA2050 and ISO 14067).

In addition, mention should be made that from a base in the UK the IEA GHG organises an annual International CCS Summer School. This is hosted at different locations worldwide each time; Germany, Canada and Australia in the first three years. This course offers an intensive week in all aspects of CCS, from capture to storage, and non-technical topics such as economics, policy, regulation, safety and public communication..

Appendix 1: Data Base of CCSM High Degrees in the UK

Institution	**University of Edinburgh**
School	School of GeoSciences

Degree	Masters of Carbon Capture and Storage
Degree Option	Diploma of Carbon Capture and Storage
Length	12 months (full time) 36 months (part time)
Entry Requirement	2.1 Honours degree or equivalent in engineering or science

Web Page Address	http://www.geos.ed.ac.uk/masters/ccs_info/

Compulsory Courses	Carbon Economics Carbon Capture and Transport Carbon Storage and Monitoring Field Excursion Introduction to Geology (for non-geoscientists) Hydrocarbons (for non-geoscientists) Research Dissertation (15000 words)
Elective Courses	Separation Processes for Carbon Capture (School of Engineering) Carbonate Sequence Stratigraphy Reservoir Quality Introduction of Geophysics Seismic Interpretation Energy Policy and Politics (School of Social and Political Science) Electrical Engineering Fundamentals of Renewable Energy (Institute of Energy) Mechanical Engineering Fundamentals of Renewable Energy (Institute of Energy) Power System Engineering and Economics (Institute of Energy) Business Response to Climate Change (School of Business and Economics) Economics for Postgraduates (School of Business and Economics)

Institution	**University of Edinburgh**
School	Business School

Degree	Masters of Carbon Management
Degree Option	
Length	12 months (full time) 24 months (part time)
Entry Requirement	2.1/ 1st Honours degree or an equivalent form overseas qualification

Web Page Address	http://www.business-school.ed.ac.uk/__data/assets/pdf_file/0011/8012/msc-carbon-management-brochure.pdf

Compulsory Courses	Induction Business and Climate Change Carbon Economics Climate Change Impacts and Adaptation Climate Change Management Applied Carbon Methods Dissertation
Elective Courses	Carbon Markets and Carbon Finance Comparative Studies in Business Management in Emerging Markets Outward Investment from Emerging Markets Management of R&D and Product Innovation Several other electives (Business School) Energy Policy and Politics (School of Social and Political Sciences) Land use / Environmental Interactions (School of GeoSciences) Management of Sustainable Development (School of GeoSciences) Participation in Policy and Planning (School of GeoSciences) Environmental Impact Assessment (School of GeoSciences) Several Other Electives (School of GeoSciences)

Institution	**EUROPEAN - University of Edinburgh (UK), University Versailles St-Quentin (France) , University of Bergen (Norway)**
School	School of GeoSciences (UoE - Scotland)

Degree	PERICLES - Predoctoral European Masters Formation on Interactions between Climate, Environment and Society
Degree Option	
Length	24 months (full time)
Entry Requirement	2.1/ 1st Honours degree or an equivalent form overseas qualification

Web Page Address	http://www.business-school.ed.ac.uk/__data/assets/pdf_file/0011/8012/msc-carbon-management-brochure.pdf

Compulsory Courses	Fundamentals in Mathematics and Physics for Earth Fluid envelops (UMSQ France - Semester 1) Earth Climate System (geophysical and geochemical world) (UMSQ France - Semester 1) Climate change impacts (UMSQ France - Semester 1) Research Project 1 (possible association with IPCC work - Semester 2) Paleoclimates and paleoceans (UoE Scotland - Semester 3) Earth System modeling past, present and future (UoE Scotland - Semester 3) Earth Observation, with emphasis on low latitudes and the water cycle (UoE Scotland - Semester 3) Research Project 2 (possible association with IPCC work - Semester 4)
Elective Courses	

Institution	**Imperial College**
School	Interdisciplinary - Faculty of Engineering with Faculty of Natural Sciences and Tanaka Business School

Degree	Masters of Science in Sustainable Energy Futures
Degree Option	
Length	12 months (full time)
Entry Requirement	2.1 Honours degree or equivalent in engineering or physical science Candidates with degrees in life sciences and economics, with an adequate component of mathematics or extensive relevant postgraduate experience will also be considered

Web Page Address	http://www3.imperial.ac.uk/energyfutureslab/students/msc

Compulsory Courses	Energy Systems Technology Methods for the Analyses of Energy Systems Energy Economics and Policy Research Report
Elective Courses	5 elective subjects must be taken Urban Energy Systems Clean Fossil Fuels - CCS Low Carbon Technologies: Bioenergy Low Carbon Technologies: Nuclear Sustainable Transport Selected Topics in Sustainable Energy Selected Topics in Sustainable Energy: Solar Energy Conversion Distinguished Seminar Series

Institution School	**University of Nottingham, Loughborough University, University of Birmingham** UoN (Chemical & Environmental Eng., Mechanical Materials & Manufacturing Eng., Geography), LU (Materials Department), UoB (Chemical Eng., Metallurgy & Materials)

Degree	Engineering Doctorate (Industrial)
Degree Option	Post Graduate Certificate (60 CP) or Post Graduate Diploma (120 CP) MSc or M.Research Degrees after 2 years completion if deemed appropriate.
Length	48 months (full time)
Entry Requirement	2.1 Honours degree or equivalent in engineering or physical science Candidates with degrees in life sciences and economics, with an adequate component of mathematics or extensive relevant postgraduate experience will also be considered

Web Page Address	http://www3.imperial.ac.uk/energyfutureslab/students/msc

Compulsory Courses	Technology, Ethics and Society Power Generation and Carbon Capture Innovation and Technology Transfer The Energy System Professional Skills Industrial Case Research Training Portfolio (40 CP) Two Summer Schools (20 CP) Research Industrial Project (3 years)
Elective Courses	Combined Heat & Power Systems Materials, Sustainability & The Environment Coal Characteristics 7 Conversion Corrosion & Oxidation of Metals Advance Analytical Techniques Fracture, Failure Methods Industrial Gas Control Energy Policy Politics of Climate Change Research Design & Practice in China Strategies for Corporate Social Responsibility International Law of Trans-Boundary Pollution Organisational Development & Change Leading People to Influence Performance Creative Problem Solving Business Ethics Strategic Management Accounting & Corporate Law Financial Management

Institution	**University of Glasgow**
School	Crichton Carbon Centre, Dunfries Campus and Department of Economics

Degree	MSc - Masters of Carbon Capture and Storage
Degree Option	
Length	12 months (full time) 24 months (part time)
Entry Requirement	2.1 Honours degree in a relevant discipline

Web Page Address	http://www.gla.ac.uk/postgraduate/taught/arts/carbonmanagementdumfriescampus/

Compulsory Courses	Climate, carbon and change Theory and principles of sustainability Carbon auditing and management Environmental and organisational ethics or Policies for sustainability and development Work placement project or Dissertation
Elective Courses	Climate change: impacts on ecology Environmental economics Sustainable buildings Sustainable energy technologies Tourism sustainability and climate change

Institution	**University of Lancaster**
School	Engineering

Degree	Masters of Low Carbon Emission
Degree Option	Postgraduate Diploma
Length	24 months (part time)
Entry Requirement	Class 2 (ii) Honours degree minimum entry requirement in a technological subject.

Web Page Address	http://www.engineering.lancs.ac.uk/postgraduate/courses.asp?ID=44

Compulsory Courses	Renewable Energy A& B Strategic Health, Safety and Environmental Management Nuclear Engineering Systems Environmental Decision Making Low Carbon Energy Use Dissertation and Technical Paper
Elective Courses	

Appendix 2: Data Base CSM Short Courses - Universities

University / Institution	**Scottish Centre for Carbon Capture and Storage**
Short Course	**CO_2 Storage: Geology for Engineers**
Date of Delivery	27 August 2009
Web Page Address	http://www.geos.ed.ac.uk/sccs/cpd/#gfe
Description	**This short course is designed for Engineers and Managers with limited or no previous geological knowledge. The aim is to provide an up-to-date introduction of the geological and geophysical aspects of CO_2 Storage.**
Programme	INTRODUCTION: CCS and the Energy Company; basics of geology DISPOSAL OPTIONS: Saline aquifers; depleted hydrocarbon reservoirs; unmineable coal beds GEOLOGY OF RESERVOIRS: Clastics and Carbonates; depositional environments; petrology TRAPS AND FAULTS: Faults and fractures; basic trap geometry GEOPHYSICS OF CO_2 DETECTION: Seismic; gravity TRACERS OF CO_2 MIGRATION: Natural and artificial

University / Institution	**Scottish Centre for Carbon Capture and Storage**
Short Course	**CO_2 Injection and Enhanced Oil Recovery (EOR)**
Date of Delivery	28 August 2009
Web Page Address	http://www.geos.ed.ac.uk/sccs/cpd/#gfe
Description	**This short course is designed for geologists, researchers, industry executives and managers with limited technical knowledge and anyone who wants to know more about CO_2 injection, flow and storage in underground geological reservoirs.**
Programme	CO_2 properties and behaviour in reservoirs Interaction between CO_2 and oil and water Oil displacement and recovery mechanisms Reservoir drive mechanisms and implications for CO_2 storage Injectivity, Mobility and relative permeability

University / Institution	**The University of Glasgow, Crichton Carbon Centre, Dunfries, Scotland**
Short Course	**Introduction to Carbon Management**
Date of Delivery	9-10 September 2009
Web Page Address	http://www.carboncentre.org/content/view/20/37/
Description	**Carbon management with a particular focuses on conducting and interpreting carbon footprint assessment, development of appropriate cost effective actions to reduce carbon impact, and implementation of a robust carbon management strategy within organisations.**
Programme	Carbon management Carbon footprint Identification of greenhouse gas emissions Monitoring and action plans to reduce carbon footprint Carbon management assessment and strategies

University / Institution	**The University of Manchester, Sustainable Consumption Institute**
Short Course	**CPD Course on Carbon Footprint**
Date of Delivery	10-13 March 2009
Web Page Address	http://www.ceas.manchester.ac.uk/business/professionaldevelopment/carbonfootprinting/
Description	**Climate change is increasingly recognised as the biggest environmental threat we face, and as such it is also becoming a critical business issue. Organisations of all types and sizes need to be aware of their environmental impacts and should be able to demonstrate what they are doing to reduce carbon emissions and mitigate climate change.**
Programme	Introduction Direct carbon footprint Carbon footprints in the supply chain Carbon management Carbon foot printing for business communications and marketing Beyond carbon foot printing

University / Institution	**University of Bath**
Short Course	**On Line Course - Primer on carbon foot printing of consumer products and services**
Date of Delivery	10-13 March 2009
Web Page Address	http://www.learnaboutcarbon.net/concepts/carbon-footprint-concepts/carbon-footprinting
Description	**Concerned about supply chain or regulatory pressures for more detailed carbon footprint information? On-line course can help you learn more about calculating and communicating product carbon footprint? Flexibly and efficiently, you can raise the level of your understanding and skills as you progress through self-paced diagnostic quizzes, interactive lessons, and expert 'round tables'.**
Programme	Key concepts and principles Basics of carbon footprint metrics and indicators Carbon foot printing and carbon labels Guidelines and standards (PA2050, ISO14067) Calculating the carbon footprint of a product or service Verification, communication, and carbon reduction claims

University / Institution	**University of East Anglia Low Carbon Innovation Centre**
Short Course	**Carbon Management Skills**
Date of Delivery	
Web Page Address	http://www.uea.ac.uk/polopoly_fs/1.123641!SC%20Carbon%20Management%20Skills.pdf
Description	**Develop business critical skills to exploit the opportunities of the low carbon economy.**
Programme	Low carbon development Carbon management Carbon trading and finance Carbon foot printing Behaviour change in the low carbon future Low carbon energy

Appendix 3: Data Base of CCSM Short Course – Private Sector

Course Provider	**IFF - International Faculty of Finance**
Short Course	Carbon Trading, Risk and Strategy
Date of Delivery	26-27 November 2009
Web Page Address	http://www.iff-training.com/carbon-trading-risk-and-strategy-training-course/116/
Description	Background and Framework of Emissions Trading Background and Framework of Credits Trading Trading and Transfer Carbon Market Specialties The Carbon Market in Practice Develop Carbon Strategy Investment,Trading and Risk Management Strategy

Course Provider	**GP Training Consultants**
Short Course	Introduction to the UK Carbon Reduction Commitment
Date of Delivery	8 December 2009
Web Page Address	http://www.gptrainingconsultants.com/courses/environmental-training/introduction-to-the-uk-carbon-reduction-commitment_161.shtml
Description	•background to climate change policy and regulation in the UK •eligibility rules and requirements •accounting rules and principles •key aspects of data management and accounting to ensure compliance •integration with existing accounting and management systems •opportunities for Q&A in relation to delegates own organisations

Course Provider	**ICAP plc and CEAG Ltd**
Short Course	**Foundation Emissions Course; Regulation, Risk Management and Carbon Pricing**
Date of Delivery	11-12 September and 20-21 November 2009
Web Page Address	http://www.gasandoil.com/ceagcourses/emissionstrading.htm
Description	**The course informs principals, advisers, investors, bankers, lawyers, accountants, verifiers and technology providers about the regulatory and business issues involved in the international carbon market; explains to regulators and policy makers the commercial implications of their decisions; provides case studies for traders and risk managers concerning the unique characteristics of the emissions market; and, equip emitters with the basic information necessary to start compiling their own emissions trading strategy and tactics.**
Programme	UNFCCC and the Kyoto Protocol APP Other international schemes Climate Change Global Warming Potentials Measurement and Verification Establishing Assigned Amounts The EU/Kyoto Linking Agreement EU Directive and the ETS CDM and JI projects The ITL, the CITL and registry accounts The value of different allowances The OTC market and regulated exchanges The voluntary market and carbon offsets Day Two (9:00 17:00) Why Companies Trade Types of Trade Physical Commodity Contracts Where Emissions Contracts Fit Forward Contracts and Forward Curves Compiling your abatement curve Compliance and Hedging ISDA/IETA/EFET- OTC Contract Case Study The Spark Spread and the Dark Spread Power Trading Case Study Futures Trading Case Study Fundamental/Technical Analysis Risk Analysis

Course Provider	**BSI Group**
Short Course	Calculating your Carbon Footprint Training Course
Date of Delivery	28 September 2009
Web Page Address	http://www.bsigroup.co.uk/en/Learning/Course-by-subject/Environmental-Management-and-Sustainability/Calculating-your-Carbon-Footprint/
Description	Carbon foot printing? reporting and verification overview Understanding the principles of reporting GHG emissions Elements of a reported carbon footprint Reporting GHG emissions The verification process Getting started on your implementation plan

Course Provider	**Aspects International**
Short Course	IEMA Approved Carbon Footprint Management Course
Date of Delivery	15September 2009
Web Page Address	http://www.aspexint.com/content.php?_p_=12&course=61
Description	Introduction Background to Carbon foot printing Carbon footprint techniques How to calculate a carbon footprint Carbon footprint standards Pilot projects Reducing your carbon footprint