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POLICY GROUP

Mapping of CO_2 Capture, Storage and Management (CCSM) in Graduate Programs: The Americas, Europe, Africa, Asia and Oceania

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Note by the Secretariat

Background

The CCS in the Academic Community Task Force has a mission to identify and engage academic programs on carbon capture and storage (CCS) throughout the world. The Task Force is currently at the end of the first phase of its activities, and has completed a report that "maps" academic institutions that offer postgraduate degree programs involving CCS.

Action Requested

The Policy Group is requested to consider the "Mapping" report by the CSLF CCS in the Academic Community Task Force.

CEPAC
Carbon Storage Research Center

Prepared for:
CSLF CCS in Academic Community Task Force

MAPPING OF CO_2 CAPTURE, STORAGE AND MANAGEMENT (CCSM) IN GRADUATE PROGRAMS: THE AMERICAS, EUROPE, AFRICA, ASIA AND OCEANIA

ARGENTINA	AUSTRIA	SOUTH AFRICA
BRASIL	BELGIUM	
CANADA	CZECH REPUBLIC	
CHILE	DENMARK	JAPAN
COLOMBIA	FINLAND	KOREA
ECUADOR	FRANCE	
MEXICO	GERMANY	
UNITED STATES	GREECE	
URUGUAY	IRELAND	
VENEZUELA	ITALY	AUSTRALIA
	NETHERLANDS	NEW ZEALAND
	NORWAY	
	POLAND	
	PORTUGAL	
	ROMANIA	
	SPAIN	
	SWEDEN	
	UNITED KINGDOM	

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Content

1. Introduction:

This report was prepared by the Brazilian Carbon Storage Research Center (CEPAC) to assist the Carbon Sequestration Leadership Forum (CSLF) task force "CCS in Academy" in the assessment of international graduate degrees at MSc and PhD level on CO_2 Capture and Storage or graduate degrees programs that contains CCS and climate change topics in the courses offered in a regular basis.

The scope of this report is to identify courses in the area of CCS and climate change inside the academic programs currently available in universities of The Americas, Europe, Africa, Asia and Oceania. Until the deadline of this report, many universities were surveyed in 10 American countries, 18 European countries, 1 African country, 2 Asian countries and 2 Oceanian countries.

This research is still in development. There are some universities to be surveyed in Europe and key economies in Asia.

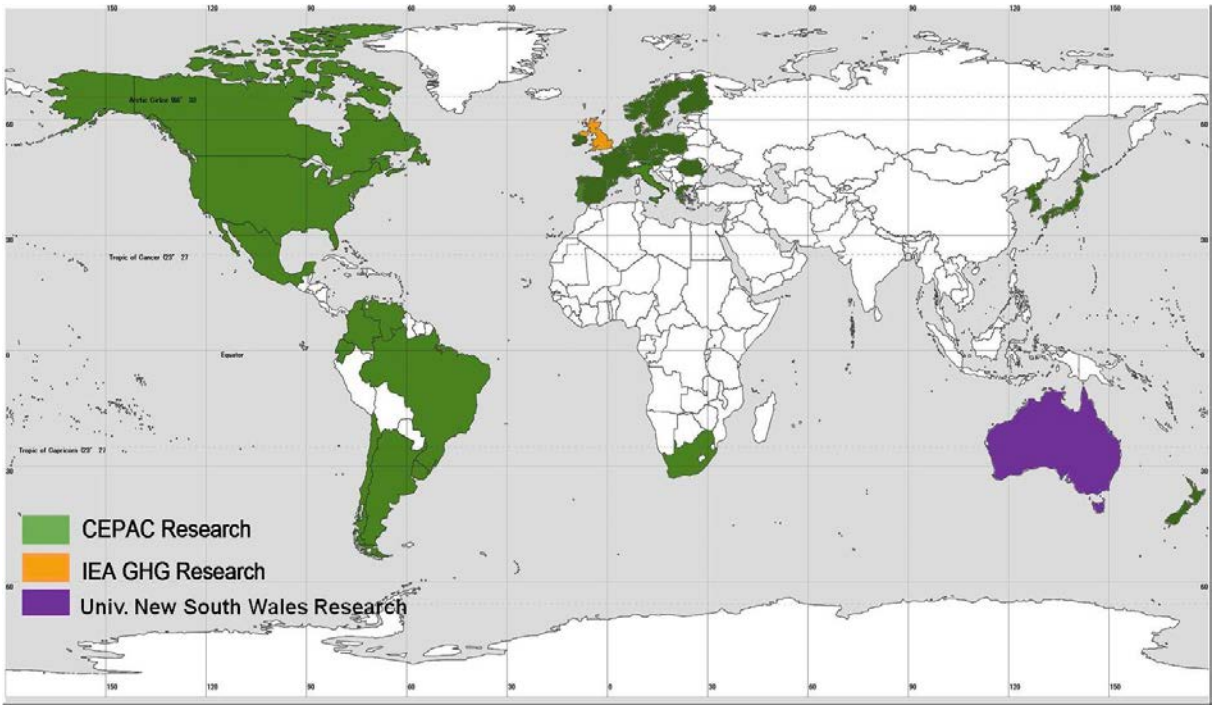

Figure 1: Map of surveyed counties.

Americas	Europe	Africa	Asia	Oceania
Argentina	Austria	South Africa	Japan	Australia**
Brazil	Belgium		Korea	New Zealand
Canada	Czech Republic			
Chile	Denmark			
Colombia	Finland			
Ecuador	France			
Mexico	Germany			
United States	Greece			
Uruguay	Ireland			
Venezuela	Italy			
	The Netherlands			
	Norway			
	Poland			
	Portugal			
	Romania			
	Spain			
	Sweden			
	United Kingdom*			

Table 1: List of surveyed countries.

* An special UK graduate programs survey was performed by the IEA Greenhouse Gas R&D Programme (IEA GHG). Results are available at the report "The Landscape of Carbon Dioxide Capture, Storage, and Management (CCSM) Education in the UK". 2009/TR5, August 2009 – see Annex 1 of this report.

** An specific report for Australian graduate programs was performed by Dr Lila W. Gurba from the University of South Wales and Sustainable Energy Resources Intl, "Mapping of CO2 Capture, Storage, and Management (CCSM) Graduate Programs in Australia" – see Annex 2 of this report.

The information presented in this report was obtained from universities *websites. The structure of this report was based on "The Landscape of CCSM* Education in the UK", made available in August 2009 by The International Energy Agency (IEA) for the CSLF task force "CCS in Academy". Mapping of United Kingdom graduate programs was performed by the IEA Greenhouse Gas R&D Programme and it is available separately in Annex 1.

We surveyed 35 important universities in countries of the Americas, in which 14 presented some topics related to Climate Change and/or CCS in courses inside

graduate programs. In Europe, 96 universities were surveyed and courses containing CCS/climate change topics were mapped inside graduate degrees in 26[1] universities. In Africa, 3 universities were surveyed and 1 of them offered courses with the topics on climate change/CCS. In Asia, 4 universities were surveyed, but they were not mapped. In Oceania, 17[2] universities were surveyed. The mapping of graduate programs in Australia was performed by Dr Lila W. Gurba from The University of New South Wales and Sustainable Energy Resources Intl, and it is available separately in Annex 2.

All the surveyed countries are listed in Appendix IX.

[1] 20 universities mapped in the surveyed countries + 6 universities mapped in the UK (IEA GHG Report – available at Annex 1).

[2] 5 universities surveyed by CEPAC (New Zealand) + 12 universities surveyed by The Univ. of New South Wales (Australia).

2. Methodology:

The information assembled in this report was obtained from the universities' web sites only[3]. The survey of graduate courses in the universities was performed using key words, such as "CO_2", "carbon", "carbon dioxide", "carbon capture", "carbon sequestration", "carbon storage", "enhanced oil recovery/EOR", "climate change" and "global warming" (Figure 2).

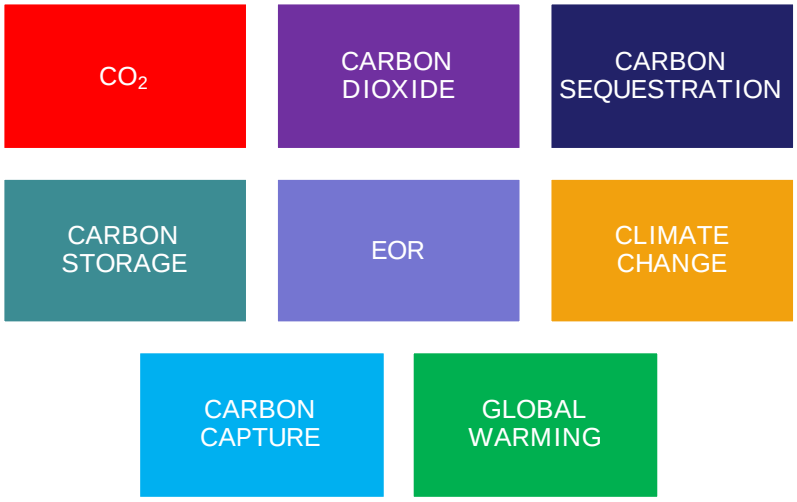

Figure 2: List of key words used in the universities' websites survey.

All courses that contained some of those key words were analyzed in terms of relevance of its content for CCS and summarized on tables in accordance with four themes: Capture, Storage, Environment and Economy, Social, Political and Legal aspects. The resultant tables show the offered courses per theme for each master/doctorate program, and if they are compulsory or elective. It is important to note that for some graduate programs there are compulsory core courses and "compulsory optional courses", in which there is a list of optional courses that students should choose to get the degree. Courses that fit this case were classified as elective courses, considering that they may or may not be chosen by the student.

[3] Free translation from texts in Spanish, French and Portuguese.

3. CCSM Educational Programs:

The graduate degrees (Master and Doctorate) were mapped according to the compulsory and elective courses' subjects. The courses were classified according to the topics Capture, Storage, Environmental subjects and Economy, social, political and legal aspects, explained bellow:

(C) Capture: Subjects in engineering and science of CO_2 capture from flue gas stream, incorporating transportation;

(S) Storage: Subjects on geology and science of CO_2 storage and enhanced oil recovery;

(E) Environmental: Subjects on climate change, environmental sciences and management, including modeling, geography and town planning;

(X) Economy, Social, Political and Legal aspects: Subjects on economical and legal issues related to CCS projects and/or environmental impacts.

In chapter 3 it is possible to check descriptive and summarized information on the mapped graduate programs per country:

- For American countries, see Chapter 3.1/Table 1;
- For European countries, see Chapter 3.2/Table 2;
- For African countries (South Africa), see Chapter 3.3/Table 3;
- For Asian countries, see Chapter 3.4;
- For Oceanian countries, see Chapter 3.5/Table 4.

More specific information of the mapped courses and programs are in Appendix I, II, III and IV. Summarized information about the graduate programs and courses, see Appendix V, VI, VII and VIII.

3.1 THE AMERICAS

3.1.1 Mapping Master and Doctorate Degrees

From all the graduate programs surveyed inside 35 universities of the American continent, 28 programs contain courses that address issues related to carbon capture and storage and/or climate change. Table 1 summarizes the courses theme mapped inside each graduate program.

Table 1: Mapped Doctorate and Master Degree in The Americas: Compulsory and Elective Courses related to (C) Capture, (S) Storage, (E) Environmental, (X) Economy, Social, Political and Legal aspects.

			Compulsories				Electives			
Country	**Institution** (state/province, country)	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
Argentina	University of Palermo (Buenos Aires federal district, Argentina)	Master in Environmental Law							X	
Brazil	Pontifical Catholic University of Rio Grande do Sul (Rio Grande do Sul, Brazil)	Master in Engineering and Materials Technology					X	X		
Brazil	Pontifical Catholic University of Rio Grande do Sul (Rio Grande do Sul, Brazil)	Doctor in Engineering and Materials Technology					X	X		
Brazil	University of São Paulo (São Paulo, Brazil)	Master / Doctor (in Geosciences)							X	
Canada	University of Alberta (Alberta, Canada)	Master of Arts in Earth and Atmospheric Sciences Master Scientist in Earth and Atmospheric Sciences							X	
Canada	University of Alberta (Alberta, Canada)	Doctor of Philosophy - Ph.D in Earth and Atmospheric Sciences							X	
Canada	University of British Columbia (BC, Canada)	Master of Engineering (M.Eng.) in Clean Energy Engineering			X					
Canada	University of British Columbia (BC, Canada)	Master of Arts/Master of Science (Resource Management and Environmental Studies)							X	

			Compulsories				Electives			
Country	**Institution** (state/province, country)	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
Canada	University of Calgary (Alberta, Canada)	Master of Science (M.Sc.) in Geosciences						X		
Canada	University of Calgary (Alberta, Canada)	Master of Science (M.Sc.) in Geosciences – *spec.* in *Reservoir Characterization*						X		
Canada	University of Calgary (Alberta, Canada)	M.Eng. / M.Sc. / Ph. D (spec. in Chemical Engineering)					X	X		
Canada	University of Calgary (Alberta, Canada)	*M.Eng. (*spec. in Petroleum Exploration Engineering)		X			X	X		
Canada	University of Calgary (Alberta, Canada)	Master of Engineering Master of Science Doctor of Philosophy (Electrical Engineering)								X
Canada	University of Regina (Saskatchewan, Canada)	Master of Applied Science (Petroleum Systems Engineering)						X		
Canada	University of Regina (Saskatchewan, Canada)	Master of Engineering (Petroleum Systems Engineering)						X		
Canada	University of Regina (Saskatchewan, Canada)	Doctor of Philosophy - Ph.D (Petroleum Systems Engineering)						X		
Canada	University of Saskatchewan (Saskatchewan, Canada)	Master in Sustainable Environmental Management (M.SEM.)			X			X	X	
Canada	University of Saskatchewan (Saskatchewan, Canada)	Master of Environment and Sustainability (M.E.S.)			X			X		
Canada	University of Saskatchewan (Saskatchewan, Canada)	Doctor of Philosophy (Ph.D) in Environment and Sustainability			X					
Chile	Pontifical Catholic University of Chile (Santiago, Chile)	Master in Energy Engineering					X			
United States of America	Harvard University (Massachusetts, USA)	Doctor of Philosophy - Ph.D (Earth and Planetary Sciences)							X	

			Compulsories				Electives			
Country	**Institution** (state/province, country)	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
United States of America	Princeton University (New Jersey, USA)	Master of Engineering in environmental engineering and water resources						X		
United States of America	Princeton University (New Jersey, USA)	Master of Science in Engineering						X		
United States of America	Princeton University (New Jersey, USA)	Doctor of Philosophy in environmental engineering and water resources						X		
United States of America	University of California, Los Angeles (California, USA)	Master of Science / Ph.D. (in Atmospheric and Oceanic Sciences)							X	
United States of America	University of Delaware (Delaware, USA)	Master of Science in Geography							X	
United States of America	University of Delaware (Delaware, USA)	Doctor of Philosophy (Ph.D) in Geography							X	
United States of America	University of Washington (Washington, USA)	M.S. / Ph.D. (geological sciences and geophysics)							X	

In the American continent courses that contents topics specifically related to CCS, such as CO_2 capture, transport and storage, enhanced oil recovery and mineral carbonation are majority subjected to Engineering or Engineering and Applied Sciences graduate programs. These topics can be found at courses of graduate programs in Brazil (Pontifical Catholic University of Rio Grande do Sul), Canada (University of Regina, University of Calgary) and the United States (Princeton University). The University of Chile offers a course on Hydrogen production, that mentions a topic about carbon transport. The University of Palermo offers an elective course in “Science and Environment” in the Master in Environmental Law program.

Courses containing topics on environmental changes, climate change, human influence on climate, global warming, climate or atmospheric modelling are majority subjected to Earth Sciences graduate programs. Courses with these topics can be found in Canada (University of Alberta, University of British Columbia, University of Saskatchewan), United States (Harvard University, University of California, University of Delaware and University of Washington) and Brazil’s (University of São Paulo)

graduate programs. Topics on carbon credits and legal aspects (Kyoto protocol) can be found at the University of Calgary's Electrical Engineering graduate program.

It was verified that topics on Carbon Capture and Storage and climate change are being discussed inside graduate programs, but currently there are no specific graduate programs on CCS in America. Courses that contain CCS topics are not compulsory in the major of the surveyed graduate programs.

In the new graduate program of University of British Columbia (Master of Engineering in Clean Energy Engineering) there are two compulsories courses in this graduate program related to climate change and fuel usage technologies.

3.2 EUROPE

3.2.1 Mapping Master and Doctorate Degrees

From all the graduate programs surveyed inside 96[4] universities in Europe (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden), there are 49[5] graduate programs that contain courses covering topics related to carbon capture and storage and/or climate change. Table 2 summarizes the courses theme mapped inside each graduate program.

Table 2: Mapped Doctorate and Master Degree in Europe: Compulsory and Elective Courses related to (C) Capture, (S) Storage, (E) Environmental, (X) Economy, Social, Political and Legal aspects.

			Compulsories				Electives			
Country	**Institution** (state/province, country)	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
Denmark	University of Copenhagen	Master of Law (LLM)				X				X
Denmark	Technical University of Denmark	MSc. Petroleum Engineering MSc. Chemical and Bichemical Engineering						X		

[4] It does not include universities in the UK (total of 6 universities)

[5] It does not include mapped graduate programs in the UK (total of 7 graduate programs mapped)

			Compulsories				Electives			
Country	**Institution** (state/province, country)	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
France	University of Paris X – Nanterre la Défense	Master of Science – Professional Management (Spec. Economics and Politics of Energy and Environment)			X	X				
Ireland	University College Dublin	Master Energy Systems Engineering	X	X	X					
Norway	University of Oslo	Master of Philosophy in Economics (spec. Environmental, Resource and Development economics)							X	X
Norway	Norwegian University of Science and Technology (NTNU)	MSc in Petroleum Engineering - MSG1 MSc. in Petroleum Geosciences (MSG2)		X				X		
Norway	Norwegian University of Science and Technology (NTNU)	MSc. In Natural Gas Technology					X			
Norway	Norwegian University of Science and Technology (NTNU)	PhD in Energy and Process Engineering					X			
Netherlands	Delft University of Technology (Delft, Netherlands)	MSc Applied Earth Sciences - Petroleum Engineering and Geosciences (spec. Petroleum Engineering)		X				X		
Netherlands	Delft University of Technology (Delft, Netherlands)	MSc Applied Earth Sciences - Petroleum Engineering and Geosciences (spec. Reservoir Geology)		X						
Netherlands	Delft University of Technology (Delft, Netherlands)	MSc Applied Earth Sciences –Resource Engineering (spec. Geotechnical and Environmental Engineering)	X	X						
Netherlands	University of Amsterdam – UvA (Amsterdam, Netherlands)	MSc. Earth Sciences – Environmental Management							X	
Netherlands	University of Amsterdam – UvA (Amsterdam, Netherlands)	MSc. Earth Sciences – Geo-Ecological Dynamics							X	

			Compulsories				Electives			
Country	**Institution** (state/province, country)	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
Netherlands	University of Amsterdam – UvA (Amsterdam, Netherlands)	LLM International and European Law - Public International Law								X
Netherlands	University of Groningen, (Groningen, Netherlands)	Master of Laws (LL.M) in International Law and the Law of International Organizations								X
Netherlands	University of Groningen, (Groningen, Netherlands)	Master of Laws (LL.M) in European Law								X
Netherlands	University of Utrecht (Utrecht, Netherlands)	MSc. Earth Sciences - Geology (spec. Sedimentary Systems)			X				X	
Netherlands	University of Utrecht (Utrecht, Netherlands)	MSc. Earth Sciences – Geochemistry			X				X	
Netherlands	University of Utrecht (Utrecht, Netherlands)	MSc. Earth Sciences - Hydrology (specialization Earth Surface Hydrology)			X				X	
Netherlands	University of Utrecht (Utrecht, Netherlands)	MSc. Earth Sciences - Biogeology							X	
Netherlands	University of Utrecht (Utrecht, Netherlands)	MSc. Earth Sciences - Physical Geography (Coastal Dynamics and Fluvial Systems) (Natural Hazards and Earth Observation)							X	
Netherlands	University of Utrecht (Utrecht, Netherlands)	MSc. Earth Sciences - Physical Geography (spec. Quaternary Geology and ClimateChange)			X				X	
Netherlands	University of Utrecht (Utrecht, Netherlands)	MSc. Energy Science			X	X			X	
Netherlands	University of Utrecht (Utrecht, Netherlands)	LLM (Master of Laws) Public International Law				X				X
Netherlands	VU University Amsterdam (Amsterdam, Netherlands)	MSc Environment and Resource Management – spec. in Environmental Studies				X			X	X
Netherlands	VU University Amsterdam	MSc Environment and Resource				X				

			Compulsories				Electives			
Country	**Institution** (state/province, country)	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
	(Amsterdam, Netherlands)	Management – spec. in Energy Studies								
Netherlands	VU University Amsterdam (Amsterdam, Netherlands)	MSc Paleoclimatology & Geo-ecosystems			X	X				
Netherlands	VU University Amsterdam (Amsterdam, Netherlands)	MSc. Earth Sciences (spec. Applied Environmental Geoscience)			X					X
Netherlands	VU University Amsterdam (Amsterdam, Netherlands)	MSc. Earth Sciences (spec. Earth Sciences and Economics – *Theme: Climate and Geo-ecosystems*)			X	X			X	
Netherlands	VU University Amsterdam (Amsterdam, Netherlands)	MSc. Earth Sciences (spec. Earth Sciences and Economics - *Theme: Water and Ecology)*							X	X
Netherlands	VU University Amsterdam (Amsterdam, Netherlands)	MSc. Earth Sciences (spec. Earth Sciences and Economics - *Theme: Energy)*							X	X
Netherlands	VU University Amsterdam (Amsterdam, Netherlands)	MSc. Geosciences of Basins and Lithosphere							X	X
Netherlands	VU University Amsterdam (Amsterdam, Netherlands)	MSc. Hydrology (spec. Hydrogeology or Ecohydrology)							X	X
Netherlands	VU University Amsterdam (Amsterdam, Netherlands)	MSc in Spatial, Transport and Environmental Economics								X
Netherlands	VU University Amsterdam (Amsterdam, Netherlands)	MSc in Economics (specialization Spatial Economics)				X				
Poland	University of Warsaw	Master of Arts in Development Economics (MADE)							X	X
Portugal	New University of Lisbon	Doctoral degree in climate change and sustainable development policies			X	X				
Portugal	University of Coimbra	Integrated Master Degree in			X	X				

			Compulsories				Electives			
Country	**Institution** (state/province, country)	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
		Environmental Engineering								
Portugal	University of Évora	Master degree in Earth, Atmospheric and Space Science Specialization: Geological Processes			X				X	
Portugal	University of Évora	Master degree in Earth, Atmospheric and Space Science Specialization: Atmospheric Physics and Climate			X				X	
Portugal	University of Évora	Master degree in Earth, Atmospheric and Space Science Specialization: Internal Geophysics			X				X	
Portugal	University of Lisbon	Master degree in Environmental Sciences and Technologies	X		X	X				
Portugal	University of Lisbon	Doctoral degree in climate change and sustainable development policies			X	X				
Portugal	University of Porto	Integrated Master Degree in Chemical Engineering	X	X	X					
Portugal	University of Porto	Doctoral Program in Sustainable Energy Systems			X					
Spain	University of Cordoba	Master in Climate Change: Natural resources and Sustainability			X				X	
Spain	Autonomous University of Barcelona (UAB)	Master in Environmental Studies (spec. Global and Climate Changes)			X					
X - specialization option/research field in this topic										

In Denmark, the Technical University of Denmark offers compulsory optional courses on Storage topics (in special Enhanced oil recovery) inside two Master programs: Petroleum Engineering and Chemical and Biochemical Engineering.

In France the University of Paris X – Nanterre la Défense was mapped, which offers a Master degree in Professional Management, Economics (Speciality: Economics and politics of energy and environment), which covers skills in economics and energy policy in the Paris region by bringing together the formation of the Ecole Nationale Superieure du Petrole et des Moteurs (IFP School) and provided jointly by the National Institute of Nuclear Science and Technology (INSTN) and the University of Paris Ouest Nanterre. Specific courses were not mapped due to lack of information, but it was considered that would fit on the topics “Environmental” and “Economic aspects”.

In Ireland, a course entitled “Fossil fuels, carbon capture and storage” is offered in the Master’s program in Energy Systems Engineering (University College Dublin).

In the Norwegian University of Science and Technology (NTNU), courses on topics related to CO_2 Storage (Enhanced oil recovery) are offered inside Master programs of the Department of Petroleum Engineering and Applied Geophysics. Moreover, in the MSc. in Natural Gas Technology there is an specialization option in “Thermal power cycles including CO_2 capture”, and the PhD program in Energy and Process Engineering offers a research field in “Thermal Energy/Air pollution and CO_2 capture”. A course containing topics on Environmental economics, including the climate problem, is offered in the University of Oslo (Master of Philosophy in Economics).

In the Netherlands, Delft University of Technology is the only one that offers compulsory courses addressed to CO_2 capture and CO_2 storage, covering topics like: CO_2 trapping mechanisms, CO_2 injection and EOR. The courses are compulsory depending on the chosen specialization of Master Applied Earth Sciences program.

Courses containing topics on legal aspects related to climate changes are inside Master of Laws (LLM) graduate programs as elective courses (University of Groeningen, University of Amsterdam). In the University of Utrecht there is a compulsory course on this topic in the Master of Laws in Public International Law program.

In the Netherlands, courses containing topics on environmental changes (climate change, man and climate, climate or atmospheric modeling, climate and hydrology) can be found in Earth Sciences/Geosciences graduate programs (University of Utrecht and VU University Amsterdam). In most of the programs at least one of the offered courses are compulsory. The course “Climate and Policy” can be also found in Master programs’ of the Graduate School Earth, Environment and Ecology of the VU University Amsterdam.

Topics on Environmental Economics are inside MSc in Economics and MSc in Spatial, Transport and Environmental Economics programs (Faculty of Economics and Business Administration, VU University Amsterdam). For MSc in Economics (spec. Spatial Economics) there is a compulsory course and for the MSc. in Spatial, Transport and Environmental Economics there are two “optional compulsory courses”.

In the universities surveyed in Poland, a Master program in Development Economics is the only one that offers an elective course with topics on climate change and economic consequences.

In Portugal there are 5 universities that offer courses related to CCS, mainly environmental issues, from a total of 9 that were surveyed. The universities of Lisbon, Évora and Porto stands out as the institutions with larger number of courses offered. The University of Lisbon has a partnership with the New University of Lisbon in the doctoral degree on climate change and sustainable development policies. The program includes 8 courses, compulsory and elective, related to climate change, ethical and economical issues. Other graduate programs are focused in general subjects with fewer options of courses. For instance, there is the Integrated Master Degree in Chemical Engineering which offers “gaseous emissions control and management” as a compulsory course.

The University of Évora provides a master degree with 3 different specializations: Geological Processes, Atmospheric Physics and Climate, Internal Geophysics. Each of these includes subjects such as ‘climate modeling’, ‘climate change’, ‘gases and aerosols dispersion in atmosphere’, ‘anthropogenic impacts on the atmospheric environment’, etc.

With a broader approach, the master degree on environmental sciences and technologies of University of Lisbon contents includes ‘environmental law and

international relations', 'environmental economy', 'conversion technologies and environmental requalification', 'climate change and renewable energy', 'new markets and environmental affairs', 'socio-economic impacts of environmental policies and markets'.

In Spain, there are 2 master programs focused in climate change, which offer courses on climate change, its interaction with society and ecosystems and international initiatives on climate change issues.

There were not mapped any graduate program in the 13 surveyed universities in Italy, neither in the 3 surveyed universities in Greece. In Austria, Sweden, Finland, Romania and Czech Republic no graduate programs ware mapped as well.

Due to national language in the websites, it was not possible to identify master courses inside some Greek, Polish, German and Belgian universities.

3.3 AFRICA

3.3.1 Mapping Master and Doctorate Degrees

Three (3) universities were surveyed in the African continent (South Africa), and it was identified 2 graduate programs that contain courses covering topics related to climate change in one university, which were mapped in this research. Table 3 summarizes the courses theme mapped inside each graduate program.

Table 3: Mapped Doctorate and Master Degree in Africa: Compulsory and Elective Courses related to (C) Capture, (S) Storage, (E) Environmental, (X) Economy, Social, Political and Legal aspects.

			Compulsories				Electives			
Country	**Institution** (state/province, country)	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
South Africa	University of Cape Town	MSc.in Engineering in Energy & Development Studies							X	
South Africa	University of Cape Town	MSc. in Engineering in Sustainable Energy Engineering			X				X	

The offered courses in these 2 master programs of the University of Cape Town are on environmental themes, such as “energy and climate change” and “energy modelling”.

3.4 ASIA

3.4.1 Mapping Master and Doctorate Degrees

Four (4) universities were surveyed in Asian continent (3 in Japan and 1 in Korea), but it was very difficult to assess the post graduate programs due to the language of the internal websites (faculties/departments websites). No graduate programs could be identified in the surveyed universities.

3.5 OCEANIA

3.5.1 Mapping Master and Doctorate Degrees

In Oceania, 5 universities were surveyed in New Zealand, and 5 postgraduate programs were mapped in this research[6,7]. It was identified some graduate programs that contain courses covering topics related to climate change and environmental law. Table 4 summarizes the courses theme mapped inside each graduate program.

Table 4: Mapped Doctorate and Master Degree in Oceania: Compulsory and Elective Courses related to (C) Capture, (S) Storage, (E) Environmental, (X) Economy, Social, Political and Legal aspects.

			Compulsories				Electives			
Country	**Institution (state/province)**	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
New Zealand	University of Canterbury	MSc. Zoology, Ecology or Plant Biology MSc. Geography			X					

[6] It does not include universities in Australia (12 universities in Australia)

[7] It does not include mapped graduate programs in Australia (up-to-date: total of 59 graduate programs mapped in Australia)

			Compulsories				Electives			
Country	**Institution (state/province)**	**Degree**	**C**	**S**	**E**	**X**	**C**	**S**	**E**	**X**
New Zealand	University of Victoria	MSc.Law				X				
New Zealand	University of Victoria	MSc. Marine Conservation			X					
New Zealand	University of Victoria	MSc. in Physical Geography			X					
New Zealand	University of Waikato	Master of Law				X				

In New Zealand courses on environmental law were found inside 2 masters of Law's programs. Other masters programs that offer courses on topics related to climate change were mapped as well. No specific course on CCS were found in the surveyed universities.

In Australia, a total of 12 universities were surveyed up-to-date and courses involving CCS were mapped in more than 50 postgraduate programs. The results for Australia is available at the special Report "Mapping of Graduate Programs in Australia" (Annex 2).

4. Conclusions

The mapping of CCSM (carbon capture, storage and management) and climate change graduate programs or courses in the academy worldwide showed that climate change issues are inside graduate programs in the countries already surveyed. Specific topics and/or graduate programs in CCS are not widely present in most countries.

Topics on Carbon Capture and Storage and Climate Change are being discussed inside graduate programs, but currently there are no specific graduate programs on CCS in America. The number of courses containing topics on CCS and climate change in America's graduate programs is limited, and the major existent courses are not compulsory in the programs. The major courses mapped are related to Engineering or Earth Sciences graduate programs.

It was verified that the compulsories courses in the surveyed universities are mostly related to environmental subjects, such as climate change, and they belong to Environmental programs.

Canada, Unites States and Brazil lead the graduate programs that have courses related to CCS and climate changes, with 9, 5 and 2 graduate programs respectively. Among the surveyed universities, the graduate program of Pontifical Catholic University of Chile is the only one that has topics on transport of CO_2 (with hydrogen). The Electrical Engineering graduate program (University of Calgary) is the only one that deals economical and political aspects related do CO_2.

In European continent, it was verified that topics on CCS/climate change are present in a considerable number of graduate programs in the surveyed countries. Unlike the case of America's graduate programs, in the European mapped graduate programs mostly of the courses of the academic institutions considered in this report are compulsory.

Courses containing CO_2 capture and storage aspects (in special Enhanced Oil Recovery) were found in universities in Denmark, Norway and Ireland. In Norway, a specialization option in a Master program and a PhD research field on CO_2 capture were also mapped.

Courses on environmental economics, energy law and related topics can be found in universities in France, Norway, Netherlands, Portugal, Spain and Poland.

The University of Lisbon's master degree in environmental sciences and technologies stands out with a broader curriculum which includes legal, socio-economical and technical issues related to environment and climate change. In Spain there is a master degree in Climate Change - Natural resources and Sustainability.

It is important to note that in the United Kingdom[8], there are at least 5 graduate programs specifically in the area of CCS and carbon management, which makes it the most notable country regarding CCS in Academy.

In the preliminary approach on African continent, specifically in South Africa, 2 elective courses that fit the environmental theme ("climate change" and "energy modelling") were mapped inside 2 master programs.

In Asia, no graduate programs could be identified in the surveyed universities.

In Oceania, research into carbon capture and storage at Doctorate and Masters' levels has been growing in Australia[9], and a large number of postgraduate courses on CCS-climate change were mapped in this country. In New Zealand, no specific course on CCS were found in the surveyed universities, but there were mapped some courses containing related issues.

We recommend that the final document must be made available for all CSLF technical group delegates for comments, suggestions and checking of information.

[8] Results in the special report published by IEA GHG: "The Landscape of Carbon Dioxide Capture, Storage, and Management (CCSM) Education in the UK". 2009/TR5, August 2009"

[9] Results in the Special Report "Mapping of CO_2 Capture, Storage, and Management (CCSM) Graduate Programs in Australia" in Annex 2.

Appendix I: Database of Doctorate and Master Programs in The Americas

Institution	**University of Palermo**
School	Faculty of Law
Address	UP Information and subscriptions center: Av. Córdoba 3501, esq. Mario Bravo | Av. Santa Fe esq. Larrea 1079. Buenos Aires – Argentina Tel: (5411) 4964-4600 informes@palermo.edu
Degree	MSc. Environmental Law
Length	2 years
Requirement	Master: 36 Credits (12 cr. compulsory courses + 24 cr. Elective courses) + Thesis
Website	http://www.palermo.edu/derecho/
Courses Related	**Science and Environment (3 credits)** – Elective The overall purpose of this course is to provide students with the tools necessary to understand from a scientific perspective the causes and effects of problems that are subject to environmental regulation, including issues such as climate change, deterioration of the ozone layer, renewable energy and non-renewable, pollution of air, water and soil, hazardous waste management, and others.

Institution	**Pontifical Catholic University of Rio Grande do Sul (PUCRS)**
School	Faculty of Engineering
Address	Av. Ipiranga, 6681/Pr. 30 Partenon - Porto Alegre, Rio Grande do Sul, CEP: 90619-900, Brasil
Degree	Master in Engineering and Materials Technology
Length	Minimum 12 months – maximum 30 months
Requirement	8 courses (24 credit hour), being 1 of these the compulsory course “Fundamentals of Materials Science”
Website	http://www3.pucrs.br/portal/page/portal/fengppg/pgetema/pgetemaApresentacao
Courses Related to CCS	**Materials and Processes for Carbon Capture and Storage** (elective) Tecnologies for separation and capture of CO_2 from flow steam gas (post-combustion, pre-combustion and oxicombustion) and industrial processes. Transport of CO_2. Carbon cycle. Rocky materials caracterization (reservoirs and seals). Carbon geological storage in depletes oil reservoirs, saline aquifer and coal beds). Enhanced hydrocarbon production in petroleum fields and coal seams. Well integrity. **Materials and Technologies for Mitigation of Environmental Impacts** (elective) Introduction to climate changes. Materials and technologies for mitigation of environmental impacts. Mineral and industrial waste carbonation for reduction of CO_2 emissions.
Dissertation Titles	Schutz, Marta Kerber. 2010. **“Study of the Interaction CO_2-Rock-Fluid in the Process of Carbonation of Saline Aquifers”** Martins, João Miguel Faim. 2009. “**Strategic CO_2 Reservoirs for future use in**

	Enhanced Oil Recovery projects and CO_2 geological storage in Brasil" Da Silva, Patricia Carneiro. 2009. **"Basalt carbonation for Carbon Storage"** Klunk, Marcos Antônio. 2009. **"CO_2 mineral sequestration: magnesium carbonate precipitation"** Nienczewski, Jonatã Rangel. 2009. "**Slag carbonation: a CO_2 sequestration alternative"** Dalla Vecchia, Felipe. 2009. **"Evaluation of degradation process on class G cement employed in oil wells in the presence of supercritical CO_2"** Bressan, Lia Weigert. 2009. **"Geochemistry and mineralogic integrity of Buracica Field reservoirs for CO_2 geological storage"** Licks, Letícia Azambuja dos Santos. 2009. **"Process evaluation of carbon dioxide capture by chemical absorption, focusing the implementation in Coal-fired Power Plant on Brazil"**

Institution	**Pontifical Catholic University of Rio Grande do Sul (PUCRS)**
School	Faculty of Engineering
Address	Av. Ipiranga, 6681/Pr. 30 - Partenon - Porto Alegre, Rio Grande do Sul, CEP: 90619-900, Brasil
Degree	Doctor in Engineering and Materials Technology
Length	Minimum 24 months – maximum 54 months
Requirement	12 courses (24 credit hour), being 1 of these the compulsory course "Fundamentals of Materials Science"
Website	http://www3.pucrs.br/portal/page/portal/fengppg/pgetema/pgetemaApresentacao
Courses Related to CCS	**Materials and Processes for Carbon Capture and Storage** (elective) Technologies for separation and capture of CO_2 from flow steam gas (post-combustion, pre-combustion and oxycombustion) and industrial processes. Transport of CO_2. Carbon cycle. Rocky materials characterization (reservoirs and seals). Carbon geological storage in depletes oil reservoirs, saline aquifer and coal beds). Enhanced hydrocarbon production in petroleum fields and coal seams. Well integrity. **Materials and Technologies for Mitigation of Environmental Impacts** (elective) Introduction to climate changes. Materials and technologies for mitigation of environmental impacts. Mineral and industrial waste carbonation for reduction of CO_2 emissions.

Institution	**University of São Paulo**
School	Geosciences Institute
Address	Rua do Lago, 562 - Cidade Universitária - CEP 05508-080 - São Paulo - SP e-mail: igc@usp.br
Degree	Master in Geosciences Doctor in Geosciences
Length	

Requirement (courses)	Master: at least 24 credits of graduate courses Doctorate: at least 40 credits of graduate courses
Website	http://www.igc.usp.br/ensino/pos_graduacao/programas.php#gs
Courses Related to CCS	**GSA-5802 – Climate Changes in Earth's present and past - 6 credits** (elective) Atmosphere and current climate. The hidrosphere. Cryosphere importance in global environment system. Chimate changes over geological time.

Institution	**University of Alberta**
School	Department of Earth and Atmospheric Sciences
Address	1-26 Earth Sciences Building, University of Alberta, Edmonton, Alberta, Canada T6G 2E3
Degree	Master of Arts in Earth and Atmospheric Sciences Master Scientist in Earth and Atmospheric Sciences
Length	MA, MSc – 2 years (max. 4 years)
Requirement	minimum of three single-term (*3) University of Alberta courses are required. Students may not take more than one 400-level course and one cross-listed graduate course, or two cross-listed graduate courses, toward their degree requirements.
Website	http://easweb.eas.ualberta.ca/page/60
Courses Related to CCS	**EAS 457: Global Change** Major processes of change in the contemporary environment, their history and their interrelationships (climate and sea level change, changes in atmospheric composition, deforestation, desertification, water resource depletion, soil erosion, atmospheric and aquatic pollution); global biogeochemical cycles and their role in environmental change. [Faculty of Science] *Prerequisites*: One of EAS 208, 225 or 250 **EAS 471: Atmospheric Modelling** Dynamics and physics of general circulation models. Numerical Weather Prediction models, ocean models, limited area models. Finite difference methods; spectral methods, and numerical stability. [Faculty of Science] Prerequisites: EAS 371, 373 and MATH 215 **EAS 493: Human Dimensions of Environmental Change** Investigation of issues related to the human use of resources and impact on the regional and global environment. Critical review of current frameworks for assessing, mitigating and adapting to global environmental change. [Faculty of Arts] Prerequisites: Any EAS 3XX course or consent of Instructor **EAS 593: Advanced Human Dimensions of Global Change** Investigation of issues related to the human use of resources and impact on the regional and global environment. Critical review of alternative frameworks for assessing, mitigating and adapting to global environmental change. Research project. Classes concurrent with EAS 493. Not available to students with credit in EAS 493. [Faculty of Arts]

CEPAC
Carbon Storage Research Center

Institution	**University of Alberta**
School	Department of Earth and Atmospheric Sciences
Address	
Degree	PhD. in Earth and Atmospheric Sciences
Length	PhD – 4 years (max. 6 years)
Requirement	At least six single-term (*3) courses beyond the undergraduate level are required. At least three (total of *9 weight) are taken at the University of Alberta. Not more than one 400-level course and two cross-listed graduate courses, or three cross-listed graduate courses are allowed
Website	http://easweb.eas.ualberta.ca/page/60
Courses Related to CCS	**EAS 457: Global Change** Major processes of change in the contemporary environment, their history and their interrelationships (climate and sea level change, changes in atmospheric composition, deforestation, desertification, water resource depletion, soil erosion, atmospheric and aquatic pollution); global biogeochemical cycles and their role in environmental change. [Faculty of Science] *Prerequisites*: One of EAS 208, 225 or 250 **EAS 471: Atmospheric Modelling** Dynamics and physics of general circulation models. Numerical Weather Prediction models, ocean models, limited area models. Finite difference methods; spectral methods, and numerical stability. [Faculty of Science] Prerequisites: EAS 371, 373 and MATH 215 **EAS 493: Human Dimensions of Environmental Change** Investigation of issues related to the human use of resources and impact on the regional and global environment. Critical review of current frameworks for assessing, mitigating and adapting to global environmental change. [Faculty of Arts] Prerequisites: Any EAS 3XX course or consent of Instructor **EAS 593: Advanced Human Dimensions of Global Change** Investigation of issues related to the human use of resources and impact on the regional and global environment. Critical review of alternative frameworks for assessing, mitigating and adapting to global environmental change. Research project. Classes concurrent with EAS 493. Not available to students with credit in EAS 493. [Faculty of Arts]

Institution	**University of British Columbia**
School	Faculty of Applied Science and The Clean Energy Research Centre
Address	The University of British Columbia 2360 East Mall - Vancouver, BC V6T 1Z3 E-mail: cerc@cerc.ubc.ca
Degree	Master of Engineering (M.Eng.) in Clean Energy Engineering (offered for the first time in September 2009)
Length	16 months (full-time study)

Requirement (courses)	30 credits: 9 Credits of required courses (CEEN 501 Thermal Energy Systems, CEEN 502 Alternative Energy Technologies, CEEN 523 Energy and the Environment) / 14 credits of approved electives / 6-credit project: for most students a paid work term with industry (CEEN 596) / 1-credit seminar course (CEEN 597)
Website	http://www.cerc.ubc.ca/Program%20Detail.pdf
Courses Related to CCS	**CEEN 523 Energy and the Environment** (compulsory) Energy/environment/society interactions; development of energy resources; energy demand and its determinants; policy dimension of energy and climate change; impacts on ecosystems; life cycle analysis; impact assessment and other tools for quantitative and qualitative evaluation of alternative energy sources; case studies. **CEEN 501 Thermal Energy Systems** (compulsory) Thermodynamics of fossil and biomass fuel usage, exergy analysis of industrial processes. Fuel usage technologies; combustion, power cycles, gasification, pyrolysis, and reforming. Nuclear energy. Control of emissions of acid gases, VOCs, particles, and carbon dioxide. Energy supply issues and policy.

Institution	**University of British Columbia**
School	Institute of Resources Management and Environmental Studies
Address	
Degree	Master of Art in Resources Management and Environmental Studies Master of Science in Resources Management and Environmental Studies
Length	2 years
Requirement (courses)	minimum of 36 credits: 24 credits of course work (At least 18 credits must be in courses numbered 500 or above. 12 of them must be selected from RMES core courses while the remaining 12 are open to electives, but only six of which may be numbered below 500) / 12-credit thesis
Website	http://www.ires.ubc.ca/academic/Master/index.html
Courses Related to CCS	**RMES 520 Climate Change in the 21st Century** – 3 credits (elective) Historical, methodological, and policy dimensions of climate change in the 21st century. Application of natural and social science literature to climate science, impacts on ecosystems and societies, and response options.

Institution	**University of Calgary**
School	Geosciences
Address	2500 University Drive NW - Earth Sciences Building, Room 118 Calgary, Alberta, Canada T2N 1N4
Degree	**Master of Science (M.Sc.) Course-based**
Length	2 years (max. 6 years)
Requirement	Eight half course equivalents including GLGY or GOPH 701 A minimum of five(5) half-course-equivalents (HCEs) must be chosen from the corresponding lists for Year 1, including at least three(3) engineering HCEs (ENPE, ENGG, ENCH) for geoscientists, and at least three geoscience HCEs (GLGY, GOPH) for engineers. / An oral public presentation of thesis results

Website	http://www.ucalgary.ca/geoscience/DegreesSpecializations
Courses Related to CCS	**GLGY 613 - Flow in Porous Media (H)*** (elective) Fundamentals of fluid flow in porous media: pore structure; capillarity; single phase flow; immiscible and miscible fluid flow; pore level modelling of porous media. Concepts applied to hydrocarbon reservoirs and fluid migration in soils including: characterization of pore space, single phase flow in porous media, capillarity, wettability, routine and advance core analysis, miscibility in porous media. Similarities and differences between hydrocarbon reservoirs and soils. Introduction to enhanced oil and gas processes. **Prerequisite:** Chemical Engineering 331 or Geology 401 or 429 or 423. **ENPE 525 – Waterflooding and Enhanced Oil Recovery** (elective) *(H) Half-course

Institution	**University of Calgary**
School	Geosciences
Address	2500 University Drive NW - Earth Sciences Building, Room 118 Calgary, Alberta, Canada T2N 1N4
Degree	**Master of Science (M.Sc.) in Geosciences - Course-based** with a *specialization* in *Reservoir Characterization* - MSRC
Length	2 years (max. 6 years)
Requirement	Eight half course equivalents / Team based project in last term
Website	http://www.ucalgary.ca/geoscience/DegreesSpecializations
Courses Related to CCS	**GLGY 613 - Flow in Porous Media (H)*** (elective) Fundamentals of fluid flow in porous media: pore structure; capillarity; single phase flow; immiscible and miscible fluid flow; pore level modelling of porous media. Concepts applied to hydrocarbon reservoirs and fluid migration in soils including: characterization of pore space, single phase flow in porous media, capillarity, wettability, routine and advance core analysis, miscibility in porous media. Similarities and differences between hydrocarbon reservoirs and soils. Introduction to enhanced oil and gas processes. **Prerequisite:** Chemical Engineering 331 or Geology 401 or 429 or 423. **ENPE 525 – Waterflooding and Enhanced Oil Recovery** (elective) *(H) Half-course

Institution	**University of Calgary**
School	Schulich School of Engineering - Department of Chemical and Petroleum Engineering
Address	2500 University Drive NW - Schulich School of Engineering, Room B202 Calgary, Alberta, Canada T2N 1N4
Degree	M.Eng. course-based, M.Eng. thesis-based , M.Sc. and Ph.D (Chemical Engineering / Petroleum Engineering)
Length	
Requirement	*M.Eng. course-based.:* A minimum of 10 half-courses with at least 6 half-courses at the graduate level (600's). Students may take no more than two half-or one full-

(Courses)	equivalent project-based courses. The majority of the courses (60% or more) should be related to the student intended field of specialization. *M.Eng. thesis-based.:* A minimum of 4 half-courses at the graduate level. *M.Sc.:* Completing a minimum of 4 half-courses at the graduate level. At least one of the courses must be either ENCH701 or ENCH703. In addition: - Students intending to have a degree specialization in Petroleum Engineering must also complete at least one course from the list of core courses: ENCH 621, 629, 647, 657, 677. - Students intending to have a degree specialization in Environmental or Biomedical Engineering should consult with their supervisors for the additional requirements. *Ph.D. (Students admitted with an acceptable Master degree)* Registering and participating in the Research Seminar course (ENCH 601 or equivalent) Completing a minimum of 2 half-courses at the graduate level. Before proceeding to the candidacy examination, all students must have completed both ENCH701 and ENCH703 or equivalents. In addition, students with a specialization in Chemical Engineering or Petroleum Engineering must also have taken at least two courses from the list of core courses for their specialization as listed in the previous section for the M.Sc., or equivalents. For other specializations, students should consult with their supervisors for the additional requirements.
Website	http://www.eng.ucalgary.ca/Chemical/
Courses Related to CCS	**Chemical Engineering 647 - *Thermal Recovery Methods (H)**** (elective) / (compulsory for degree specialization in Petroleum Engineering) Oil sands and heavy oil resources. Fluid and rock properties. Heat transfer processes in porous media. Comparative analysis of viscous oil recovery methods: steam flooding, cyclic steam stimulation, insitu combustion and steam-assisted-gravity-drainage. Surface equipment and operation. Laboratory and field performance evaluation of thermal recovery methods. Process economics. **Chemical Engineering 621 - *Reservoir Simulation (H)**** (elective) / (compulsory for degree specialization in Petroleum Engineering) Enhanced recovery modelling (generalized black-oil models, compositional and miscible), well treatment, grid orientation. New developments in gridding, thermal models, naturally fractured reservoirs, modelling of induced fractures (hydraulic and waterflood), reservoir geomechanics, and practical aspects of conducting simulation studies. **Prerequisite or Corequisite:** Petroleum Engineering 523 or equivalent. **Chemical Engineering 643 (Environmental Engineering 641) - *Air Pollution Control Engineering (H)**** (elective) Introduction to air quality and air pollution. Impact of air pollution and greenhouse gases on health and climate change. Energy and air pollution. Fundamentals of fossil fuel combustion and related air pollution. Pre-combustion air pollution control strategies: fossil fuel cleaning/refinery, renewable energy (wind, solar, biomass, etc.), and alternative energy sources (hydrogen, etc). In-combustion air pollution control. Post-combustion air pollution control. Industrial air pollution control. Control of particulate matter. Control of VOCs, SOx, and NOx. Adsorption and absorption of air pollutants. GHG emission control. Indoor air quality engineering. Recent advances on related topics. **Note:** Credit for both Chemical Engineering 643 and Environmental Engineering 641 will not be allowed.

	Chemical Engineering 647 - *Thermal Recovery Methods (H)** (elective) Oil sands and heavy oil resources. Fluid and rock properties. Heat transfer processes in porous media. Comparative analysis of viscous oil recovery methods: steam flooding, cyclic steam stimulation, insitu combustion and steam-assisted-gravity-drainage. Surface equipment and operation. Laboratory and field performance evaluation of thermal recovery methods. Process economics. **Chemical Engineering 629 - *Secondary and Tertiary Recovery (H)**** (elective) / (compulsory for degree specialization in Petroleum Engineering) Displacement processes for improved recovery of hydrocarbons. Waterflooding, gas flooding, solvent flooding and chemical flooding. Performance prediction techniques. Comparative economics. **Prerequisite:** Petroleum Engineering 525 or equivalent. *(H) Half-course

Institution	**University of Calgary**
School	Schulich School of Engineering - Department of Electrical and Computer Engineering
Address	2500 University Drive NW - ICT Building, Room 402 Calgary, Alberta, Canada T2N 1N4
Degree	Master of Engineering (M.Eng) Master of Science (M.Sc) Doctor of Philosophy (Ph.D)
Length	Master of Engineering (M.Eng) – 2 years (max. 4 years) Master of Science (M.Sc) – 1 years (max. 4 years) Doctor of Philosophy (Ph.D) – max. 6years
Requirement (courses)	Master of Engineering (M.Eng): 10 to 12 half courses of which at least 7 must be graduate courses / a final comprehensive oral examination. Master of Science (M.Sc): 5 to 7 half courses / a final oral examination on the research reported in the thesis. Doctor of Philosophy (Ph.D): 2 to 5 half courses beyond the Master's degree or 7 to 10 half courses beyond the Bachelor's degree.
Website	http://enel.ucalgary.ca/graduate
Courses Related to CCS	**Electrical Engineering 669 (formerly Electrical Engineering 619.52) - Renewable Energy and Solid State Lighting for the Developing World (H)*** History of Lighting, Illumination Measurements & Standards – Incandescent, Fluorescent, LEDs & OLEDs. Generation using Hydro, Solar, Photovoltaic, Wind, Thermoelectric, Biomass, Thermal. Energy Storage & Supply Chains. System Design, Analysis & Life Cycle Assessment. Kyoto Protocol, Carbon Credits and Trading. **Electrical Engineering 581 - Renewable Energy and Solid State Lighting for Human Development (H)*** Introduction to solid state lighting (SSL) and renewable energy (RE) systems. Topics include: history of lighting, illumination standards, incandescent bulbs, fluorescent tubes, White LEDs their properties and measurement; photovoltaic, wind power, hydro power, human and animal power, thermoelectric, biomass energy, biodiesel, fuel cells and SSL system design. SSL project planning and financing, environmental and social impact assessments, carbon credits and SSL system metrics for the developing world.

	Prerequisite: Electrical Engineering 489 or permission of the instructor. Note: Credit for both Electrical Engineering 581 and Electrical Engineering 519.39 will not be allowed. (H) Half-course

Institution	**University of Regina**
School	Faculty of Engineering
Address	3737 Wascana Parkway, Regina, Saskatchewan, Canada, S4S 0A2 Contact: engg@uregina.ca
Degree	Master of Applied Science (Petroleum Systems Engineering) - 30 credit hours
Length	
Requirement	minimum of five 3 credit hour courses / 15 credit hours of thesis research (ENPE 901) / Graduate Engineering Seminar / Up to two courses may be taken in related disciplines such as mathematics or computer science
Website	http://www.uregina.ca/gradstudies/calendar/programs/engineering.shtml
Courses Related to CCS	**ENPE 831 Advanced Enhanced Oil Recovery (3)** (elective) Microscopic and macroscopic displacement of fluids in a reservoir, mobility control processes, miscible displacement processes, chemical flooding, and thermal recovery processes will be covered in this course. Mathematical representations and physical descriptions will be developed. Carbon dioxide flooding and steam assisted gravity drainage will be covered in more depth.

Institution	**University of Regina**
School	Faculty of Engineering
Address	3737 Wascana Parkway, Regina, Saskatchewan, Canada, S4S 0A2 Contact: engg@uregina.ca
Degree	Master of Engineering (Petroleum Systems Engineering) - 30 credit hours
Length	
Requirement	Nine courses including a minimum of seven courses from the 800 level course series (27 credit hours). Among the nine 3 credit hour courses and one Project Report, at least five of them must be 800 level courses from Engineering and one of the five must be the 902 Project course.* / Graduate Engineering Seminar / Engineering Project (ENPE 902) / Up to two courses may be taken in related disciplines such as mathematics or computer science
Website	http://www.uregina.ca/gradstudies/calendar/programs/engineering.shtml
Courses Related to CCS	**ENPE 831 Advanced Enhanced Oil Recovery (3)** (elective) Microscopic and macroscopic displacement of fluids in a reservoir, mobility control processes, miscible displacement processes, chemical flooding, and thermal recovery processes will be covered in this course. Mathematical representations and physical descriptions will be developed. Carbon dioxide flooding and steam assisted gravity drainage will be covered in more depth.

Institution	**University of Regina**
School	Faculty of Engineering
Address	3737 Wascana Parkway, Regina, Saskatchewan, Canada, S4S 0A2 Contact: engg@uregina.ca
Degree	Ph.D. in Engineering (Petroleum Systems Engineering) - 30 credit hours
Length	
Requirement	Five 800 level courses after a Master's degree, including ENGG 800 (at least three must be Engineering courses); or eleven courses after a Bachelor's degree, including eight 800 level courses and ENGG 800. / ENGG 800 will serve as a comprehensive examination for the candidate. Normally this course will be completed within one year of admission to the Ph.D. program / 45 credit hours of research (ENPE 901) after a Master's degree; or 60 credit hours after a Bachelor's degree. All students will be required to complete and defend the Ph.D. thesis / Graduate Engineering Seminar / Up to two courses may be taken in related disciplines such as mathematics or computer science
Website	http://www.uregina.ca/gradstudies/calendar/programs/engineering.shtml
Courses Related to CCS	**ENPE 831 Advanced Enhanced Oil Recovery (3)** (elective) Microscopic and macroscopic displacement of fluids in a reservoir, mobility control processes, miscible displacement processes, chemical flooding, and thermal recovery processes will be covered in this course. Mathematical representations and physical descriptions will be developed. Carbon dioxide flooding and steam assisted gravity drainage will be covered in more depth.

Institution	**University of Saskatchewan**
School	School of Environment and Sustainability
Address	University of Saskatchewan, Room 217, Law Building 15 Campus Drive, Saskatoon, SK S7N 5A6, Canada
Degree	Master of Sustainable Environmental Management (M.SEM.)
Length	1 year of full-time study (max. 5 years)
Requirement	total of 30 credit units including: 12 credit units of core courses / 6 credit units of electives from a restricted list / 6 credit units from this list or anywhere else on campus / A 6 credit unit research project. A Seminar in Environment and Sustainability. *A student may take up to two 400-level undergraduate courses to fulfill the elective requirement with the approval of the Graduate Affairs Committee or their faculty advisor.
Website	http://www.usask.ca/sens/graduate_programs/mes/index.php
Courses Related to CCS	**ENVS 802.3 – Human Dimensions of Environmental Change** (compulsory) This course explores the past and present interactions between people and the natural world. It addresses ways that environment has molded human societies and ways that people have altered nature. Contemporary concerns for environmental sustainability are introduced by examining human entanglement with a range of natural and modified systems. **ENVS 831.3 – Current Issues in Land Reclamation and Remediation** (restricted set of electives) Current issues in land reclamation and remediation are examined. The impact of human activity in a variety of environments is examined and strategies for

	reclamation and remediation are investigated. Biophysical factors are the emphasis of the course, however the context of social and economic issues are incorporated. **ENVS 898.3 - Environmental Economics and Policy Making** (restricted set of electives) This course will focus on developing a formal understanding of natural resource use and resource and environmental policy using economic models. The focus on the course will be on renewable resources but with some consideration of the unique characteristics of non-renewable resources. The course will examine a series of natural resource and environmental issues with a priority given to Canadian issues but not excluding issues from other jurisdictions and those global scale environmental issues. The course will develop detailed analyses of existing and proposed natural resource and environmental policy using the economic framework to evaluate the structure and the efficiency, effectiveness and flexibility of these policies. Through this approach the student will develop the tools to understand and critically evaluate environmental policy and also build a familiarity with the primary policy measures and tools. **GEOE 412.3 – Reservoir Mechanics** (elective) Fluid flow in hydrocarbon reservoirs; material balance equations; oil and gas well testing; waterflooding and EOR methods; fractional and segregated flow of immiscible fluids. *Prerequisite(s):* (CE 328 or CHE 320 or ME 335) and GEOL 245 **GEOL 463.3 — 2(3L-3P)** Petroleum Geology The composition and physical properties of petroleum. Organic matter evolution, maturation, and migration of hydrocarbons from source rock to reservoir. Introduction to petroleum exploration, development and recovery methods, and the main types of reservoirs and traps. *Prerequisite(s):* GEOL 224, 245 (formerly GEOL 243), and GEOL 258.

Institution	**University of Saskatchewan**
School	School of Environment and Sustainability
Address	University of Saskatchewan, Room 217, Law Building 15 Campus Drive, Saskatoon, SK S7N 5A6, Canada
Degree	Master of Environment and Sustainability (M.E.S.)
Length	2 years (full-time study)
Requirement	Total of 12 credit units (9 credit units of required courses, 3 credit units of electives courses from anywhere on campus) / A thesis based on original research *Students are advised to consult their faculty supervisor or advisory committee when selecting their elective courses. A student may take one 400-level undergraduate course to fulfill the elective requirement with the approval of the advisory committee
Website	http://www.usask.ca/sens/graduate_programs/mes/index.php
Courses Related to CCS	**ENVS 802.3 – Human Dimensions of Environmental Change** (compulsory) This course explores the past and present interactions between people and the natural world. It addresses ways that environment has molded human societies and ways that people have altered nature. Contemporary concerns for environmental sustainability are introduced by examining human entanglement with a range of natural and modified systems.

	ENVS 803.3 – Research in Environment and Sustainability (compulsory) The purpose of this course is to introduce graduate students to conceptual, practical, and ethical issues in conducting interdisciplinary research about environment and sustainability. By the end of the course, students will have a research plan from which their proposal and research activities can be developed. **GEOE 412.3 – Reservoir Mechanics** (elective) Fluid flow in hydrocarbon reservoirs; material balance equations; oil and gas well testing; waterflooding and EOR methods; fractional and segregated flow of immiscible fluids. *Prerequisite(s):* (CE 328 or CHE 320 or ME 335) and GEOL 245 **GEOL 463.3 – Petroleum Geology** (elective) The composition and physical properties of petroleum. Organic matter evolution, maturation, and migration of hydrocarbons from source rock to reservoir. Introduction to petroleum exploration, development and recovery methods, and the main types of reservoirs and traps *Prerequisite(s):* GEOL 224, 245 (formerly GEOL 243), and GEOL 258.

Institution	**University of Saskatchewan**
School	School of Environment and Sustainability
Address	University of Saskatchewan, Room 217, Law Building 15 Campus Drive, Saskatoon, SK S7N 5A6, Canada
Degree	Doctor of Philosophy in Environment and Sustainability (Ph.D)
Length	3 years of full-time study (max. 6 years)
Requirement	Complete 6 credit units of course work / a dissertation based on original research / participate in the Environment and Sustainability Seminar. Ph.D. students must also complete a qualifying exam within four months of their first registration and a comprehensive exam (written and oral examination) within 16 months of their first registration.
Website	http://www.usask.ca/sens/graduate_programs/mes/index.php
Courses Related to CCS	**ENVS 802.3 – Human Dimensions of Environmental Change** (compulsory) This course explores the past and present interactions between people and the natural world. It addresses ways that environment has molded human societies and ways that people have altered nature. Contemporary concerns for environmental sustainability are introduced by examining human entanglement with a range of natural and modified systems.

Institution	**Pontifical Catholic University of Chile**
School	School of Engineering
Address	Av. Libertador Bernardo O'Higgins 340 Santiago, Chile
Degree	Master in Energy Engineering
Length	2 years
Requirement (courses)	16 required courses and 8 elective courses / a graduation activity (individual project + internship in a company)

Website	http://www.ing.puc.cl/mie/magister.html
Courses Related to CCS	**IEN 3620 Hydrogen Production and uses** (elective) Hydrogen chemical and energetic fundamentals. Methane reforming and electrolysis, and current uses. Future hydrogen demand and scenarios of fossil fuel substitution. Conversion of chemical energy. Uses in propulsion systems, emergency generation. Recovered in-situ. Future technologies for hydrogen production: high-temperature electrolysis, thermochemical processes, solar and nuclear, bio-photolysis and others. Packing for compression or liquefaction and cryogenics, land transport, road or sea transport, storage and transfer of hydrogen. Materials. Energy chains: analysis of life cycle in the production and use of hydrogen. State of the art in research and commercialization. Projects and initiatives implemented. National and international regulations. Environmental contribution. Economic aspects of hydrogen production and use. Projections of future limits of hydrogen technology, and practical substitutes. Link with carbon technologies for efficient transport. Symbiosis with electricity.

Institution	**Harvard University**
School	Graduate School of Arts and Sciences - Department of Earth and Planetary Sciences (EPS)
Address	Massachusetts Hall, Cambridge, MA 02138, USA
Degree	Ph.D. (AM*) (Earth and Planetary Sciences) * The AM (Master of Arts) in parentheses indicates that the degree is awarded only in the course of study for the PhD.
Length	4 years (minimum of 2 years)
Requirement	at least eight graduate-level courses in fulfillment of the PhD degree. Four of these courses must be letter-graded at the 200 level in earth and planetary sciences or related courses at a suitable level in other disciplines such as applied mathematics, applied physics, astronomy, biology, chemistry, engineering sciences, mathematics, or physics. Two letter-graded courses must be Applied Math 105a and Applied Math 105b, or other equivalent courses approved by the faculty.
Website	http://www.gsas.harvard.edu./programs_of_study/earth_and_planetary_sciences.php
Courses Related to CCS	**Earth and Planetary Sciences 132. Introduction to Meteorology and Climate** (elective) Catalog Number: 8495 *Brian F. Farrell* *Half course (spring term).* Physical concepts necessary to understand atmospheric structure and motion. Phenomena studied include the formation of clouds and precipitation, solar and terrestrial radiation, dynamical balance of the large-scale wind, and the origin of cyclones. Concepts developed for understanding today's atmosphere are applied to understanding the record of past climate change and the prospects for climate change in the future. *Prerequisite:* Mathematics 21 or Applied Mathematics 21a and 21b; Physics 11 or 15; or permission of instructor. **Earth and Planetary Sciences 134. Global Warming Debates: The Reading Course** (elective) Catalog Number: 45399 *Peter John Huybers and Eli Tziperman* *Half course (spring term).* The atmospheric carbon dioxide concentration is now the highest it has been in at

	least 800,000 years, raising concerns regarding possible future climate changes. This seminar will survey the science of global change from the perspective of scientific debates within climate community. Specifically, the course will involve guided reading and discussion of papers that present contentious view points on the science of global change, with the goal of students learning how to scientifically evaluate these claims. Laboratories will provide students with hands on experience with some climate models and data. *Note:* Given in alternate years. *Prerequisite:* Applied Mathematics 21a or equivalent, or permission of instructor.
Recent EPS Dissertation Titles	**Kurt House,** "On the Physics and Chemistry of Carbon Dioxide Capture and Storage in Terrestrial and Marine Environments"

Institution	**Princeton University**
School	School of Engineering and Applied Science – Department of Civil and Environmental Engineering
Address	Princeton University, E-209A Engineering Quad, Princeton, NJ, 08544 Contact: cee@princeton.edu
Degree	Master of Engineering in environmental engineering and water resources
Length	1 academic year (full time)
Requirement	Completing 8 one-semester courses selected from a list of relevant courses
Website	http://www.princeton.edu/cee/graduate/degree_programs/
Courses Related to CCS	**CEE 599Topics- Enviro Eng'ing & Water Resources** (elective) A promising approach for reducing atmospheric carbon dioxide is geologic carbon sequestration (GCS), in which CO_2 is captured from power plants and injected into deep geologic formations. Widespread adoption of GCS will require a sound understanding of the processes that govern the fate of the injected CO_2. The course will examine these processes through coverage of the fundamental scientific and engineering principles relevant to GCS. The course will also examine these principles in the context of emerging government regulations for site selection, injection operations, and post-injection monitoring and stewardship.

Institution	**Princeton University**
School	School of Engineering and Applied Science – Department of Civil and Environmental Engineering
Address	Princeton University, E-209A Engineering Quad, Princeton, NJ, 08544 Contact: cee@princeton.edu
Degree	Master of Science in Engineering
Length	2 academic years (full time)
Requirement	completing 10 one-semester courses
Website	http://www.princeton.edu/cee/graduate/degree_programs/
Courses Related to CCS	**CEE 599Topics- Enviro Eng'ing & Water Resources** (elective) A promising approach for reducing atmospheric carbon dioxide is geologic carbon sequestration (GCS), in which CO_2 is captured from power plants and injected into deep geologic formations. Widespread adoption of GCS will require a sound understanding of the processes that govern the fate of the injected CO_2. The course

	will examine these processes through coverage of the fundamental scientific and engineering principles relevant to GCS. The course will also examine these principles in the context of emerging government regulations for site selection, injection operations, and post-injection monitoring and stewardship.

Institution	**Princeton University**
School	School of Engineering and Applied Science – Department of Civil and Environmental Engineering
Address	Princeton University, E-209A Engineering Quad, Princeton, NJ, 08544 Contact: cee@princeton.edu
Degree	Doctor of Philosophy in environmental engineering and water resources
Length	2 academic years (full time)
Requirement	eight courses, one being CEE 509 (required research course)
Website	http://www.princeton.edu/cee/graduate/degree_programs/
Courses Related to CCS	**CEE 599Topics- Enviro Eng'ing & Water Resources** (elective) A promising approach for reducing atmospheric carbon dioxide is geologic carbon sequestration (GCS), in which CO_2 is captured from power plants and injected into deep geologic formations. Widespread adoption of GCS will require a sound understanding of the processes that govern the fate of the injected CO_2. The course will examine these processes through coverage of the fundamental scientific and engineering principles relevant to GCS. The course will also examine these principles in the context of emerging government regulations for site selection, injection operations, and post-injection monitoring and stewardship.

Institution	**University of California, Los Angeles**
School	Department of Atmospheric and Oceanic Sciences
Address	Los Angeles, CA 90095-1565
Degree	Master of Science in Atmospheric and Oceanic Sciences Ph.D. in Atmospheric and Oceanic Sciences
Length	*M. Sc.:* 6 quarters (max. 9 quarters) *Ph.D:* 6 quarters
Requirement (courses)	M. Sc. and Ph.D: at least 9 courses (36 units), five (20 units) of which must be entry level graduate courses drawn from a list maintained by the department and chosen to ensure proper breadth and preparation. The minimum of 16 additional units of coursework are chosen, from the 200-series, to develop a specialization.
Website	http://www.atmos.ucla.edu/content/view/44/121/
Courses Related to CCS	**M235. Ocean Biogeochemical Dynamics and Climate (4)** (elective) (Same as Ecology and Evolutionary Biology M238.) Interaction of ocean biogeochemical cycles with physical climate system. Biogeochemical processes controlling carbon dioxide and oxygen in oceans and atmosphere over time-scales from few million years to several years. Anthropogenic perturbation of global carbon cycle and climate. Response of ocean ecosystems to past and future global changes. Use of isotopes to study ocean biogeochemical cycles and climate. Interactions between biogeochemical cycles on land and in ocean. S/U or letter grading.

Institution	University of Delaware
School	College of Earth, Ocean and Environment – Department of Geography
Address	Newark, DE 19716, USA
Degree	Master of Science in Geography
Length	
Requirement	24 course credits as well as a thesis (6 credits)
Website	http://www.ceoe.udel.edu/academics/geography/degree.shtml
Courses Related to CCS	**GEOG152 – Climate and Life (4hrs)** Introduction to those physical and biological processes that shape our climatic environment. Important themes include the exchanges of energy and mass between the atmosphere and both vegetation and built environments; and the influence of climate on humans and humans on climate. **GEOG236 - Conservation: Global Issues (3hr)** Introduces the global nature of resources management and discusses the relationships between population growth, the market economy, agricultural production and mineral and energy exploitation, worldwide. **GEOG417 - Seminar in Climate Change (3hr)** Examines facts and fallacies regarding global warming and climate science and assesses the current state of scientific understanding of and ability to forecast climate change.*Prerequisites*: GEOG101 or GEOG152 or GEOG220 or equivalent

Institution	University of Delaware
School	College of Earth, Ocean and Environment – Department of Geography
Address	Robinson Hall, Newark, DE 19716, USA
Degree	Ph. D. in Geography
Length	
Requirement	
Website	http://www.ceoe.udel.edu/academics/geography/degree.shtml
Courses Related to CCS	**GEOG152 – Climate and Life (4hrs)** Introduction to those physical and biological processes that shape our climatic environment. Important themes include the exchanges of energy and mass between the atmosphere and both vegetation and built environments; and the influence of climate on humans and humans on climate. **GEOG236 - Conservation: Global Issues (3hr)** Introduces the global nature of resources management and discusses the relationships between population growth, the market economy, agricultural production and mineral and energy exploitation, worldwide. **GEOG417 - Seminar in Climate Change (3hr)** Examines facts and fallacies regarding global warming and climate science and

	assesses the current state of scientific understanding of and ability to forecast climate change. *Prerequisites*: GEOG101 or GEOG152 or GEOG220 or equivalent

Institution	**University of Washington**
School	College of the Environment - Department of Earth and Space Sciences
Address	College of the Environment 131 ACC, Box 355679 Seattle, WA 98195-5679 coenv@u.washington.edu
Degree	M.S. or Ph.D. degrees (geological sciences and geophysics)
Length	M.S.: 2 years (max. 6 years) Ph.D. 5 years (max 10 years)
Requirement (courses)	36 credits (At least 18 credits must be in courses numbered 500 and above / 18 credits must be numerically graded in department approved 400-level courses accepted as part of the major and in 500-level courses. This excludes 498 and 499 and transfer credits) / including ESS 594 Introduction to ESS Research, and 599 ESS Seminar In the thesis option, a minimum of 36 credits must be earned; no more than 9 may be in Field Geology; at least 18 must be for courses numbered 400 and above, of which 9 must be thesis (Geology 700). In the non-thesis option, a minimum of 45 credits must be earned. At least 18 must be in courses numbered 400 and above, and no more than 9 may be in Field Geology.
Website	http://www.ess.washington.edu/ess/education/grad/degrees.html
Courses Related to CCS	**ESS 559 Climate Modeling (3)** (elective) Principles of Earth system modeling. Emphasis on atmosphere, ocean sea ice, and land-surface components. Climate forcing. Appropriate use of models. Topics of current interest including carbon cycle, atmosphere chemistry, and biogeochemistry. Prerequisite: either ATM S/OCEAN/ESS 587, ATM S 504 or ATM S 505. **ESS 585 Climate Impacts on the Pacific Northwest (4)** (elective) Knowledge of past/future patterns of climate to improve Pacific Northwest resource management. Topics include the predictability of natural/human-caused climate changes; past societal reactions to climate impacts on water, fish, forest, and coastal resources; how climate and public policies interact to affect ecosystems and society. **ESS 586 Current Research in Climate Change (2, max. 20)** (elective) Weekly lectures focusing on a particular aspect of climate (topic to change each year) from invited speakers (both UW and outside), plus one or two keynote speakers, followed by class discussion. **ESS 587 Climate Dynamics (3)** (elective) Examines Earth's climate system; distribution of temperature, precipitation, wind ice, salinity, and ocean currents; fundamental processes determining Earth's climate; energy and constituent transport mechanisms; climate sensitivity; natural climate variability on interannual to decadal time scales; global climate models; predicting future climate. **ESS 588 The Global Carbon Cycle and Climate (3)** (elective) Oceanic and terrestrial biogeochemical processes controlling atmospheric CO2 and other greenhouse gases. Records of past changes in the earth's carbon cycle from geological, oceanographic and terrestrial archives. Anthropogenic perturbations to cycles. Develop simple box models, discuss results of complex models.

Appendix II: Database of Doctorate and Master Programs in Europe

Institution	University of Copenhagen
School	Faculty of Law
Address	
Degree	Master of Law (LLM)
Length	
Requirement	
Website	
Courses Related to CCS/climate change	**Climate Change and the Law (10 ECTS**) The course is divided in three parts. The first part of the course covers the United Nations Framework Convention on Climate Change, the Kyoto Protocol and its flexibility mechanisms. Focus is put on developments, principles, competences and right and duties of the parties. Included are also the negotiations on post 2012 commitments, and to familiarise the students with various options for further developments the course will include a negotiation exercise to be executed by the end of the course. The second part of the course will focus on the European regime on climate change. It will cover the the EU regime on climate change, with a special focus on the European Union Emission Trading Scheme, its relevant regulation and case law and the relationship with other environmental legislation. The third part will focus on the energy law aspects connected to climate change. Energy consumption is one of the main causes of green house gasses emissions. This part of the course will cover legal challenges posed by the need to substitute fossil fuels with alternative sources, the need for energy savings, and the potential to render traditional carbon based consumption 'clean' by extracting CO2 for storage. **International Energy Law and Sustainability (10 ECTS)** <u>1. Introduction to the Energy and Environment Scene</u> • What is Energy Law? • Major energy sectors: Gas, oil, coal, renewables, nuclear, electricity, heat, and conservation. • Major energy activities: Production, transport, transmission, distribution, supply and trade. • The environmental impact of energy production and use: the air, the water, the subsoil, the landscape and the sea. • Institutional framework: International organizations, European Union institutions and national governments. <u>2. Policy Developments</u> • From extensive public intervention and control to market liberalisation and competition. • Increased cooperation and globalisation. • Energy security in an unsecure world. • The need to balance market philosophy against negative environmental consequences. • The Sustainability Revolution. <u>3. Regulatory Models and the Interaction Between Different Instruments</u> • The structure of the industry – public and private, monopoly and competition-exposed structures. • Allocation of rights and duties between the industry and the government. • Statutory regulation, licence systems, tendering, planning systems, negotiation

	systems, taxes and subsidies. 4. Application of Basic Principles of the EU Treaties to the Energy Sector • Free movement of goods, competition rules and State aids. • The Impact of International Environmental Law Principles on the Energy Sector. • Principle of Sustainable Development. 6. Exploration and Exploitation of Oil and Gas • The rights under international law of coastal and other states in the mineral resources of the oceans and the sea bed. • Licensing regimes - award and conditions - EU and national regulation. • State taking and Regulation of Resource Interests under international law. 7. Protection of the Environment in relation to Oil and Gas Activities • Environmental Impact Assesment. • Abandonment of offshore installations. 8. Electricity, Gas and Heat Supply and Trade • The internal energy market directives and regulations • Licence regimes - award and conditions. • Rights of transit and third party access to electricity and gas pipeline systems. • Public service obligations. • Price regulation. 9. Protection of the Environment in relation to Energy Supply and Use • Planning requirements • Green taxes and green certificates. • The regime on climate - the 1992 Climate Convention (UNFCCC), the 1997 Kyoto Protocol and the emission trading schemes 10. Renewables and energy efficiency. • Wind, solar and biofuels. • Public support and other regulatory instruments. 11. Energy Security. • Securing energy in an unstable world. • **Beyond the carbon economy – replacing oil and gas resources.** 12. The European Energy Charter Treaty • East-West treaty-based co-operation in the energy field. • Promotion of economic development and investment protection in Eastern Europe and Russia. • Legal rules governing investment protection conflicts.

Institution	**Technical University of Denmark**
School	Department of Chemical Engineering
Address	
Degree	MSc. Petroleum Engineering MSc. in Chemical and Biochemical Engineering
Length	2 years
Requirement	General Competence Courses (30 ECTS) + Technological Specialization Courses (30 ECTS) + Master Thesis (30 ECTS) + Elective Courses (30 ECTS)
Website	http://www.kt.dtu.dk/English/Uddannelse/Uddannelser/CBE_retning_DTU_K/CBE_retning_DTU_D.aspx
Courses Related to CCS/climate change	**28415 Oil and gas production (5 ECTS) – compulsory optional course (Technological Specialization Courses)** Properties and models of the porous rocks. Thermodynamic properties and phase equilibria of hydrocarbon mixtures. Laboratory studies of hydrocarbon mixtures (visiting the laboratories). Capillary forces and fluid distribution in porous space. Fluid distribution on the reservoir scale. Governing equations of flows in porous media. The Darcy Law. Inflow to an isolated well Steady and unsteady flows. The pressure conductivity equation. Well tests. Multiphase flows in porous media. Introduction to waterflooding and enhanced oil recovery. Visualization of the

	flows with the X-ray computer tomography scanner. Peculiarities of the Danish petroleum reservoirs. Overall picture of the world oil recovery. **28515 Enhanced Oil Recovery (5 ECTS) - compulsory optional course (Technological Specialization Courses)** Properties of reservoir fluids and porous rocks (repetition). Flow equations in porous media. Constituting dependencies: relative permeabilities, capillary pressure. Buckley-Leverett theory of waterflooding: fractional-flow function; Graphical solution of the Buckley-Leverett equation in one dimension; calculation of the basic parameters of oil recovery; systems of wells and streamlines; laboratory experiments on waterflooding, involving visualization with X-ray computer tomography; gravity; stability of waterflooding; effects of heterogeneity; miscible gas injection: minimum miscibility pressure, forward-, backward- and multicontact miscibility mechanisms, predictions and experiments; peculiarities of carbon dioxide injection and water-alternate-gas flooding; chemical flooding; in situ combustion; microbial flooding.

Institution	**University of Paris X – Nanterre la Défense**
School	
Address	Master 1 : Bât.G - Bureau R40.4 / Phone:. 01 40 97 70 78 Master 2 : Bât.G - Bureau 313C / Phone: 01 40 97 78 14
Degree	Master of Science – Professional Management, Economics Mention: Environmental Economics and Energy Speciality: Economics and politics of energy and environment
Length	2 years (4 semesters)
Requirement	
Website	http://www.u-paris10.fr/servlet/com.jsbsoft.jtf.core.SG
Courses Related to CCS/climate change	The energy sector offers young graduates career opportunities for which training in energy conservation is highly desirable. This course intends to respond combining different approaches: market analysis and strategies of actors in the energy, financial analysis applied to the energy sector, the state of the art basic techniques of energy systems, management of energy projects. It brings together skills in economics and energy policy in the Paris region by bringing together the formation of the Ecole Nationale Superieure du Petrole et des Moteurs (IFP School) and provided jointly by the National Institute of Nuclear Science and Technology (INSTN) and the University of Paris Ouest Nanterre. The training will also benefit from the skills of the French Petroleum Institute (IFP) and the Commissariat a l'Energie Atomique (CEA). Lessons take place in Paris Ouest Nanterre, INSTN-CEA (Saclay) and the IFP School, IFP (Rueil Malmaison).

Institution	**University of Oslo**
School	Department of Economics
Address	Moltke Moes vei 31, Eilert Sundts house, 12th floor Phone: +47 22855127 Fax: +47 22855035 E-mail: post@econ.uio.no
Degree	Master of Philosophy in Economics – Environmental, Resource- and Development economics (specialization)
Length	2 years

Requirement	Pre requirement: Bachelor's degree in Economics, or equivalent. 120 credits (9courses) + master's thesis (30 credits), in which five courses are compulsory and four courses are optional
Website	http://www.sv.uio.no/econ/english/
Courses Related to CCS/climate change	ECON4910: Environmental Economics (10 credits) – **optional compulsory course** The course gives a systematic analysis of environmental issues using microeconomic theory. The topics covered include elements of welfare economics, theories of environmental policy instruments, valuation of environmental goods, dynamic aspects of environmental issues, and international aspects of environmental issues. You will be given a thorough introduction to analyses of environmental policy instruments, with particular emphasis on situations with uncertainty and/or asymmetric information and on situations with other market failures. The international dimension of environmental economics covers both the case in which the environmental problem itself is international and the case in which there may be other reasons for international co-ordination of environmental policies. The climate problem will be given particular emphasis.

Institution	**University College Dublin (UCD)**
School	College of Engineering, Mathematical and Physical Sciences
Address	UCD, Belfield, Dublin 4, Ireland. Tel : 353-1-716 4043 Email: oran.orua@ucd.ie
Degree	Master Energy Systems Engineering
Length	Duration full time: 1 Year / 2 Years
Requirement	
Web site	http://www.ucd.ie/graduatestudies/collegesandschools/graduateschools/engineeringmathematicalandphysicalsci/
Courses Related to CCS/climate change	*Compulsory:* Energy Systems & Climate Change Chemical Processes of Sustainable and Renewable Energy Fossil Fuels, Carbon Capture & Storage *Elective:* Power System Engineering Energy in Transport

Institution	**Norwegian University of Science and Technology (NTNU)**
School	Faculty of Engineering Science and Technology Department of Petroleum Engineering and Applied Geophysics
Address	Faculty of Engineering Science and Technology 7491 Trondheim N – Norway PHONE: + 47 73 59 49 25

	TELEFAX: + 47 73 94 44 72 E-MAIL: studier@ivt.ntnu.no
Degree	MSc in Petroleum Engineering - MSG1
Length	2 years
Requirement	
Website	
Courses Related to CCS/climate change	**TPG4150 - Reservoir Recovery Techniques (7.5 ECTS) - compulsory** The course addresses internal and external energy sources for reservoir production, and analysis of their influence on recovery of oil and gas from the various types of reservoirs. Topics: Oil, gas and condensate reservoir systems; microscopic and macroscopic displacement efficiency; natural drive mechanisms; injection of water and gas; material balance analysis; flow equations; simplified recovery estimation methods. **TPG4117 - Unconventional Oil and Gas Reservoirs (7.5 ECTS) – optional for spec. in Reservoir Engineering** Unconventional oil and gas resources like very viscous oil and gas from low-permeability rocks, coal bed, and hydrates, will assume greater roles in meeting world energy demands. This course will include classification of resources, geologic and geographic occurrences, recovery technology and economics of unconventional hydrocarbon resources. Methods for hydrocarbon recovery based on drilling of wells will be emphasized. Various methods for recovery of viscous oil; cold production, thermal recovery and more advanced methods for improved oil recovery will be presented in detail.

Institution	**Norwegian University of Science and Technology (NTNU)**
School	Faculty of Engineering Science and Technology Department of Petroleum Engineering and Applied Geophysics
Address	Faculty of Engineering Science and Technology 7491 Trondheim N – Norway PHONE: + 47 73 59 49 25 TELEFAX: + 47 73 94 44 72 E-MAIL: studier@ivt.ntnu.no
Degree	MSc. in Petroleum Geosciences (MSG2)
Length	2 years
Requirement	
Website	www.ntnu.no/studies/msc-petroleumengineering-geosciences
Courses Related to CCS/climate change	**TPG4150 - Reservoir Recovery Techniques (7.5 ECTS) - optional** The course addresses internal and external energy sources for reservoir production, and analysis of their influence on recovery of oil and gas from the various types of reservoirs. Topics: Oil, gas and condensate reservoir systems; microscopic and macroscopic displacement efficiency; natural drive mechanisms; injection of water and gas; material balance analysis; flow equations; simplified recovery estimation methods.

Institution	Norwegian University of Science and Technology (NTNU)
School	Faculty of Engineering Science and Technology Department of Energy and Process Engineering (EPT)
Address	NTNU, Kolbjørn Hejes v 1B, 7491 Trondheim PHONE: (+47) 73 59 38 60 FAX: (+47) 73 59 35 80 E-mail: international@adm.ntnu.no
Degree	MSc. in Natural Gas Technology **→ Specialization option: Thermal power Cycles including CO2 capture**
Length	2 years
Requirement	Pre Requirement: BSc or equivalent in Mechanical or Chemical Engineering
Website	www.ntnu.no/studies/msc-natural-gastechnology
Courses Related to CCS/climate change	**→ Specialization option: Thermal power Cycles including CO2 capture**

Institution	Norwegian University of Science and Technology (NTNU)
School	Faculty of Engineering Science and Technology
Address	
Degree	PhD in Energy and Process Engineering
Length	3 years (full-time)
Requirement	study and research totalling 180 credits.
Website	
Courses Related to CCS/climate change	**Research fields** Area 1: Thermal Energy → Airpolution and CO2 capture Thermal energy group: Thermal Power Cycles, including CO2 capture Application of gas turbines, steam turbines and heat recovery steam generators for power generation and in cogeneration. Integration of thermal power cycles with other types of processes, like natural gas processing plants, oil refineries, methanol production plants, LNG-plants. Power cycles with CO2 capture are focused. In particular pre-combustion options based on for example high-temperature membrane technology, and oxy-fuel options are part of our activity. The methodology is modeling and simulation of unit operations and cycles, both steady-state and dynamic performance. Tools being used are GTPRO/GTMASTER, IPSEPro, PRO/II, Hysis and gPROMS.

Institution	Norwegian University of Science and Technology (NTNU)
School	Faculty of Engineering Science and Technology Department of Petroleum Engineering and Applied Geophysics
Address	Petroleumsteknisk senter, 2. etasje, S.P. Andersens veg 15A Lerkendal og Valgrinda Phone: 73 59 49 25

Degree	PhD.
Length	
Requirement	
Website	
Courses Related to CCS/climate change	**PG8604 - Enhanced Oil Recovery (7.5 ECTS) – Study level: Doctoral degree level** The subject is enhanced oil recovery (EOR) used to improve recovery beyone that expected by pressure depletion. Water injection, hydrocarbon (HC) gas injection, and combined water/gas injection (WAG) are the most common EOR methods used in the industry today. Other EOR methods (typically more expensive and technically more complicated) covered are non-hydrocarbon (CO_2 and N2) injection, compositional effects e.g vaporization, and developed miscibility, both in conventional reseervoirs and natrually fractured reservoirs. The course will primarily consider reservoir aspects of EOR methods using HC gas and water injection. Key parameters include microscopic (pore-level) recovery, areal and vertical sweep efficiency. Variations in reservoir rock – i.e. heterogeneities – and fluid property variations with depth can have a strong influence on the success of EOR methods. Therefore we will concentrate on accurate geologic and fluid description and its influence on recovery.

Institution	**Norwegian University of Science and Technology (NTNU)**
School	Faculty of Engineering Science and Technology Department of Petroleum Engineering and Applied Geophysics
Address	Petroleumsteknisk senter, 2. etasje, S.P. Andersens veg 15A Lerkendal og Valgrinda Phone: 73 59 49 25
Degree	PhD.
Length	
Requirement	
Website	
Courses Related to CCS/climate change	**PG8604 - Enhanced Oil Recovery (7.5 ECTS) – Study level: Doctoral degree level** The subject is enhanced oil recovery (EOR) used to improve recovery beyone that expected by pressure depletion. Water injection, hydrocarbon (HC) gas injection, and combined water/gas injection (WAG) are the most common EOR methods used in the industry today. Other EOR methods (typically more expensive and technically more complicated) covered are non-hydrocarbon (CO2 and N2) injection, compositional effects e.g vaporization, and developed miscibility, both in conventional reseervoirs and natrually fractured reservoirs. The course will primarily consider reservoir aspects of EOR methods using HC gas and water injection. Key parameters include microscopic (pore-level) recovery, areal and vertical sweep efficiency. Variations in reservoir rock – i.e. heterogeneities – and fluid property variations with depth can have a strong influence on the success of EOR methods. Therefore we will concentrate on accurate geologic and fluid description and its influence on recovery. →There is no specification of the PhD Program in which this course is related to in the Univesity website.

Institution	**Delft University of Technology (TUD)**
School	Faculty of Civil Engineering and Geosciences (CiTG) Department of Geotechnology
Address	Faculty of Civil Engineering and Geosciences (CEG) Stevinweg 1 2628 CN Delft Tel.: +31 (0)15 27 85440
Degree	MSc Applied Earth Sciences - track Petroleum Engineering and Geosciences (specialization Petroleum Engineering)
Length	2 years (full-time)
Requirement	120 Credits: 52 ECTS: Compulsory courses + 13 ECTS: Convergence courses / Elective + 44 ECTS: Thesis + 9 ECTS Field Development Project + 1 ECTS Company Visits / Excursion + 1 ECTS Colloquium *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://citg.home.tudelft.nl/en/
Courses Related to CCS	**AES1340 - Applied Reservoir Engineering & Simulation, part I (2 ECTS) -** Compulsory Material Balance,Determination of Oil Water contact; Well testing, Productivity Index; Waterflooding; EOR; Reservoir Simulation; Black Oil Model; Numerical Control; Well Models; **AES1350 - Applied Reservoir Engineering & Simulation, part II (2 ECTS) -** Compulsory Material Balance,Determination of Oil Water contact; Well testing, Productivity Index; Waterflooding; EOR; Reservoir Simulation; Black Oil Model; Numerical Control; Well Models **WM0916TA - Special Topics Geotechnology and Sustainable Development (2ECTS) -** Elective In the second quarter of the course year a series of lectures will be held around the theme of geotechnology and sustainable development. The series will start with a kick off meeting, informing students on sustainable development and geotechnology and the possibility to obtain a certificate for a specialization Technology in Sustainable Development. See also graduation specialization in sustainable development elsewhere in the MSc course guide. Students are given the possibility to follow these lectures and write an essay on one of the subjects of the lectures. In the essay a certain technology and the relation of the technology to sustainable development and society will have to be discussed, paying close attention to the technical issues, but also to actors, their views and opinions, and a solution direction, incorporating all elements studied. The topics of the essay can vary from CO_2 injection in coal layers or empty gas fields to the use of the shallow subsurface for heat and cold storage.

Institution	**Delft University of Technology (TUD)**
School	Faculty of Civil Engineering and Geosciences (CiTG) Department of Geotechnology
Address	Faculty of Civil Engineering and Geosciences (CEG) Stevinweg 1 2628 CN Delft T. : Tel. : +31 (0)15 27 85440
Degree	MSc Applied Earth Sciences - track Petroleum Engineering and Geosciences (specialization Reservoir Geology)

Length	2 years (full-time)
Requirement	120 Credits: 54 ECTS: Compulsory courses + 12 ECTS: Convergence Courses / Elective + 44 ECTS: Thesis + 9 ECTS Field Development Project+ 1 ECTS Colloquium *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://citg.home.tudelft.nl/en/
Courses Related to CCS	**AES1340 - Applied Reservoir Engineering & Simulation, part I (2 ECTS) -** Compulsory Material Balance,Determination of Oil Water contact; Well testing, Productivity Index; Waterflooding; EOR; Reservoir Simulation; Black Oil Model; Numerical Control; Well Models;

Institution	**Delft University of Technology (TUD)**
School	Faculty of Civil Engineering and Geosciences (CiTG) Department of Geotechnology
Address	Faculty of Civil Engineering and Geosciences (CEG) Stevinweg 1 2628 CN Delft T. : Tel. : +31 (0)15 27 85440
Degree	MSc Applied Earth Sciences – track Resource Engineering (Specialization Geotechnical and Environmental Engineering - EGEC)
Length	2 years
Requirement	120 Credits: 60 ECTS: Compulsory courses + 15 ECTS: Elective courses + 44 ECTS: Thesis + 1 ECTS Colloquium *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://citg.home.tudelft.nl/en/
Courses Related to CCS	**EGEC-M/EG** - **(Miskolc) Environmental Geology & Geophysics** (2007)- Compulsory Main goal of this course is to give a general overview on the most important applied environmental-mining geology and geophysics. * Environmental-Geology Block: Geology and the environment. The system approach. Interactions of hyumand and the geological environment. Natural hazards. Geological resources and management. Contamination of soil and water. Environmental mineralogy. ARD and mine waste environmental geology. The phenomenon and its environmental consequences. Basic chemistry of the process. Minerals in the acidrock drainage - acid producing and neutralizing capacities. Sampling of rock outcrops and waste dumps to forecast ARD behaviour. Acid-base-accounting ABA procedure. Static and kinetic tests. Interpretation of test results. Case studies. The carbon cycle. Effects of CO_2 emission on climate. CO_2 capture and transport. Storage reservoir characteristics. Transport of fluids in rocks. Physical, chemical and mineralogical trapping of CO_2. Geological storage sites. Current CO_2 storage activities. Risks and monitoring. Economics and legal aspects. Case studies. * Environmental-Geophysics Block: General overview on the most important near-surface, borehole and in-mine geophysical methods. Methods and their applications: magnetic, DC-, EM- and IP, seismic refractions, guided waves, borehole nuclear. acoustic, -density methods. Special in-mine seamwave- and seamsounding methods. Planning of survey, data aquisition, data processing, geophysical inversion, geological-, geotechnical-, environmental- and in-mine interpretations. Field measurements over a waste site. Individual processing and interpretation of the collected geophysical data by commercial and in Miskolc developed special software. → This course is given at University of Miskolc **EGEC-W/UW - (Wroclaw) Underground Waste Management (2ECTS)** - Compulsory Underground waste management includes the scientific and technical work necessary to provide safe and economic means for long- term waste management protecting men and environment from the harmfull effects of toxic substances. Procedures and

	methods adopted to address future needs will be nation- or programme specific. Waste management activities are at the interface to technical, public and political affairs. To fullfill the mentioned requirements the lecture is devided into two parts, the industrial and radioactive wastes. The waste cycle is introduced, starting with underground production and the environmental effects of mining: mine waste, acid mine drainage, process wastes; flooding and dewatering. After using and recycling the raw material, there is always a rest of material left for final disposal near-surface or underground. The hazardous waste disposal is discussed for land disposal and underground disposal. Waste disposal during mining presents the same problems as disposal for other industries. Potential wastes can include waste rock with potentially reactive minerals. The disposal of concentrated wastes, which requires special handling, and disposal of large volumes of low concentration will be differently handled. Underground disposal covers the mine as an operating or abandoned mine or planned as an underground disposal mine. Advantages and disadvantages from new mines as storage sites and from inactive mines as waste sites will be given. Possible pathways and leakages of the underground openings will be discussed as well as effective barriers. Within the disposal of liquid waste in permeable formations/aquifers the injection of CO_2 is included. It covers the options for storing CO_2, the capture and storage systems, the storage risks and the costs. The second part of the lecture covers management concepts for the disposal of environmetally hazardous waste as low, medium and high level radioactive waste. Laws and regulations in Germany and other countries , final disposal and emplacement in deep geological formations in mines, caverns or deep boreholes. The emplacement procedure, the drift and borehole disposal will be explained under aspects of type and volume of radioactive waste material to be disposed of, available repository formations, protection objectives and applicable regulations. A final disposal strategy is based on safety and technical as well as economic feasibility. ➔ This course is given at Wroclaw University of Technology. ** Resource Engineering M.Sc. is offered through a joint programme run by TU Delft and 5 other universities in Europe, united in the FEMP (the Federation of European Mineral Programs)

Institution	**<u>University of Amsterdam</u> (UvA)**
School	Master School of Life and Earth sciences
Address	Education Office Exact Sciences and Earth Sciences Nieuwe Achtergracht 166 1018 WV Amsterdam Building C, second floor, tel: 020- 525 7100
Degree	MSc. Earth Sciences – Environmental Management
Length	2 years full-time or part-time study
Requirement	120 EC (courses + thesis) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.studeren.uva.nl/msc_earth_sciences/
Courses Related to CCS	**AW4230 – Climate Change (6 EC of 12 EC) – Optional from the "Optional compulsory courses list"** Climate is an important boundary condition for natural ecosystems and human societies. Climate change causes stress on natural ecosystems and provides challenges (and sometimes opportunities) for human society. In the past climate has changed due to several natural factors. Nowadays human activities are also interfering with climate and causing extra climate change. This course seeks to deepen your knowledge about climatology, meteorology and climate change by studying the relevant literature and writing an essay or carrying out a small research project.

	If the student has little prior knowledge of meteorology and climatology the course starts by discussing the basic principles of meteorology. These will be applied to the problem of climate change. The course van be done as a 6 EC course or a 12 EC course. In the case of a 6 EC course an essay will be written on a subject related to climate change. In the case of a 12 EC course the student will do a small research project. **Paleo-ecology and Global Change (6 EC)** - Optional from the "Optional compulsory courses list"

Institution	**University of Amsterdam (UvA)**
School	Master School of Life and Earth sciences
Address	Education Office Exact Sciences and Earth Sciences Nieuwe Achtergracht 166 1018 WV Amsterdam Building C, second floor, tel: 020- 525 7100
Degree	MSc. Earth Sciences – Geo-Ecological Dynamics
Length	2 years full-time or part-time study
Requirement	120 EC (courses + thesis) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.studeren.uva.nl/msc_earth_sciences/
Courses Related to CCS	**AW4230 – Climate Change (6 EC of 12 EC) – Elective** Climate is an important boundary condition for natural ecosystems and human societies. Climate change causes stress on natural ecosystems and provides challenges (and sometimes opportunities) for human society. In the past climate has changed due to several natural factors. Nowadays human activities are also interfering with climate and causing extra climate change. This course seeks to deepen your knowledge about climatology, meteorology and climate change by studying the relevant literature and writing an essay or carrying out a small research project. If the student has little prior knowledge of meteorology and climatology the course starts by discussing the basic principles of meteorology. These will be applied to the problem of climate change. The course van be done as a 6 EC course or a 12 EC course. In the case of a 6 EC course an essay will be written on a subject related to climate change. In the case of a 12 EC course the student will do a small research project.

Institution	**University of Amsterdam (UvA)**
School	Amsterdam Graduate Law School
Address	Secretariat Department of International Law Oudemanhuispoort 4-6 +31 20 5252632
Degree	LLM International and European Law - Public International Law
Length	1 year
Requirement	60 EC (Compulsory courses 20 EC + Elective courses 30 EC + thesis 10 EC) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.studeren.uva.nl/ma_public_international_law/object.cfm/2C2BE22E-1321-B0BE-685EADD5F89F9F57

Courses Related to CCS	**M2420 - International Environmental Law (5 EC)** - Elective International Environmental Law is a relatively new field of international law. It developed in particular after the 1972 Stockholm Conference on the Human Environment. The course is designed to provide a general orientation of the subject. The following issues will be addressed: • Principles of international environmental law • Living natural resources • Non-living natural resources • Climate change • Transboundary movement of hazardous substances • Liability for environmental damage • Compliance with international environmental agreements Although the issues will be introduced by lecturer, the active participation of students is expected in discussions and simulations.

Institution	**University of Groningen**
School	Faculty of Law
Address	Faculty of Law, University of Groningen P.O. Box 716 9700 AS Groningen, Netherlands Telephone: +31 50 363 5243 Fax: +31 50 363 7408 E-mail: LLM@rug.nl Visiting address: Turftorenstraat 21, room 67, 9712 BM Groningen, Netherlands
Degree	Master of Laws (LL.M) in International Law and the Law of International Organizations
Length	One year (full-time)
Requirement	At least 60 credits* = 1 compulsory course (6 credits) + 4 optional compulsory courses (24 credits) + at least 6 credits of optional courses + a seminar (6 credits) and the writing of a thesis(18 credits). *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.rug.nl/rechten/informatievoor/foreign/llm/il/index
Courses Related to CCS	**International Environmental Law (seminar, 6 credits)** – Optional from the "Optional compulsory courses list" This practical module on international environmental law is aimed at providing students with an understanding – i.e. developing a helicopter view – of this field of international law and developing practical skills by writing a paper and giving a presentation. This module deals with the legal aspects of environmental protection, with particular emphasis on protection of the marine environment. Main events and developments are analysed, highlighting the relevance of the Stockholm Conference of 1972, the Rio Conference on environment and development of 1992 and the Johannesburg Conference of 2002. The main topics to be discussed include the history and basic principles of international environmental law and sustainable development; transboundary pollution; marine pollution; liability questions; the protection of biodiversity; climate change; the protection of the Arctic and Antarctica; waste disposal. Students are expected to play an active role in this module, e.g. by writing and defending a paper of approx. 2,500 words on a specific topic. **Energy Law (5 credits) -** Elective The course on energy law provides an overview of the organizational and

	regulatory framework applying to the European and Dutch energy sector. The focus will be on the production and supply of energy (oil, gas and electricity) and the impact of the European liberalization process. The course focuses on the legal regime applying to the energy sector. The sector is currently being re-regulated as a result of the liberalization process which has been taking place in the EU since the 1990s. This process has a major impact on the way in which the production, transmission and supply of electricity and gas is organized and regulated. Another important development concerns the aspect of global warning resulting from the use of fossil fuels. The course will therefore also consider the regulatory attempts to limit the use of fossil fuels by stimulating the application of renewable energy sources and the development of a (international) system of emission trading. The following subjects will be discussed: - The exploration and production of oil and gas onshore and offshore in Netherlands and elsewhere in Europe - The liberalization of the European energy sector - The entry into force in Netherlands of the Electricity Act and Gas Act implementing the EU Electricity and Gas Directives. - The relationship between the State and the energy industry - The development of sustainable energy sources such as offshore wind energy - The (possible) privatization of the energy sector - Emission trading

Institution	**University of Groningen**
School	Faculty of Law
Address	Faculty of Law, University of Groningen P.O. Box 716 9700 AS Groningen, Netherlands Telephone: +31 50 363 5243 Fax: +31 50 363 7408 E-mail: LLM@rug.nl Visiting address: Turftorenstraat 21, room 67, 9712 BM Groningen, Netherlands
Degree	Master of Laws (LL.M) in European Law
Length	One year (full-time)
Requirement	At least 60 credits* = 4 compulsory courses (24 credits) + 2 optional courses (at least 12 credits) + a seminar (6 credits) + thesis(18 credits). *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.rug.nl/rechten/informatievoor/foreign/llm/il/index
Courses Related to CCS	**International Environmental Law (seminar - 6 credits)** – Elective This module deals with the legal aspects of environmental protection, with particular emphasis on protection of the marine environment. Main events and developments are analysed, highlighting the relevance of the Stockholm Conference of 1972, the Rio Conference on environment and development of 1992 and the Johannesburg Conference of 2002. The main topics to be discussed include the history and basic principles of international environmental law and sustainable development; transboundary pollution; marine pollution; liability questions; the protection of biodiversity; climate change; the protection of the Arctic and Antarctica; waste disposal. **Energy Law (5 credits) -** Elective The course on energy law provides an overview of the organizational and regulatory framework applying to the European and Dutch energy sector. The focus will be on the production and supply of energy (oil, gas and electricity) and the impact of the

	European liberalization process. The course focuses on the legal regime applying to the energy sector. The sector is currently being re-regulated as a result of the liberalization process which has been taking place in the EU since the 1990s. This process has a major impact on the way in which the production, transmission and supply of electricity and gas is organized and regulated. Another important development concerns the aspect of global warning resulting from the use of fossil fuels. The course will therefore also consider the regulatory attempts to limit the use of fossil fuels by stimulating the application of renewable energy sources and the development of a (international) system of emission trading. The following subjects will be discussed: - The exploration and production of oil and gas onshore and offshore in the Netherlands and elsewhere in Europe - The liberalization of the European energy sector - The entry into force in the Netherlands of the Electricity Act and Gas Act implementing the EU Electricity and Gas Directives. - The relationship between the State and the energy industry - The development of sustainable energy sources such as offshore wind energy - The (possible) privatization of the energy sector - Emission trading These subjects will be discussed on the basis of lectures and tutorials. At the end of the course there will be a written exam. Students are also required two write a paper during the course. The result of the paper is included in the final result. **European Environmental Law (6 credits)** - Elective This course deals with the development of European environmental law and policy from its inception in the early 70's until today. While the main focus will be on European environmental law, the interactions between the latter and the international and national legal orders and general European law will also be examined. The following topics will be covered: - The development and principles of European environmental law - Legal basis of European environmental law, internal and external competence - Harmonisation and implementation of European environmental law - Legal protection in European environmental law - Free trade and environmental protection - Competition policy and the environment - Substantive European environmental law; horizontal legislation - Substantive European environmental law; sectoral legislation - Current topics in European environmental law

Institution	**University of Utrecht**
School	Faculty of Geosciences
Address	Departement of Earth Sciences Budapestlaan 4, 3584 CD Utrecht *Post address*: P.O. Box 80.021, 3508 TA Utrecht Tel: (030) 253 50 50 / Fax: (030) 253 50 30 E: info@geo.uu.nl Marketing and Communication of the Faculty of Geosciences Telephone: +31 (0)30 253 5116 Email: mscinfo@geo.uu.nl
Degree	MSc. Earth Sciences - Geology (specialization Sedimentary Systems)
Length	2 years (full-time)

Requirement	120 Credits (60 ECTS Courses, including a fieldwork programme in Spain or laboratory work + 30-60 ECTS MSc research project and/or traineeship + 0-30 ECTS courses) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.uu.nl/EN/informationfor/internationalstudents/geology/Pages/study.aspx
Courses Related to CCS	**GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS)** – Compulsory (for Specialization in Sedimentary Systems) (Palaeo)ocean circulation during different climatic regimes and related proxy variability will be discussed while sequentially introducing different concepts and aspects during the first 7 weeks. In particular the Glacial world will be contrasted to the (present-day) Interglacial, and compared to high-frequency (e.g. El-Nino) palaeoceanographic and proxies variations. Amongst the aspects to be discussed are: Glacial climate and its forcing; sediment dating techniques; palaeoproductvity; pCO_2 reconstruction; oxygenation; sea surface temperature; deep water circulation; and proxy preservation. Theory and application of marine proxies is illustrated by relevant case studies. General academic skills such as written presentations will be trained. On the basis of realistic scientific data, students are trained to identify, interpret and reconstruct paleoclimate and variations there in. This is a fundamental exercise for independent scientific research in the field of paleoceanography and paleoclimatology. **GEO4-1412 – Astronomical climate forcing & time scales (7.5 ETCS)** – Compulsory (for Specialization in Sedimentary Systems) Paleoclimatic research dedicated to unravel natural climate variability is becoming increasingly important especially in view of current global warming. Astronomical forced climate change related to the Earth's orbital parameters represent a crucial and integral part of the natural behavior of the climate system in the past on millennial to million year time scales. Paleoclimate studies has solved the problem of the Ice Ages and focused on the orbital theory of the Monsoon. In this course we will focus on climate forcing by the Earth's orbital parameters computed by means of astronomical solutions for the Solar System. In addition, we will focus on the use of (Milankovitch) cycles to construct geological time scales with an unprecedented resolution and accuracy that are necessary for climate studies of the past and on mathematical methods to statistically detect cyclic variability in paleoclimate records. The course is divided in two parts that are intricately linked: A) *Astronomical time scales and their applications:* Introduction and astronomical solutions; Time scale development and spectral analysis; Ar/Ar dating and geodynamic linkages; Cyclostratigraphy and link to sequence stratigraphy. B) *Astronomical forcing of climate:* Astronomical forcing and phase relations; Climate modelling of orbital variations; Sub-Milankovitch cyclicity. **GEO4-1420 - Organic geochemistry (7.5 ETCS) - Elective** *Biochemistry, Organic molecules and Sources of organic matter:* Chemical evolution of organic molecules, Big Bang, nucleosynthesis, isotopes, origin of life; Biological evolution of organic compounds: Phylogenetic tree of life, DNA/RNA, symbioses theory; Methane the simplest organic molecule; Membranes: Lipid biochemistry, different lipids, i.e. fatty acids, alkanes, acyclic isoprenoids, steroids, terpenoids; Macromolecules: sugars, proteins and peptides, resins, lignins, biopolyesters, biopolymers. *Preservation and the Quality of organic matter:* Chemical stability versus depositional environment, chemical taphonomy; Preservation models: neogenesis, selective preservation, in-situ polymerization; Export productivity, Oxygen exposure time (OET); Marine versus terrigenous sources; Preservation versus production; Sulphur and Oxygen incorporation. *Diagenesis, catagenesis and fossil fuel formation:* Diagenetic transformation reactions; Chemical transformation reactions during catagenesis; Coalification; Oil and gas formation: oil exploration and oil exploitation. *Molecular palaeontology:* Biomarkers: molecular markers based on carbon skeleton,

	position and nature of functional groups and/or stable carbon isotope composition. Biological markers as indicators of evolution of Life on earth. Age-related biomarkers: Molecular proxies for palaeoenvironmental and palaeoclimate reconstructions: sea surface temperatures, photic zone anoxia, anaerobic methane oxidation, C3/C4 vegetation shifts, atmospheric pCO_2 changes.

Institution	**University of Utrecht**
School	Faculty of Geosciences
Address	Departement of Earth Sciences Budapestlaan 4, 3584 CD Utrecht Post address: P.O. Box 80.021, 3508 TA Utrecht Tel: (030) 253 50 50 / Fax: (030) 253 50 30 E: info@geo.uu.nl Marketing and Communication of the Faculty of Geosciences Telephone: +31 (0)30 253 5116 Email: mscinfo@geo.uu.nl
Degree	MSc. Earth Sciences - Geochemistry
Length	2 years (full-time)
Requirement	120 Credits (60 ECTS –courses + 30-60 ECTS - MSc research projects/traineeship + optional courses) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	www.uu.nl/EN/informationfor/internationalstudents/geochemistry/Pages/study.aspx
Courses Related to CCS	**GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS)** - Optional from a 2 optional-compulsory courses list (Palaeo)ocean circulation during different climatic regimes and related proxy variability will be discussed while sequentially introducing different concepts and aspects during the first 7 weeks. In particular the Glacial world will be contrasted to the (present-day) Interglacial, and compared to high-frequency (e.g. El-Nino) palaeoceanographic and proxies variations. Amongst the aspects to be discussed are: Glacial climate and its forcing; sediment dating techniques; palaeoproductvity; pCO2 reconstruction; oxygenation; sea surface temperature; deep water circulation; and proxy preservation. Theory and application of marine proxies is illustrated by relevant case studies. General academic skills such as written presentations will be trained. On the basis of realistic scientific data, students are trained to identify, interpret and reconstruct paleoclimate and variations there in. This is a fundamental exercise for independent scientific research in the field of paleoceanography and paleoclimatology. **GEO4-1420 - Organic geochemistry (7.5 ETCS) - Compulsory** *Biochemistry, Organic molecules and Sources of organic matter:* Chemical evolution of organic molecules, Big Bang, nucleosynthesis, isotopes, origin of life; Biological evolution of organic compounds: Phylogenetic tree of life, DNA/RNA, symbioses theory; Methane the simplest organic molecule; Membranes: Lipid biochemistry, different lipids, i.e. fatty acids, alkanes, acyclic isoprenoids, steroids, terpenoids; Macromolecules: sugars, proteins and peptides, resins, lignins, biopolyesters, biopolymers. *Preservation and the Quality of organic matter:* Chemical stability versus depositional environment, chemical taphonomy; Preservation models: neogenesis, selective preservation, in-situ polymerization; Export productivity, Oxygen exposure time (OET); Marine versus terrigenous sources; Preservation versus production; Sulphur and Oxygen incorporation. *Diagenesis, catagenesis and fossil fuel formation:* Diagenetic transformation

	reactions; Chemical transformation reactions during catagenesis; Coalification; Oil and gas formation: oil exploration and oil exploitation. D) *Molecular palaeontology:* Biomarkers: molecular markers based on carbon skeleton, position and nature of functional groups and/or stable carbon isotope composition. Biological markers as indicators of evolution of Life on earth. Age-related biomarkers: Molecular proxies for palaeoenvironmental and palaeoclimate reconstructions: sea surface temperatures, photic zone anoxia, anaerobic methane oxidation, C3/C4 vegetation shifts, atmospheric pCO_2 changes. **GEO4- 4423 – Hydrology, climate change and fluvial systems *(7.5 ETCS)*** - elective Traditionally, the terrestrial part of the hydrological cycle is mainly studied by hydrologists while the atmospheric part is left to atmospheric science. As a consequence, apart from the study of evaporation, the two sciences have shown but limited interaction. The last two decades however, have shown an increased interest in climate change an its impacts, not only by the atmospheric science community, but also by hydrologists. The first studies on hydrology and climate that were performed by hydrologists mainly focussed on the impact of climate change and variability on the water balance and river discharge. Recently, atmospheric scientist have turned more and more to hydrology to come up with better land-atmosphere parameterisations in order to improve climate models and weather prediction. These developments together have led to an almost separate hydrological discipline called ?climate hydrology? where hydrological systems are viewed as part of the climate system being both influenced by climate change and variability, as well as constraining the climate system through positive and negative feedbacks. The study of the hydrological cycle in the context of the climate system has developed sufficiently to warrant a self contained course on the subject. **GEO4-1412 – Astronomical climate forcing & time scales (7.5 ETCS)** – Elective Paleoclimatic research dedicated to unravel natural climate variability is becoming increasingly important especially in view of current global warming. Astronomical forced climate change related to the Earth¿s orbital parameters represent a crucial and integral part of the natural behavior of the climate system in the past on millennial to million year time scales. Paleoclimate studies has solved the problem of the Ice Ages and focused on the orbital theory of the Monsoon. In this course we will focus on climate forcing by the Earth¿s orbital parameters computed by means of astronomical solutions for the Solar System. In addition, we will focus on the use of (Milankovitch) cycles to construct geological time scales with an unprecedented resolution and accuracy that are necessary for climate studies of the past and on mathematical methods to statistically detect cyclic variability in paleoclimate records. The course is divided in two parts that are intricately linked: A) *Astronomical time scales and their applications:* Introduction and astronomical solutions; Time scale development and spectral analysis; Ar/Ar dating and geodynamic linkages; Cyclostratigraphy and link to sequence stratigraphy. B) *Astronomical forcing of climate:* Astronomical forcing and phase relations; Climate modelling of orbital variations; Sub-Milankovitch cyclicity.

Institution	**University of Utrecht**
School	Faculty of Geosciences
Address	Department of Earth Sciences Budapestlaan 4, 3584 CD Utrecht *Post address*: P.O. Box 80.021, 3508 TA Utrecht Tel: (030) 253 50 50/Fax: (030) 253 50 30 E: info@geo.uu.nl

	Marketing and Communication of the Faculty of Geosciences Telephone: +31 (0)30 253 5116 Email: mscinfo@geo.uu.nl
Degree	MSc. Earth Sciences - Hydrology (specialization Earth Surface Hydrology)
Length	2 years (full-time)
Requirement	120 Credits: Courses (45-60 ECTS) + MSc research project (30-60 ECTS) + Optional: internship (15-30 ECTS) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.uu.nl/EN/informationfor/internationalstudents/hydrology/studyprogramme/Pages/default.aspx
Courses Related to CCS	**GEO4- 4423 – Hydrology, climate change and fluvial systems (7.5 ETCS)** – Compulsory for specialization in Earth Surface Hydrology Traditionally, the terrestrial part of the hydrological cycle is mainly studied by hydrologists while the atmospheric part is left to atmospheric science. As a consequence, apart from the study of evaporation, the two sciences have shown but limited interaction. The last two decades however, have shown an increased interest in climate change an its impacts, not only by the atmospheric science community, but also by hydrologists. The first studies on hydrology and climate that were performed by hydrologists mainly focussed on the impact of climate change and variability on the water balance and river discharge. Recently, atmospheric scientist have turned more and more to hydrology to come up with better land-atmosphere parameterisations in order to improve climate models and weather prediction. These developments together have led to an almost separate hydrological discipline called ?climate hydrology? where hydrological systems are viewed as part of the climate system being both influenced by climate change and variability, as well as constraining the climate system through positive and negative feedbacks. The study of the hydrological cycle in the context of the climate system has developed sufficiently to warrant a self contained course on the subject. **GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS)** - Elective (Palaeo)ocean circulation during different climatic regimes and related proxy variability will be discussed while sequentially introducing different concepts and aspects during the first 7 weeks. In particular the Glacial world will be contrasted to the (present-day) Interglacial, and compared to high-frequency (e.g. El-Nino) palaeoceanographic and proxies variations. Amongst the aspects to be discussed are: Glacial climate and its forcing; sediment dating techniques; palaeoproductvity; pCO2 reconstruction; oxygenation; sea surface temperature; deep water circulation; and proxy preservation. Theory and application of marine proxies is illustrated by relevant case studies. General academic skills such as written presentations will be trained. On the basis of realistic scientific data, students are trained to identify, interpret and reconstruct paleoclimate and variations there in. This is a fundamental exercise for independent scientific research in the field of paleoceanography and paleoclimatology. **GEO4-1420 - Organic geochemistry (7.5 ETCS) - Elective** *Biochemistry, Organic molecules and Sources of organic matter:* Chemical evolution of organic molecules, Big Bang, nucleosynthesis, isotopes, origin of life; Biological evolution of organic compounds: Phylogenetic tree of life, DNA/RNA, symbioses theory; Methane the simplest organic molecule; Membranes: Lipid biochemistry, different lipids, i.e. fatty acids, alkanes, acyclic isoprenoids, steroids, terpenoids; Macromolecules: sugars, proteins and peptides, resins, lignins, biopolyesters, biopolymers. *Preservation and the Quality of organic matter:* Chemical stability versus depositional environment, chemical taphonomy; Preservation models: neogenesis, selective preservation, in-situ polymerization; Export productivity, Oxygen exposure time (OET); Marine versus terrigenous sources; Preservation versus production; Sulphur

	and Oxygen incorporation. *Diagenesis, catagenesis and fossil fuel formation:* Diagenetic transformation reactions; Chemical transformation reactions during catagenesis; Coalification; Oil and gas formation: oil exploration and oil exploitation. D) *Molecular palaeontology:* Biomarkers: molecular markers based on carbon skeleton, position and nature of functional groups and/or stable carbon isotope composition. Biological markers as indicators of evolution of Life on earth. Age-related biomarkers: Molecular proxies for palaeoenvironmental and palaeoclimate reconstructions: sea surface temperatures, photic zone anoxia, anaerobic methane oxidation, C3/C4 vegetation shifts, atmospheric pCO_2 changes. **GEO4-1412 – Astronomical climate forcing & time scales (7.5 ETCS)** – Elective Paleoclimatic research dedicated to unravel natural climate variability is becoming increasingly important especially in view of current global warming. Astronomical forced climate change related to the Earth¿s orbital parameters represent a crucial and integral part of the natural behavior of the climate system in the past on millennial to million year time scales. Paleoclimate studies has solved the problem of the Ice Ages and focused on the orbital theory of the Monsoon. In this course we will focus on climate forcing by the Earth¿s orbital parameters computed by means of astronomical solutions for the Solar System. In addition, we will focus on the use of (Milankovitch) cycles to construct geological time scales with an unprecedented resolution and accuracy that are necessary for climate studies of the past and on mathematical methods to statistically detect cyclic variability in paleoclimate records. The course is divided in two parts that are intricately linked: A) *Astronomical time scales and their applications:* Introduction and astronomical solutions; Time scale development and spectral analysis; Ar/Ar dating and geodynamic linkages; Cyclostratigraphy and link to sequence stratigraphy. B) *Astronomical forcing of climate:* Astronomical forcing and phase relations; Climate modelling of orbital variations; Sub-Milankovitch cyclicity.

Institution	**University of Utrecht**
School	Faculty of Geosciences
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Degree	MSc. Earth Sciences - Biogeology
Length	2 years (full-time)
Requirement	120 Credits: Courses (45-60 ECTS) + MSc research project (30-60 ECTS) + Optional: internship (15-30 ECTS) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.uu.nl/EN/informationfor/internationalstudents/biogeology/Pages/study.aspx
Courses Related to CCS	**GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS)** - Elective (Palaeo)ocean circulation during different climatic regimes and related proxy variability will be discussed while sequentially introducing different concepts and aspects during the first 7 weeks. In particular the Glacial world will be contrasted to the (present-day) Interglacial, and compared to high-frequency (e.g. El-Nino) palaeoceanographic and proxies variations. Amongst the aspects to be discussed

	are: Glacial climate and its forcing; sediment dating techniques; palaeoproductvity; pCO2 reconstruction; oxygenation; sea surface temperature; deep water circulation; and proxy preservation. Theory and application of marine proxies is illustrated by relevant case studies. General academic skills such as written presentations will be trained. On the basis of realistic scientific data, students are trained to identify, interpret and reconstruct paleoclimate and variations there in. This is a fundamental exercise for independent scientific research in the field of paleoceanography and paleoclimatology. **GEO4-1412 – Astronomical climate forcing & time scales (7.5 ETCS)** – Optional from a 2/3 optional-compulsory courses list Paleoclimatic research dedicated to unravel natural climate variability is becoming increasingly important especially in view of current global warming. Astronomical forced climate change related to the Earth¿s orbital parameters represent a crucial and integral part of the natural behavior of the climate system in the past on millennial to million year time scales. Paleoclimate studies has solved the problem of the Ice Ages and focused on the orbital theory of the Monsoon. In this course we will focus on climate forcing by the Earth¿s orbital parameters computed by means of astronomical solutions for the Solar System. In addition, we will focus on the use of (Milankovitch) cycles to construct geological time scales with an unprecedented resolution and accuracy that are necessary for climate studies of the past and on mathematical methods to statistically detect cyclic variability in paleoclimate records. The course is divided in two parts that are intricately linked: A) *Astronomical time scales and their applications:* Introduction and astronomical solutions; Time scale development and spectral analysis; Ar/Ar dating and geodynamic linkages; Cyclostratigraphy and link to sequence stratigraphy. B) *Astronomical forcing of climate:* Astronomical forcing and phase relations; Climate modelling of orbital variations; Sub-Milankovitch cyclicity. **B-MABP.. Advanced Botanical Paleoecology – Extreme Climate Transitions -** Optional from a 2/3 optional-compulsory courses list

Institution	**University of Utrecht**
School	Faculty of Geosciences
Address	Departement of Earth Sciences Budapestlaan 4, 3584 CD Utrecht *Post address*: P.O. Box 80.021, 3508 TA Utrecht Tel: (030) 253 50 50 / Fax: (030) 253 50 30 E: info@geo.uu.nl Marketing and Communication of the Faculty of Geosciences Telephone: +31 (0)30 253 5116 Email: mscinfo@geo.uu.nl
Degree	MSc. Earth Sciences - Physical Geography (specialization: Coastal Dynamics and Fluvial Systems) MSc. Earth Sciences - Physical Geography (specialization: Natural Hazards and Earth Observation)
Length	2 years (full-time)
Requirement	120 Credits: Courses (min. 45 ECTS) + MSc research project and fieldtrip (45 ECTS) + Individual programme which can include a traineeship (max. 30 ECTS) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.uu.nl/EN/informationfor/internationalstudents/physicalgeography/studyprogramme/Pages/default.aspx
Courses Related to	**GEO4- 4423 – Hydrology, climate change and fluvial systems (7.5 ETCS)** – Optional from a 3/6 optional-compulsory courses list

CCS	Traditionally, the terrestrial part of the hydrological cycle is mainly studied by hydrologists while the atmospheric part is left to atmospheric science. As a consequence, apart from the study of evaporation, the two sciences have shown but limited interaction. The last two decades however, have shown an increased interest in climate change an its impacts, not only by the atmospheric science community, but also by hydrologists. The first studies on hydrology and climate that were performed by hydrologists mainly focussed on the impact of climate change and variability on the water balance and river discharge. Recently, atmospheric scientist have turned more and more to hydrology to come up with better land-atmosphere parameterisations in order to improve climate models and weather prediction. These developments together have led to an almost separate hydrological discipline called ?climate hydrology? where hydrological systems are viewed as part of the climate system being both influenced by climate change and variability, as well as constraining the climate system through positive and negative feedbacks. The study of the hydrological cycle in the context of the climate system has developed sufficiently to warrant a self contained course on the subject. **GEO4- 4430 Advanced Course in Quaternary Geology and Climate Change (7.5-15 ETCS)** - Elective **GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS)** - Elective (Palaeo)ocean circulation during different climatic regimes and related proxy variability will be discussed while sequentially introducing different concepts and aspects during the first 7 weeks. In particular the Glacial world will be contrasted to the (present-day) Interglacial, and compared to high-frequency (e.g. El-Nino) palaeoceanographic and proxies variations. Amongst the aspects to be discussed are: Glacial climate and its forcing; sediment dating techniques; palaeoproductvity; pCO2 reconstruction; oxygenation; sea surface temperature; deep water circulation; and proxy preservation. Theory and application of marine proxies is illustrated by relevant case studies. General academic skills such as written presentations will be trained. On the basis of realistic scientific data, students are trained to identify, interpret and reconstruct paleoclimate and variations there in. This is a fundamental exercise for independent scientific research in the field of paleoceanography and paleoclimatology. **GEO4-1420 - Organic geochemistry (7.5 ETCS) - Elective** *Biochemistry, Organic molecules and Sources of organic matter:* Chemical evolution of organic molecules, Big Bang, nucleosynthesis, isotopes, origin of life; Biological evolution of organic compounds: Phylogenetic tree of life, DNA/RNA, symbioses theory; Methane the simplest organic molecule; Membranes: Lipid biochemistry, different lipids, i.e. fatty acids, alkanes, acyclic isoprenoids, steroids, terpenoids; Macromolecules: sugars, proteins and peptides, resins, lignins, biopolyesters, biopolymers. *Preservation and the Quality of organic matter:* Chemical stability versus depositional environment, chemical taphonomy; Preservation models: neogenesis, selective preservation, in-situ polymerization; Export productivity, Oxygen exposure time (OET); Marine versus terrigenous sources; Preservation versus production; Sulphur and Oxygen incorporation. *Diagenesis, catagenesis and fossil fuel formation:* Diagenetic transformation reactions; Chemical transformation reactions during catagenesis; Coalification; Oil and gas formation: oil exploration and oil exploitation. D) *Molecular palaeontology:* Biomarkers: molecular markers based on carbon skeleton, position and nature of functional groups and/or stable carbon isotope composition. Biological markers as indicators of evolution of Life on earth. Age-related biomarkers: Molecular proxies for palaeoenvironmental and palaeoclimate reconstructions: sea surface temperatures, photic zone anoxia, anaerobic methane oxidation, C3/C4 vegetation shifts, atmospheric pCO_2 changes.

Institution	**University of Utrecht**
School	Faculty of Geosciences
Address	Departement of Earth Sciences Budapestlaan 4, 3584 CD Utrecht *Post address*: P.O. Box 80.021, 3508 TA Utrecht Tel: (030) 253 50 50 / Fax: (030) 253 50 30 E: info@geo.uu.nl
Degree	MSc. Earth Sciences - Physical Geography (specialization: Quaternary Geology and Climate Change)
Length	2 years (full-time)
Requirement	120 Credits: Courses (min. 45 ECTS) + MSc research project and fieldtrip (45 ECTS) + Individual programme which can include a traineeship (max. 30 ECTS) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.uu.nl/EN/informationfor/internationalstudents/physicalgeography/studyprogramme/Pages/default.aspx
Courses Related to CCS	**GEO4- 4423 – Hydrology, climate change and fluvial systems (7.5 ETCS)** – Compulsory Traditionally, the terrestrial part of the hydrological cycle is mainly studied by hydrologists while the atmospheric part is left to atmospheric science. As a consequence, apart from the study of evaporation, the two sciences have shown but limited interaction. The last two decades however, have shown an increased interest in climate change an its impacts, not only by the atmospheric science community, but also by hydrologists. The first studies on hydrology and climate that were performed by hydrologists mainly focussed on the impact of climate change and variability on the water balance and river discharge. Recently, atmospheric scientist have turned more and more to hydrology to come up with better land-atmosphere parameterisations in order to improve climate models and weather prediction. These developments together have led to an almost separate hydrological discipline called ?climate hydrology? where hydrological systems are viewed as part of the climate system being both influenced by climate change and variability, as well as constraining the climate system through positive and negative feedbacks. The study of the hydrological cycle in the context of the climate system has developed sufficiently to warrant a self contained course on the subject. **GEO4-4430 Advanced Course in Quaternary Geology and Climate Change (7.5-15 ETCS)** - Elective **GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS)** - Elective (Palaeo)ocean circulation during different climatic regimes and related proxy variability will be discussed while sequentially introducing different concepts and aspects during the first 7 weeks. In particular the Glacial world will be contrasted to the (present-day) Interglacial, and compared to high-frequency (e.g. El-Nino) palaeoceanographic and proxies variations. Amongst the aspects to be discussed are: Glacial climate and its forcing; sediment dating techniques; palaeoproductvity; pCO2 reconstruction; oxygenation; sea surface temperature; deep water circulation; and proxy preservation. Theory and application of marine proxies is illustrated by relevant case studies. General academic skills such as written presentations will be trained. On the basis of realistic scientific data, students are trained to identify, interpret and reconstruct paleoclimate and variations there in. This is a fundamental exercise for independent scientific research in the field of paleoceanography and paleoclimatology. **GEO4-1420 - Organic geochemistry (7.5 ETCS) - Elective** A) Biochemistry, Organic molecules and Sources of organic matter: Chemical

	evolution of organic molecules, Big Bang, nucleosynthesis, isotopes, origin of life; Biological evolution of organic compounds: Phylogenetic tree of life, DNA/RNA, symbioses theory; Methane the simplest organic molecule; Membranes: Lipid biochemistry, different lipids, i.e. fatty acids, alkanes, acyclic isoprenoids, steroids, terpenoids; Macromolecules: sugars, proteins and peptides, resins, lignins, biopolyesters, biopolymers. B) Preservation and the Quality of organic matter: Chemical stability versus depositional environment, chemical taphonomy; Preservation models: neogenesis, selective preservation, in-situ polymerization; Export productivity, Oxygen exposure time (OET); Marine versus terrigenous sources; Preservation versus production; Sulphur and Oxygen incorporation. C) Diagenesis, catagenesis and fossil fuel formation: Diagenetic transformation reactions; Chemical transformation reactions during catagenesis; Coalification; Oil and gas formation: oil exploration and oil exploitation. D) Molecular palaeontology: Biomarkers: molecular markers based on carbon skeleton, position and nature of functional groups and/or stable carbon isotope composition. Biological markers as indicators of evolution of Life on earth. Age-related biomarkers: Molecular proxies for palaeoenvironmental and palaeoclimate reconstructions: sea surface temperatures, photic zone anoxia, anaerobic methane oxidation, C3/C4 vegetation shifts, atmospheric pCO_2 changes.

Institution	**University of Utrecht**
School	Graduate School of Natural Sciences and Faculty of Science
Address	Faculty of Science Budapestlaan 6 3584 CD Utrecht tel: (030) 253 3686 / (030) 253 4628 e-mail: science.bureau@uu.nl
Degree	MSc. Energy Science → This Master's programme is officially registered under the name Science and Business (code 60710).
Length	2 years (full-time)
Requirement	120 Credits: 52.5 ECTS compulsory courses, 15 ECTS elective courses and 67.5 ECTS of research projects and practical work. *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	www.uu.nl/EN/informationfor/internationalstudents/energyscience/Pages/study.aspx
Courses Related to CCS	**GEO4-2311 – SUSD - Energy and Resources Policies (7.5 ECTS)** - Compulsory A great variety of policies and measures are implemented by governments and others to promote the sustainable production and use of energy and other resources. Important questions addressed in this course are: how do these policies and measures work?, are these instruments effective? and do they lead to the targets in an efficient way? This course combines the theory and methods of policy analysis with its practical application to energy and resources policies. First, this course provides insight into the main methods of policy analysis such as policy theory, stakeholder analysis, impact assessment, cost effectiveness analysis and cost benefit analysis. In parallel, the practical application to energy and resources policies will be developed. A range of policy instruments will be discussed, including labelling, standard-setting, taxes and subsidies, emission trading, and voluntary agreements. How do these instruments work? Where are they applied? For what sectors were they effective? What are the undesired side-effects? What developments do we see in the application of these instruments? Special attention will be also paid to the history and the international context of these policies, including the ever more important European Union context and the United Nations Framework Convention on Climate Change (Kyoto protocol). In several assignment and exercises you will learn to apply the methods to analyse

	the impact of energy and resources policies: e.g. assignment on the reconstruction of policy theory; assignment evaluating an impact assessment study, exercises on cost benefit analysis, exercises on the economics of pollution control. **GEO4-2307 –SUSD - Research Methods for Energy and Materials (7.5 ECTS)** - Compulsory A variety of information is needed to evaluate and judge the impacts and performance of different technologies and options for production of energy, materials, for waste treatment and many other. The performance of these options is to be expressed in the emissions per unit of product, the efficiency of the process, the costs, the perspectives on longer term (can the technology be improved and if yes, what development trajectory does that require?). Furthermore, the impacts of deploying different technologies in a (national) economy can vary from jobs generated, to impacts on GDP or changes in the attractiveness of using alternatives for the energy supply system as a whole. Finally, from a diverse information basis it is a challenge to compose an integral picture and give well-founded recommendations about the technology or process in question. This course addresses those questions in a very practical way. You will learn to use a diverse set of important research methods to assess a variety of impacts of technologies and systems and actually deploy those methods yourselves by doing concrete assignments, using literature, databases and by building spreadsheet tools. Also, you are asked to give proper argumentation for conclusions that may be drawn from the outcomes, supported by proper sensitivity analyses. Examples of cases are: production of alternative fuels for the transport sector from biomass, underground storage of CO_2 in deep coal layers, energy efficiency in the food industry, the perspectives of wind energy, recycling of plastics, etc. Concrete, the course covers: - Understanding and using the concept of technological learning for analyzing and prediction the development and performance of technologies over time - Process analysis by setting up energy and mass balances and simple performance calculations of complex technologies, using principles from Life Cycle Analyses and process technology. - Economic analyses of technologies and systems, using basic knowledge from cost engineering. - Proper use of energy and other statistics for comparing and analyzing performance of e.g. economic sectors. - Using Input/Output analysis as a tool to evaluate impacts on a national economy, e.g. impacts on GDP and jobs generated by deploying different technologies - Using a case study, a life cycle analysis is performed with the help of the computer tool Simapro. - Using (simple) Multi-Criteria Analysis as a system to combine very different types of information to provide an integrated evaluation. An important goal of the course is to give insight in the strong and weak points of these research methods and how to deal with uncertainties. You must be able to understand limitations of the methods and data-inputs used and their consequences for conclusions that can be drawn on basis of results produced. **NS-MO501M - NS-Simulation of Ocean, Atmosphere and Climate (7.5 ECTS)** – Elective **NS-MO440M - NS-Topics in Climate Science (7.5 ECTS)** – Elective

Institution	**University of Utrecht**
School	School of Law Faculty of Law, Economics & Governance
Address	Utrecht University School of Law Janskerkhof 3

	Utrecht 3512 BK, Netherlands Tel: +31 (0)30 253 7004
Degree	LLM (Master of Laws) Public International Law → This Master's programme is officially registered under the name International and European Law (code 66829).
Length	1 year
Requirement	60 Credits: 4 compulsory courses and a master thesis (45 ECTS) + 2 courses from a list (15 ECTS) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	www.uu.nl/EN/informationfor/internationalstudents/publicinternationallaw/Pages/study.aspx
Courses Related to CCS	**RGMAIN450 - International Environmental Law (7.5 ECTS)** - Compulsory The course aims to provide a thorough understanding of the theoretical and practical aspects of international environmental law. Students will obtain a good basic knowledge of the subject, learn about the practical application of international law to specific environmental issues and develop legal and practical skills through the simulations. The course is designed to provide students with firsthand experience of international environmental law in practice. Several guest lectures will be given by practitioners and the practical skills of students will be trained in reality-based simulations. The course starts with a general introduction into the subject and then continues with a series of lectures addressing specific environmental issues of international concern. The general introduction covers the historical development and main sources of international environmental law, key actors and the particularities of the process of law-making and law-enforcement in this field. It also covers the most important general rules and principles of international environmental law and the concept of sustainable development. The course will then focus on several substantive issues and the associated multilateral environmental agreements and/or applicable rules of customary international law. These issues include the protection of the atmosphere (air pollution, ozone depletion and climate change), international watercourses, the oceans, biodiversity and nature conservation, and the polar regions. The course will also address several horizontal issues including responsibility and liability for environmental damage and the relationship between trade and the environment. **RGMAIN750 - International Law of the Sea (7.5 ECTS)** – Optional (Choice of one course out of three options) Subjects covered in the course are centered at the United Nations Convention on the Law of the Sea of 1982 (UNCLOS) providing a comprehensive global framework for all peaceful uses of the sea and legal regulations of the various maritime spaces (baselines, internal waters, archipelagic waters, territorial sea, contiguous zone, 200-mile zones, continental shelf and deep sea-bed/high seas) and the activities conducted within them, such as navigational uses, oil and gas exploitation, fishing, protection of the marine environment and marine scientific research. Also covered are issues of equitable maritime delimitation and peaceful settlement of disputes.

Institution	**VU University Amsterdam**
School	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology
Address	Faculty of Earth and Life Sciences - Vrije Universitet De Boelelaan 1085-1087 1081 HV Amsterdam , Netherlands Phone: +31 (0)20 59 87000 / Fax: +31 (0)20 646 2457 E-mail: falw@falw.vu.nl
Degree	MSc Environment and Resource Management - specialization in Environmental Studies
Length	12 months

Requirement	60 credits* = 48 credits of compulsory courses, supplemented with 12 credits chosen from core optional packages A or B. *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.falw.vu.nl/en/
Courses Related to CCS	**468020 - Environmental Economics (6 credits)** - Compulsory This module aims to give an overview of basic economic concepts and principles from economic welfare theory applied to the environment. A critical cause of environmental problems is that not all costs due to economic production and consumption are borne by those responsible for generating them. This problem will be conceptualised in this course through the notion of externalities. There are various economic policy instruments and institutional-economic arrangements for addressing such externalities. Criteria for their selection and evaluation will be discussed. Cost-benefit analysis is an important economic evaluation method. Particular attention will be paid to the economic valuation of environmental change in cost-benefit analysis. Economic sustainability concepts and sustainable economic growth, equity and poverty will also be addressed from local to global scale, including the externalities associated with international trade across different economic sectors and environmental domains such as climate change, water, energy, waste, forestry, fisheries, and biodiversity. **468022 - Environmental Problems: Case Studies (6 credits) -** Compulsory Two present-day, practical but complex environmental issues will be used as cases: Spatial planning in the Vecht area - water management and nature development / Climate change and development. These cases have been selected to address an increase in spatial scale, because of their need of multidisciplinary inputs, and because they cover important policy themes that feature in national and European policy texts. The first case will highlight contrasting interests among stakeholders in a complex spatial planning context. The Vecht area is a well-studied landscape where urban development, recreation, agriculture, and nature conservation require a balanced planning. Future needs in terms of water quantity and quality interfere with these needs. In the second case, the effects of climate change in developing countries will be discussed. Beyond the physically apparent changes, i.e. sea level rise and altered regional precipitation patterns, socio-economic consequences and international dependencies will be addressed. This course is linked with the course Climate and Policy. **450188 - Climate and Policy (6 credits)** – Compulsory International policy on human-induced climate change and its mitigation is a hotly debated subject. Current international climate policy is the result of a complex and long-lasting negotiation process. In this process, the science of the complex earth and climate system is closely mixed with questions on socio-economic effects of climate change, options for global environmental governance as determined by the structure of international organizations, international economical and political relations and environmental law. These close relations between earth system research and economic/political questions make this course an interesting subject for students with diverse backgrounds. The course include: - an overview of climate change, its impacts (IPCC Fourth Assessment - Report) uncertainties, mitigation, adaptation; - options for global environmental governance, environmental law, environmental policy negotiations, the role of international organizations (governmental and non-governmental) and the role of developed vs. developing countries; The Climate Change Convention, the Kyoto Protocol, flexible mechanisms (Emission trading, Clean Development Mechanisms) and options for Post Kyoto measures.

Institution	VU University Amsterdam
School	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology
Address	Faculty of Earth and Life Sciences - Vrije Universitet De Boelelaan 1085-1087 1081 HV Amsterdam , Netherlands Phone: +31 (0)20 59 87000 / Fax: +31 (0)20 646 2457 E-mail: falw@falw.vu.nl
Degree	MSc Environment and Resource Management - specialization in Energy Studies
Length	12 months
Requirement	60 credits = 48 credits of compulsory courses, supplemented with 12 credits for the specialization of choice *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.falw.vu.nl/en/prospective-students/Masters-programs/environment-and-resource-management/study-programme/index.asp
Courses Related to CCS	**468020 - Environmental Economics** (6 credits) - Compulsory This module aims to give an overview of basic economic concepts and principles from economic welfare theory applied to the environment. A critical cause of environmental problems is that not all costs due to economic production and consumption are borne by those responsible for generating them. This problem will be conceptualised in this course through the notion of externalities. There are various economic policy instruments and institutional-economic arrangements for addressing such externalities. Criteria for their selection and evaluation will be discussed. Cost-benefit analysis is an important economic evaluation method. Particular attention will be paid to the economic valuation of environmental change in cost-benefit analysis. Economic sustainability concepts and sustainable economic growth, equity and poverty will also be addressed from local to global scale, including the externalities associated with international trade across different economic sectors and environmental domains such as climate change, water, energy, waste, forestry, fisheries, and biodiversity.

Institution	VU University Amsterdam
School	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology
Address	Faculty of Earth and Life Sciences - Vrije Universitet De Boelelaan 1085-1087 1081 HV Amsterdam , Netherlands Phone: +31 (0)20 59 87000 / Fax: +31 (0)20 646 2457 E-mail: falw@falw.vu.nl
Degree	MSc Palaeoclimatology & Geo-ecosystems
Length	24 months
Requirement	120 credits (optional: 18 credits) / Bachelor's degree in Earth Sciences from the Vrije Universiteit Amsterdam or Examination Board will control the level of knowledge and application skills of each individual student from other inter/-national universities *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.vu.nl/en/programs/international-masters/programs/n-q/paleoclimatology-and-geoecosystems-msc/index.asp
Courses Related to	**450188 - Climate and Policy (6 credits)** – Compulsory International policy on human-induced climate change and its mitigation is a hotly

CCS	debated subject. Current international climate policy is the result of a complex and long-lasting negotiation process. In this process, the science of the complex earth and climate system is closely mixed with questions on socio-economic effects of climate change, options for global environmental governance as determined by the structure of international organizations, international economical and political relations and environmental law. These close relations between earth system research and economic/political questions make this course an interesting subject for students with diverse backgrounds. The course include: - an overview of climate change, its impacts (IPCC Fourth Assessment - Report) uncertainties, mitigation, adaptation; - options for global environmental governance, environmental law, environmental policy negotiations, the role of international organizations (governmental and non-governmental) and the role of developed vs. developing countries; The Climate Change Convention, the Kyoto Protocol, flexible mechanisms (Emission trading, Clean Development Mechanisms) and options for Post Kyoto measures. **450004 - Climate Modelling (6 credits) -** Compulsory Geological archives show convincingly that the climate system experiences variability on a wide range of time-scales. For Quaternary studies, climate variations at the following time-scales are most important: glacials-interglacials, millennia and centuries-decades. This course focuses at the mechanisms behind these variations, thereby using climate models as a tool, i.e. numerical computer models in which the dynamics of the climate system are calculated. The combination of these models and geological data will be treated extensively. The course consists of lectures giving an overview of climate models and their application (different types for different time-scales) and of discussion meetings, in which students discuss the recent literature in detail. In this way the course considers case studies for the different time-scales and deals with recent developments in climate modelling. The following two questions are central to the course: 1) What is the driving mechanism behind climate change at a particular time-scale? 2) How can we optimise the combination of climate models and geological data in order to increase our understanding of climate evolution? **450146 - From Source to Sink: Chemical and Physical Cycles (6 credits) -** Compulsory This course deals with the parameters regulating the production, transfer and storage of sediments and solutes from their sources to their sinks, addressing short-term and long-term landscape evolution and sustainability. It covers the linked processes of tectonics, weathering, erosional systems (fluvial, glacial, marine) and climate changes (including 'real-world' examples on the SE Netherlands, the Ardennes and Pyrenees) as well as the methods to constrain these processes (e.g. provenance studies and thermochronology). Lecturers from variety of disciplines will teach the students how to view these topics from various backgrounds. **450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits)** – Compulsory This course addresses the various climate processes and events which shaped the development of actual mankind and the influence man takes on climate. Questions to be addressed are : • How did climate shape the development of *Homo sapiens*? • Did changing climate cause the extermination of various cultures? • Natural versus anthropogenic climate change. Future perspectives.

	450185 - Modern Climate Systems (3 credits) - Compulsory This introductory course gives a (short) overview into the physical and chemical processes driving the atmosphere and the ocean. First the basic parameters and properties will be described, followed by examples for the formation and circulation of air and water masses. The different climatic regions of the world from the poles to the tropics will be highlighted and various compounds and features of the climate systems like the monsoon, ENSO and NAO systems will be explained. This knowledge of the modern climate processes forms the basis for understanding Climate Change today and in the past. **450313 - Modern Geo-ecosystems (3 credits)** – Compulsory This introductory course gives a (short) overview into the interactions between the geo-, bio-, hydro- and atmosphere. The interaction between modern climate systems and important processes like rock weathering, soil formation, sediment erosion-transport-deposition will be highlighted, and illustrated (partly in the field) for a selected number of modern terrestrial and marine geo-ecosystems. The focus is on those processes relevant for understanding how modern climate and climate change are affecting the various modern geo-ecosystems. **450266** - **Practical: Palaeoclimate Change and Environmental Impacts (3 credits)** - Compulsory The practical comprises a series of lab classes, discussion meetings, concluded by a series of meetings during which the obtained results will be written up in a research report. During the practical a marine and a terrestrial sediment core/section will be investigated. The research includes core description, defining sampling strategy, basic sample processing, determination of micropaleontological, palynological, geochemical and geophysical properties, and data analysis. The emphasis will be on both long-term climate change (glacial-interglacial time scale) and on millennial-scale climate change records (e.g., Heinrich events, deglaciation). **450330 - Sedimentary Environments and Climate Archives (6 credits)** - Compulsory The course deals with the sedimentology, geochemistry and/or ecology of marine, coastal, fluvial, lacustrine, eolian, and periglacial environments that record climate changes. The focus is on those processes relevant for understanding how climate change is recorded in the various environments. In addition, the susceptibility of key aspects of those environments to climate-change impacts will be addressed. The course is subdivided into: • Terrestrial/coastal archives and proxies • Marine archives and proxies • Capita selecta. These will be incorporated into both parts.

Institution	**VU University Amsterdam**
School	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology
Address	Faculty of Earth and Life Sciences - Vrije Universitet De Boelelaan 1085-1087 1081 HV Amsterdam , Netherlands Phone: +31 (0)20 59 87000 / Fax: +31 (0)20 646 2457 E-mail: falw@falw.vu.nl
Degree	MSc. Earth Sciences (specialization: Applied Environmental Geoscience)
Length	24 months
Requirement	120 credits (83 credits of compulsory components and 37 credits of free elective options) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS

Website	http://www.falw.vu.nl/en/prospective-students/Masters-programs/earth-sciences/index.asp
Courses Related to CCS	**450185 - Modern Climate Systems (3 credits)** - Compulsory This introductory course gives a (short) overview into the physical and chemical processes driving the atmosphere and the ocean. First the basic parameters and properties will be described, followed by examples for the formation and circulation of air and water masses. The different climatic regions of the world from the poles to the tropics will be highlighted and various compounds and features of the climate systems like the monsoon, ENSO and NAO systems will be explained. This knowledge of the modern climate processes forms the basis for understanding Climate Change today and in the past. **450313 - Modern Geo-ecosystems (3 credits)** – Compulsory This introductory course gives a (short) overview into the interactions between the geo-, bio-, hydro- and atmosphere. The interaction between modern climate systems and important processes like rock weathering, soil formation, sediment erosion-transport-deposition will be highlighted, and illustrated (partly in the field) for a selected number of modern terrestrial and marine geo-ecosystems. The focus is on those processes relevant for understanding how modern climate and climate change are affecting the various modern geo-ecosystems. **450146 - From Source to Sink: Chemical and Physical Cycles (6 credits) -** Compulsory This course deals with the parameters regulating the production, transfer and storage of sediments and solutes from their sources to their sinks, addressing short-term and long-term landscape evolution and sustainability. It covers the linked processes of tectonics, weathering, erosional systems (fluvial, glacial, marine) and climate changes (including 'real-world' examples on the SE Netherlands, the Ardennes and Pyrenees) as well as the methods to constrain these processes (e.g. provenance studies and thermochronology). Lecturers from variety of disciplines will teach the students how to view these topics from various backgrounds. **450266** - **Practical: Palaeoclimate Change and Environmental Impacts (3 credits)** - Compulsory The practical comprises a series of lab classes, discussion meetings, concluded by a series of meetings during which the obtained results will be written up in a research report. During the practical a marine and a terrestrial sediment core/section will be investigated. The research includes core description, defining sampling strategy, basic sample processing, determination of micropaleontological, palynological, geochemical and geophysical properties, and data analysis. The emphasis will be on both long-term climate change (glacial-interglacial time scale) and on millennial-scale climate change records (e.g., Heinrich events, deglaciation). **450330 - Sedimentary Environments and Climate Archives (6 credits)** - Compulsory The course deals with the sedimentology, geochemistry and/or ecology of marine, coastal, fluvial, lacustrine, eolian, and periglacial environments that record climate changes. The focus is on those processes relevant for understanding how climate change is recorded in the various environments. In addition, the susceptibility of key aspects of those environments to climate-change impacts will be addressed. The course is subdivided into: • Terrestrial/coastal archives and proxies • Marine archives and proxies Capita selecta. These will be incorporated into both parts. **450004 - Climate Modelling (6 credits) -** Elective Geological archives show convincingly that the climate system experiences variability on a wide range of time-scales. For Quaternary studies, climate variations at the following time-scales are most important: glacials-interglacials, millennia and

	centuries-decades. This course focuses at the mechanisms behind these variations, thereby using climate models as a tool, i.e. numerical computer models in which the dynamics of the climate system are calculated. The combination of these models and geological data will be treated extensively. The course consists of lectures giving an overview of climate models and their application (different types for different time-scales) and of discussion meetings, in which students discuss the recent literature in detail. In this way the course considers case studies for the different time-scales and deals with recent developments in climate modelling. The following two questions are central to the course: 1) What is the driving mechanism behind climate change at a particular time-scale? 2) How can we optimize the combination of climate models and geological data in order to increase our understanding of climate evolution? **450188 - Climate and Policy (6 credits)** – Elective International policy on human-induced climate change and its mitigation is a hotly debated subject. Current international climate policy is the result of a complex and long-lasting negotiation process. In this process, the science of the complex earth and climate system is closely mixed with questions on socio-economic effects of climate change, options for global environmental governance as determined by the structure of international organizations, international economical and political relations and environmental law. These close relations between earth system research and economic/political questions make this course an interesting subject for students with diverse backgrounds. The course include: - an overview of climate change, its impacts (IPCC Fourth Assessment - Report) uncertainties, mitigation, adaptation; - options for global environmental governance, environmental law, environmental policy negotiations, the role of international organizations (governmental and non-governmental) and the role of developed vs. developing countries; The Climate Change Convention, the Kyoto Protocol, flexible mechanisms (Emission trading, Clean Development Mechanisms) and options for Post Kyoto measures.

Institution	**VU University Amsterdam**
School	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology
Address	Faculty of Earth and Life Sciences - Vrije Universitet De Boelelaan 1085-1087 1081 HV Amsterdam , Netherlands Phone: +31 (0)20 59 87000 / Fax: +31 (0)20 646 2457 E-mail: falw@falw.vu.nl
Degree	MSc. Earth Sciences (specialization: Earth Sciences and Economics - *Theme: Climate and Geo-ecosystems*)
Length	24 months
Requirement	120 credits (63 credits of compulsory components for all students + 27 compulsory credits for this theme + 30 elective credits) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.falw.vu.nl/en/prospective-students/Masters-programs/earth-sciences/index.asp
Courses Related to CCS	**450185 - Modern Climate Systems (3 credits)** – Compulsory for theme Climate and Geo-ecosystems This introductory course gives a (short) overview into the physical and chemical processes driving the atmosphere and the ocean. First the basic parameters and properties will be described, followed by examples for the formation and circulation of air and water masses. The different climatic regions of the world from the poles to

	the tropics will be highlighted and various compounds and features of the climate systems like the monsoon, ENSO and NAO systems will be explained. This knowledge of the modern climate processes forms the basis for understanding Climate Change today and in the past. **450313 - Modern Geo-ecosystems (3 credits)** – Compulsory for theme Climate and Geo-ecosystems This introductory course gives a (short) overview into the interactions between the geo-, bio-, hydro- and atmosphere. The interaction between modern climate systems and important processes like rock weathering, soil formation, sediment erosion-transport-deposition will be highlighted, and illustrated (partly in the field) for a selected number of modern terrestrial and marine geo-ecosystems. The focus is on those processes relevant for understanding how modern climate and climate change are affecting the various modern geo-ecosystems. **450188 - Climate and Policy (6 credits)** – Compulsory for theme Climate and Geo-ecosystems International policy on human-induced climate change and its mitigation is a hotly debated subject. Current international climate policy is the result of a complex and long-lasting negotiation process. In this process, the science of the complex earth and climate system is closely mixed with questions on socio-economic effects of climate change, options for global environmental governance as determined by the structure of international organizations, international economical and political relations and environmental law. These close relations between earth system research and economic/political questions make this course an interesting subject for students with diverse backgrounds. The course include: - an overview of climate change, its impacts (IPCC Fourth Assessment - Report) uncertainties, mitigation, adaptation; - options for global environmental governance, environmental law, environmental policy negotiations, the role of international organizations (governmental and non-governmental) and the role of developed vs. developing countries; The Climate Change Convention, the Kyoto Protocol, flexible mechanisms (Emission trading, Clean Development Mechanisms) and options for Post Kyoto measures. **60422150 - International Environmental Economics (6 credits) -** Compulsory for theme Climate and Geo-ecosystems The course consists of lecturers teaching the state-of-the-art, and students giving presentations on seminal papers in the literature. The lectures cover the following topics (provisional scheme) • Introduction: Externalities and environmental policy • Trade the environment: pollution havens versus factor endowments • International environmental agreements • Economic impacts of climate change • Climate change policy making: instruments and costs • The economics of acidification and ozone depletion The first six classes are on the relationship between trade and the environment. Common wisdom is that trade is the source of many environmental problems. One of the main reasons for this is that governments are afraid that domestic environmental policies will reduce the home economy's international competitiveness and hence environmental policies are set too lax. In the first four lectures we analyze to what extent this fear is correct, both theoretically and empirically. We compare how the trade-off between international competitiveness and the environment depends on the type of pollutant (local pollutants such as PM10, or transboundary pollutants, such as SO_2) as well as on the size of the domestic economy. In lectures 5 and 6 we turn to the issue of international agreements. Writing down a protocol which requires countries to reduce their emissions of CO_2 or SO_2 is easy (see for example the Kyoto Protocol and the Sofia

	Protocol), but what are the incentives for countries to actually join the coalition? And what is the role of trade sanctions therein? The last eight lectures are on the economics of climate change and climate policy, and also on the problems of acidification and ozone depletion. The following subjects are analysed. What is climate change, and what are its causes and consequences? What are the economic impacts of climate change? What are the costs of emission reduction? How can emission reductions be achieved? What lessons do acidification and ozone policy hold for climate policy? What is optimal and equitable climate policy? How likely is this in reality? Are there effective and acceptable alternatives to optimal climate policy? **450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits)** – Compulsory for theme Climate and Geo-ecosystems This course addresses the various climate processes and events which shaped the development of actual mankind and the influence man takes on climate. Questions to be addressed are : • How did climate shape the development of *Homo sapiens*? • Did changing climate cause the extermination of various cultures? • Natural versus anthropogenic climate change. Future perspectives. **450330 - Sedimentary Environments and Climate Archives (6 credits)** - Optional from the "Optional Compulsory courses list" - theme Climate and Geo-ecosystems The course deals with the sedimentology, geochemistry and/or ecology of marine, coastal, fluvial, lacustrine, eolian, and periglacial environments that record climate changes. The focus is on those processes relevant for understanding how climate change is recorded in the various environments. In addition, the susceptibility of key aspects of those environments to climate-change impacts will be addressed. The course is subdivided into: • Terrestrial/coastal archives and proxies • Marine archives and proxies **450004 - Climate Modelling (6 credits) -** Elective Geological archives show convincingly that the climate system experiences variability on a wide range of time-scales. For Quaternary studies, climate variations at the following time-scales are most important: glacials-interglacials, millennia and centuries-decades. This course focuses at the mechanisms behind these variations, thereby using climate models as a tool, i.e. numerical computer models in which the dynamics of the climate system are calculated. The combination of these models and geological data will be treated extensively. The course consists of lectures giving an overview of climate models and their application (different types for different time-scales) and of discussion meetings, in which students discuss the recent literature in detail. In this way the course considers case studies for the different time-scales and deals with recent developments in climate modelling. The following two questions are central to the course: 1) What is the driving mechanism behind climate change at a particular time-scale? 2) How can we optimise the combination of climate models and geological data in order to increase our understanding of climate evolution?

Institution	**VU University Amsterdam**
School	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology
Address	Faculty of Earth and Life Sciences - Vrije Universitet De Boelelaan 1085-1087 1081 HV Amsterdam , Netherlands Phone: +31 (0)20 59 87000 / Fax: +31 (0)20 646 2457 E-mail: falw@falw.vu.nl

Degree	MSc. Earth Sciences (specialization: Earth Sciences and Economics - *Theme: Water and Ecology)*
Length	24 months
Requirement	120 credits (63 credits of compulsory components for all students + 30 compulsory credits for this theme + 27 elective credits) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.falw.vu.nl/en/prospective-students/Masters-programs/earth-sciences/index.asp
Courses Related to CCS	**468020 - Environmental Economics** (6 credits) - Optional from the "Optional Compulsory courses list" - theme Water and Ecology This module aims to give an overview of basic economic concepts and principles from economic welfare theory applied to the environment. A critical cause of environmental problems is that not all costs due to economic production and consumption are borne by those responsible for generating them. This problem will be conceptualised in this course through the notion of externalities. There are various economic policy instruments and institutional-economic arrangements for addressing such externalities. Criteria for their selection and evaluation will be discussed. Cost-benefit analysis is an important economic evaluation method. Particular attention will be paid to the economic valuation of environmental change in cost-benefit analysis. Economic sustainability concepts and sustainable economic growth, equity and poverty will also be addressed from local to global scale, including the externalities associated with international trade across different economic sectors and environmental domains such as climate change, water, energy, waste, forestry, fisheries, and biodiversity. **60422150 - International Environmental Economics (6 credits) -** Optional from the "Optional Compulsory courses list" - theme Water and Ecology The course consists of lecturers teaching the state-of-the-art, and students giving presentations on seminal papers in the literature. The lectures cover the following topics (provisional scheme) • Introduction: Externalities and environmental policy • Trade the environment: pollution havens versus factor endowments • International environmental agreements • Economic impacts of climate change • Climate change policy making: instruments and costs • The economics of acidification and ozone depletion The first six classes are on the relationship between trade and the environment. Common wisdom is that trade is the source of many environmental problems. One of the main reasons for this is that governments are afraid that domestic environmental policies will reduce the home economy's international competitiveness and hence environmental policies are set too lax. In the first four lectures we analyze to what extent this fear is correct, both theoretically and empirically. We compare how the trade-off between international competitiveness and the environment depends on the type of pollutant (local pollutants such as PM10, or transboundary pollutants, such as SO_2) as well as on the size of the domestic economy. In lectures 5 and 6 we turn to the issue of international agreements. Writing down a protocol which requires countries to reduce their emissions of CO_2 or SO_2 is easy (see for example the Kyoto Protocol and the Sofia Protocol), but what are the incentives for countries to actually join the coalition? And what is the role of trade sanctions therein? The last eight lectures are on the economics of climate change and climate policy, and also on the problems of acidification and ozone depletion. The following subjects are analysed. What is climate change, and what are its causes and consequences? What are the economic impacts of climate change? What are the costs of emission reduction? How can emission reductions be achieved? What lessons do acidification and ozone policy hold for climate policy? What is optimal

	and equitable climate policy? How likely is this in reality? Are there effective and acceptable alternatives to optimal climate policy? **470502 - Spatial Ecology and Global Change (6 credits) -** Optional from the "Optional Compulsory courses list" - theme Water and Ecology The main aim of the course is the analysis of spatial and temporal distribution of organisms in the context of global climate change. In fact this refers to the field of biogeography. In this course, M Sc students will learn about the different vegetation zones of the earth, climate zones and climate change, biodiversity, disturbance history, ecosystem dynamics, patterns of distribution, and patterns of fauna and flora in the past and future. Special attention will be given to the range dynamics of species, that is, analysis of the factors that cause the range of a species to expand or diminish, depending on locally varying environmental factors. This course will emphasize an evolutionary and ecological approach, providing a causal explanation of the (changes) in the distribution of organisms. At the end of this course, students will have a deeper understanding of the patterns of distribution of living organisms across the earth's surface, and the underlying mechanisms. **450188 - Climate and Policy (6 credits)** – Elective International policy on human-induced climate change and its mitigation is a hotly debated subject. Current international climate policy is the result of a complex and long-lasting negotiation process. In this process, the science of the complex earth and climate system is closely mixed with questions on socio-economic effects of climate change, options for global environmental governance as determined by the structure of international organizations, international economical and political relations and environmental law. These close relations between earth system research and economic/political questions make this course an interesting subject for students with diverse backgrounds. The course include: - an overview of climate change, its impacts (IPCC Fourth Assessment - Report) uncertainties, mitigation, adaptation; - options for global environmental governance, environmental law, environmental policy negotiations, the role of international organizations (governmental and non-governmental) and the role of developed vs. developing countries; The Climate Change Convention, the Kyoto Protocol, flexible mechanisms (Emission trading, Clean Development Mechanisms) and options for Post Kyoto measures. **450004 - Climate Modelling (6 credits) -** Elective Geological archives show convincingly that the climate system experiences variability on a wide range of time-scales. For Quaternary studies, climate variations at the following time-scales are most important: glacials-interglacials, millennia and centuries-decades. This course focuses at the mechanisms behind these variations, thereby using climate models as a tool, i.e. numerical computer models in which the dynamics of the climate system are calculated. The combination of these models and geological data will be treated extensively. The course consists of lectures giving an overview of climate models and their application (different types for different time-scales) and of discussion meetings, in which students discuss the recent literature in detail. In this way the course considers case studies for the different time-scales and deals with recent developments in climate modelling. The following two questions are central to the course: 1) What is the driving mechanism behind climate change at a particular time-scale? 2) How can we optimise the combination of climate models and geological data in order to increase our understanding of climate evolution? **450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits)** – Elective

	This course addresses the various climate processes and events which shaped the development of actual mankind and the influence man takes on climate. Questions to be addressed are : • How did climate shape the development of *Homo sapiens*? • Did changing climate cause the extermination of various cultures? • Natural versus anthropogenic climate change. Future perspectives.

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Degree	MSc. Earth Sciences (specialization: Earth Sciences and Economics - *Theme: Energy)*
Length	24 months
Requirement	120 credits (63 credits of compulsory components for all students + 30 compulsory credits for this theme + 27 elective credits) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.falw.vu.nl/en/prospective-students/Masters-programs/earth-sciences/index.asp
Courses Related to CCS	**468020 - Environmental Economics** (6 credits) - Optional from the "Optional Compulsory courses list" - theme Energy This module aims to give an overview of basic economic concepts and principles from economic welfare theory applied to the environment. A critical cause of environmental problems is that not all costs due to economic production and consumption are borne by those responsible for generating them. This problem will be conceptualised in this course through the notion of externalities. There are various economic policy instruments and institutional-economic arrangements for addressing such externalities. Criteria for their selection and evaluation will be discussed. Cost-benefit analysis is an important economic evaluation method. Particular attention will be paid to the economic valuation of environmental change in cost-benefit analysis. Economic sustainability concepts and sustainable economic growth, equity and poverty will also be addressed from local to global scale, including the externalities associated with international trade across different economic sectors and environmental domains such as climate change, water, energy, waste, forestry, fisheries, and biodiversity. **60422150 - International Environmental Economics (6 credits) -** Optional from the "Optional Compulsory courses list" - theme Energy The course consists of lecturers teaching the state-of-the-art, and students giving presentations on seminal papers in the literature. The lectures cover the following topics (provisional scheme) • Introduction: Externalities and environmental policy • Trade the environment: pollution havens versus factor endowments • International environmental agreements • Economic impacts of climate change • Climate change policy making: instruments and costs • The economics of acidification and ozone depletion The first six classes are on the relationship between trade and the environment. Common wisdom is that trade is the source of many environmental problems. One

	of the main reasons for this is that governments are afraid that domestic environmental policies will reduce the home economy's international competitiveness and hence environmental policies are set too lax. In the first four lectures we analyze to what extent this fear is correct, both theoretically and empirically. We compare how the trade-off between international competitiveness and the environment depends on the type of pollutant (local pollutants such as PM10, or transboundary pollutants, such as SO_2) as well as on the size of the domestic economy. In lectures 5 and 6 we turn to the issue of international agreements. Writing down a protocol which requires countries to reduce their emissions of CO_2 or SO_2 is easy (see for example the Kyoto Protocol and the Sofia Protocol), but what are the incentives for countries to actually join the coalition? And what is the role of trade sanctions therein? The last eight lectures are on the economics of climate change and climate policy, and also on the problems of acidification and ozone depletion. The following subjects are analysed. What is climate change, and what are its causes and consequences? What are the economic impacts of climate change? What are the costs of emission reduction? How can emission reductions be achieved? What lessons do acidification and ozone policy hold for climate policy? What is optimal and equitable climate policy? How likely is this in reality? Are there effective and acceptable alternatives to optimal climate policy? **450188 - Climate and Policy (6 credits)** – Elective International policy on human-induced climate change and its mitigation is a hotly debated subject. Current international climate policy is the result of a complex and long-lasting negotiation process. In this process, the science of the complex earth and climate system is closely mixed with questions on socio-economic effects of climate change, options for global environmental governance as determined by the structure of international organizations, international economical and political relations and environmental law. These close relations between earth system research and economic/political questions make this course an interesting subject for students with diverse backgrounds. The course include: - an overview of climate change, its impacts (IPCC Fourth Assessment - Report) uncertainties, mitigation, adaptation; - options for global environmental governance, environmental law, environmental policy negotiations, the role of international organizations (governmental and non-governmental) and the role of developed vs. developing countries; The Climate Change Convention, the Kyoto Protocol, flexible mechanisms (Emission trading, Clean Development Mechanisms) and options for Post Kyoto measures. **450004 - Climate Modelling (6 credits) -** Elective Geological archives show convincingly that the climate system experiences variability on a wide range of time-scales. For Quaternary studies, climate variations at the following time-scales are most important: glacials-interglacials, millennia and centuries-decades. This course focuses at the mechanisms behind these variations, thereby using climate models as a tool, i.e. numerical computer models in which the dynamics of the climate system are calculated. The combination of these models and geological data will be treated extensively. The course consists of lectures giving an overview of climate models and their application (different types for different time-scales) and of discussion meetings, in which students discuss the recent literature in detail. In this way the course considers case studies for the different time-scales and deals with recent developments in climate modelling. The following two questions are central to the course: 1) What is the driving mechanism behind climate change at a particular time-scale? 2) How can we optimise the combination of climate models and geological data in order to increase our understanding of climate evolution?

	450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits) – Elective This course addresses the various climate processes and events which shaped the development of actual mankind and the influence man takes on climate. Questions to be addressed are : • How did climate shape the development of *Homo sapiens*? • Did changing climate cause the extermination of various cultures? • Natural versus anthropogenic climate change. Future perspectives.

Institution	**VU University Amsterdam**
School	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology
Address	Faculty of Earth and Life Sciences - Vrije Universitet De Boelelaan 1085-1087 1081 HV Amsterdam , Netherlands Phone: +31 (0)20 59 87000 / Fax: +31 (0)20 646 2457 E-mail: falw@falw.vu.nl
Degree	MSc. Geosciences of Basins and Lithosphere (This is a research master's programme at the Vrije Universiteit which participates in the European master of Geosciences of Basins and Lithosphere (BASINMASTER). The latter is based on co-operation with foreign partner universities. When students finish the Basinmaster programme they obtain two diplomas (Double-Degree) from universities in the consortium)
Length	24 months
Requirement	120 credits (optional: 15 credits) / Students who apply for the Basinmaster programme can only be admitted on the basis of a decision of the *Selection and Examination Committee (SEC)* of the Basinmaster programme, consisting of representatives from the core universities. *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.falw.vu.nl/en/prospective-students/Masters-programs/geosciences-of-basins-and-lithosphere/index.asp
Courses Related to CCS	**450146 - From Source to Sink: Chemical and Physical Cycles (6 credits) -** Compulsory This course deals with the parameters regulating the production, transfer and storage of sediments and solutes from their sources to their sinks, addressing short-term and long-term landscape evolution and sustainability. It covers the linked processes of tectonics, weathering, erosional systems (fluvial, glacial, marine) and climate changes (including 'real-world' examples on the SE Netherlands, the Ardennes and Pyrenees) as well as the methods to constrain these processes (e.g. provenance studies and thermochronology). Lecturers from variety of disciplines will teach the students how to view these topics from various backgrounds. **450188 - Climate and Policy (6 credits)** – Elective International policy on human-induced climate change and its mitigation is a hotly debated subject. Current international climate policy is the result of a complex and long-lasting negotiation process. In this process, the science of the complex earth and climate system is closely mixed with questions on socio-economic effects of climate change, options for global environmental governance as determined by the structure of international organizations, international economical and political relations and environmental law. These close relations between earth system research and economic/political questions make this course an interesting subject for students with diverse backgrounds. The course include: - an overview of climate change, its impacts (IPCC Fourth Assessment - Report) uncertainties, mitigation, adaptation; - options for global environmental governance, environmental law,

	environmental policy negotiations, the role of international organizations (governmental and non-governmental) and the role of developed vs. developing countries; The Climate Change Convention, the Kyoto Protocol, flexible mechanisms (Emission trading, Clean Development Mechanisms) and options for Post Kyoto measures. **450004 - Climate Modelling (6 credits) -** Elective Geological archives show convincingly that the climate system experiences variability on a wide range of time-scales. For Quaternary studies, climate variations at the following time-scales are most important: glacials-interglacials, millennia and centuries-decades. This course focuses at the mechanisms behind these variations, thereby using climate models as a tool, i.e. numerical computer models in which the dynamics of the climate system are calculated. The combination of these models and geological data will be treated extensively. The course consists of lectures giving an overview of climate models and their application (different types for different time-scales) and of discussion meetings, in which students discuss the recent literature in detail. In this way the course considers case studies for the different time-scales and deals with recent developments in climate modelling. The following two questions are central to the course: 1) What is the driving mechanism behind climate change at a particular time-scale? 2) How can we optimise the combination of climate models and geological data in order to increase our understanding of climate evolution? **450187 - Man and Climate: From Hominids to Modern Civilization (3 credits)** – Elective This course addresses the various climate processes and events which shaped the development of actual mankind and the influence man takes on climate. Questions to be addressed are : • How did climate shape the development of *Homo sapiens*? • Did changing climate cause the extermination of various cultures? • Natural versus anthropogenic climate change. • Future perspectives.

Institution	**VU University Amsterdam**
School	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology
Address	Faculty of Earth and Life Sciences - Vrije Universitet De Boelelaan 1085-1087 1081 HV Amsterdam , Netherlands Phone: +31 (0)20 59 87000 / Fax: +31 (0)20 646 2457 E-mail: falw@falw.vu.nl
Degree	MSc. Hydrology (specialization: Hydrogeology or Ecohydrology)
Length	24 months
Requirement	120 credits* = 90 credits of compulsory course modules + 12 credits of core optional modules + 18 credits of elective optional modules. *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.falw.vu.nl/en/prospective-students/Masters-programs/hydrology/index.asp
Courses Related to CCS	**450188 - Climate and Policy (6 credits)** – Elective **Aim:** Discussing (the uncertainty of) causes and impacts of climate change and presenting an overview of current international climate policy. **Content**: International policy on human-induced climate change and its mitigation is a hotly debated subject. Current international climate policy is the result of a complex and long-lasting negotiation process. In this process, the science of the

	complex earth and climate system is closely mixed with questions on socio-economic effects of climate change, options for global environmental governance as determined by the structure of international organizations, international economical and political relations and environmental law. These close relations between earth system research and economic/political questions make this course an interesting subject for students with diverse backgrounds. The course include: - an overview of climate change, its impacts (IPCC Fourth Assessment - Report) uncertainties, mitigation, adaptation; - options for global environmental governance, environmental law, environmental policy negotiations, the role of international organizations (governmental and non-governmental) and the role of developed vs. developing countries; The Climate Change Convention, the Kyoto Protocol, flexible mechanisms (Emission trading, Clean Development Mechanisms) and options for Post Kyoto measures. **450004 - Climate Modelling (6 credits) -** Elective Geological archives show convincingly that the climate system experiences variability on a wide range of time-scales. For Quaternary studies, climate variations at the following time-scales are most important: glacials-interglacials, millennia and centuries-decades. This course focuses at the mechanisms behind these variations, thereby using climate models as a tool, i.e. numerical computer models in which the dynamics of the climate system are calculated. The combination of these models and geological data will be treated extensively. The course consists of lectures giving an overview of climate models and their application (different types for different time-scales) and of discussion meetings, in which students discuss the recent literature in detail. In this way the course considers case studies for the different time-scales and deals with recent developments in climate modelling. The following two questions are central to the course: 1) What is the driving mechanism behind climate change at a particular time-scale? 2) How can we optimise the combination of climate models and geological data in order to increase our understanding of climate evolution? **450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits)** – Elective This course addresses the various climate processes and events which shaped the development of actual mankind and the influence man takes on climate. Questions to be addressed are : • How did climate shape the development of *Homo sapiens*? • Did changing climate cause the extermination of various cultures? • Natural versus anthropogenic climate change. Future perspectives.

Institution	**VU University Amsterdam**
School	Faculty of Economics and Business Administration Department Economics
Address	VU University Amsterdam - Graduate School of Economics and Business Ms. drs. W. Maat De Boelelaan 1105, Room 2E-70 Telephone: + 31 (0)20 598 5585 Email: Masterprogramme@feweb.vu.nl
Degree	MSc in Spatial, Transport and Environmental Economics
Length	12 months

Requirement	60 credits* *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	www.feb.uva.nl/english http://www.feweb.vu.nl/nl/opleidingen/graduate-school/master-programs/streem/index.asp
Courses Related to CCS	**468020 - Environmental Economics (6 credits)** - Optional from the "Optional Compulsory courses list – Core courses" This module aims to give an overview of basic economic concepts and principles from economic welfare theory applied to the environment. A critical cause of environmental problems is that not all costs due to economic production and consumption are borne by those responsible for generating them. This problem will be conceptualised in this course through the notion of externalities. There are various economic policy instruments and institutional-economic arrangements for addressing such externalities. Criteria for their selection and evaluation will be discussed. Cost-benefit analysis is an important economic evaluation method. Particular attention will be paid to the economic valuation of environmental change in cost-benefit analysis. Economic sustainability concepts and sustainable economic growth, equity and poverty will also be addressed from local to global scale, including the externalities associated with international trade across different economic sectors and environmental domains such as climate change, water, energy, waste, forestry, fisheries, and biodiversity. **60422150 - International Environmental Economics (6 credits)** - Optional from the "Optional Compulsory courses list" The course consists of lecturers teaching the state-of-the-art, and students giving presentations on seminal papers in the literature. The lectures cover the following topics (provisional scheme) • Introduction: Externalities and environmental policy • Trade the environment: pollution havens versus factor endowments • International environmental agreements • Economic impacts of climate change • Climate change policy making: instruments and costs • The economics of acidification and ozone depletion The first six classes are on the relationship between trade and the environment. Common wisdom is that trade is the source of many environmental problems. One of the main reasons for this is that governments are afraid that domestic environmental policies will reduce the home economy's international competitiveness and hence environmental policies are set too lax. In the first four lectures we analyze to what extent this fear is correct, both theoretically and empirically. We compare how the trade-off between international competitiveness and the environment depends on the type of pollutant (local pollutants such as PM10, or transboundary pollutants, such as SO2) as well as on the size of the domestic economy. In lectures 5 and 6 we turn to the issue of international agreements. Writing down a protocol which requires countries to reduce their emissions of CO_2 or SO_2 is easy (see for example the Kyoto Protocol and the Sofia Protocol), but what are the incentives for countries to actually join the coalition? And what is the role of trade sanctions therein? The last eight lectures are on the economics of climate change and climate policy, and also on the problems of acidification and ozone depletion. The following subjects are analysed. What is climate change, and what are its causes and consequences? What are the economic impacts of climate change? What are the costs of emission reduction? How can emission reductions be achieved? What lessons do acidification and ozone policy hold for climate policy? What is optimal and equitable climate policy? How likely is this in reality? Are there effective and acceptable alternatives to optimal climate policy?

Institution	**VU University Amsterdam**
School	Faculty of Economics and Business Administration Department Economics
Address	VU University Amsterdam - Faculty of Economics and Business Administration De Boelelaan 1105 1081 HV Amsterdam Telephone +31 (0) 20 - 598 6000 (faculty) Email: Masterprogramme@feweb.vu.nl
Degree	MSc in Economics (specialization Spatial Economics)
Length	12 months
Requirement	60 credits* (3 courses related to the Specialization) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.feweb.vu.nl/en/education/graduate-school/index.asp
Courses Related to CCS	**60422150 - International Environmental Economics (6 credits)** – Compulsory (for Specialization in Spatial Economics) The course consists of lecturers teaching the state-of-the-art, and students giving presentations on seminal papers in the literature. The lectures cover the following topics (provisional scheme) • Introduction: Externalities and environmental policy • Trade the environment: pollution havens versus factor endowments • International environmental agreements • Economic impacts of climate change • Climate change policy making: instruments and costs • The economics of acidification and ozone depletion The first six classes are on the relationship between trade and the environment. Common wisdom is that trade is the source of many environmental problems. One of the main reasons for this is that governments are afraid that domestic environmental policies will reduce the home economy's international competitiveness and hence environmental policies are set too lax. In the first four lectures we analyze to what extent this fear is correct, both theoretically and empirically. We compare how the trade-off between international competitiveness and the environment depends on the type of pollutant (local pollutants such as PM10, or transboundary pollutants, such as SO2) as well as on the size of the domestic economy. In lectures 5 and 6 we turn to the issue of international agreements. Writing down a protocol which requires countries to reduce their emissions of CO2 or SO2 is easy (see for example the Kyoto Protocol and the Sofia Protocol), but what are the incentives for countries to actually join the coalition? And what is the role of trade sanctions therein? The last eight lectures are on the economics of climate change and climate policy, and also on the problems of acidification and ozone depletion. The following subjects are analysed. What is climate change, and what are its causes and consequences? What are the economic impacts of climate change? What are the costs of emission reduction? How can emission reductions be achieved? What lessons do acidification and ozone policy hold for climate policy? What is optimal and equitable climate policy? How likely is this in reality? Are there effective and acceptable alternatives to optimal climate policy?

Institution	**University of Warsaw**
School	Faculty of Economic Sciences
Address	Graduate Office Mrs. Dominika Szkoda e-mail: dszkoda@wne.uw.edu.pl

	phone: +48 22 55 49 164 (Mon-Fri, 9 AM - 4 PM CET) MADE Team e-mail: development@wne.uw.edu.pl phone: +48 22 55 49 125 (Mon-Fri, 9 AM - 4 PM CET)
Degree	Master of Arts in Development Economics (MADE)
Length	2 years
Requirement	120 ECTS
Website	http://www.wne.uw.edu.pl/www_2.php?id_www_2=11
Courses Related to CCS/climate change	**2400-ITC-2 International Environmental Cooperation (5 ECTS) - optional course** The purpose of the lecture is to review contemporary literature addressing the problem of international environmental cooperation and to discuss several controversial issues arising in this context. Emphasis will be placed on cooperation, conflicts and convergence of interest in those agreements which Poland is (or plans to be) a party to. Specific topics include: 1. Introduction to the lecture; examples of international environmental cooperation. 2. Eutrophication of the Baltic Sea; economic roots of the problem; the so-called limiting factor; methods to achieve cost-effectiveness; international initiatives to solve the problem; models of an international optimum of the Baltic Sea clean-up: cost and benefit budgets. 3. The "acid rain" in Europe; economic roots of the problem; international transfers of sulphur dioxide and nitrogen oxides emissions. A model of environmental-economic linkages. International initiatives to solve the problem. 4. Protecting the ozone layer; economic instruments at work; a "competition" between the developing countries and economies in transition. 5. Global climate as a public good; a greenhouse effect risk; economic consequences of limiting the energy demand; approaches to an equitable cost-sharing in climate protection activities; the Kyoto Protocol. 6. Biodiversity protection as an international problem; cost-benefit analyses of conserving biodiversity. 7. Conventions and other documents adopted at Rio (1992); the conference as a milestone in maturing the sustainable development concept. 8. International environmental assistance; the North-South conflict; the concept of "incrementality" in environmental assistance; Eastern Europe as a target for interest groups from the OECD countries. 9. Debt-for-environment swaps; path-breaking agreements from the 1980s; a critique of early debt-for-environment models; the Polish debt-for-environment swap of 1991; Operations of the EcoFund in Poland. 10. International trade and the environment; a modern critique of the comparative advantage theory; environmental consequences of the contemporary international trade. 11. Environmental policy in the European Union; Lisbon Strategy – a compromise with economic development objectives?

Institution	**New University of Lisbon + University of Lisbon**
School	Faculty of Sciences
Address	Cidade Universitária - Edifício C5, Campo Grande 1749-016 Lisboa - Portugal
Degree	Doctoral degree in climate change and sustainable development policies
Length	3 years
Requirement	180 credits
Website	http://www.alteracoesclimaticas.ics.ul.pt/pub/
Courses Related to CCS	**Adaptation and Mitigation of Climate Change** ECTS Credits 5 **(compulsory)** The main objective of this course is to understand the current state of knowledge and methods in the adaptation and mitigation of climate change. The first part aims to give students the ability to understand the current integrated assessments of impacts and adaptation measures to climate change. In the second part seeks to

	introduce students in issues relating to mitigation processes. It is given special emphasis to policies and instruments to mitigate climate regimes and the Kyoto Protocol and Post-Kyoto. Will be addressed the following themes: Adaptation and mitigation of climate change, sensitivity, adaptability and vulnerability to climate change, methods and tools for evaluating impacts and adaptation measures to climate change impacts of climate change: water resources, coastal systems and fisheries , agriculture (food, fiber and forest products), human health, ecosystems and biodiversity, industry, urban and rural settlements, tourism and society, adapting to climate change: practices, options and constraints; Scenarios for mitigation of emissions of greenhouse gases and its implications, technological and economic potential for reducing emissions of greenhouse gases; mitigation strategies in various sectors: energy, transport, housing and services, industry, agriculture, forestry and waste management; Policies and instruments mitigation; Kyoto climate regimes and post-Kyoto. **Science of Climate Change** ECTS Credits 5 **(compulsory)** The aim of this semester course is to understand the foundations and the main aspects of the science of climate change. The main focus is on the scientific basis of current concerns about anthropogenic climate change and aims to give students the ability to assess the current situation and future climate scenarios. The course begins with an analysis of the climate system and discusses the study of climate modeling and the construction of scenarios of climate change on various spatial scales. Will be addressed the following topics: The climate system Energy balance in the atmosphere, dynamics of the atmosphere and oceans, the Earth's climate history. Paleoclimatology; The carbon cycle and atmospheric carbon dioxide, changes in the concentrations of constituent gases in the atmosphere and radiative forcing; Observations of climate change: the soil surface, atmosphere, snow, ice and the mean sea level; Modeling System climate; projections of global climate, regional climate projections. **Economy and Market Regulation** ECTS Credits 5 **(compulsory)** This course introduces the fundamental concepts and methodologies of economics to deal with the impacts, mitigation and adaptation measures to climate change, with special emphasis on the instruments of economic value and market-based (market oriented). The main topics include: the foundations of economic science, the economic system, the role of economic approaches to climate change, the market to function when the prices are wrong, the need for regulation, market-oriented tools, techniques cost-benefit analysis, economic modeling and assessment of impacts of climate change, economic measures for mitigation and adaptation - the role of market-based mechanisms and fiscal. **Ethics, Public Policy and Environmental Diplomacy** ECTS Credits 5 **(compulsory)** Analyzes the formation processes of public policy environment, in response to different events members and their representations, the global environmental crisis. Takes into account the different models of institutionalization and grids criteria for measuring quality performance as well as the interaction of these policies with the political and administrative cultures prevailing in different national contexts studied. Special attention will be given to the role of the European Union, either as an international actor, or as reference for the horizon will shape domestic environmental policies in different Member States. The theme of climate change will be considered transversally, not forgetting his role in resetting the priorities of the agenda of the international system and environmental diplomacy. **History, Development and Environment** ECTS Credits 5 **(compulsory)** Although the phenomenon of climate change is usually identified as an issue of recent concern intends to realize the importance of Environmental History for the thorough understanding of the interactions between environment and society. To

	familiarize students with this expanding field, they will be able to recognize environmental factors as central in the unfolding of human history, a perspective not common in more traditional histories. After a general introduction to the discipline (objects, schools, methods), it follows a detailed study of each of the environmental issues already identified as most pressing for the effects of climate change nationally and globally. Examination of key historical events such as floods, fires and drought, all matters which the models indicate that most of the Mediterranean societies will face more sharply in the near future. Tourism, leisure and recreation will also be considered, not only because they have significant environmental impacts, and by his own vulnerability to climate change. The aim is to understand the role of all these phenomena in the redefinition of social forms throughout history. Thus offers students a comprehensive view - both for different geographies, such as the multiple historical contexts - which functions as an essential tool to learn to look at the current issues related to Climate Change. **Earth and Ocean Systems** ECTS Credits 5 **(compulsory)** This course aims to give a panoramic view of planetary dynamics and identify the principles of responsible and sustainable environmental future. It is described in an integrated system of the planet and its major flows of energy and resources. Addresses the evolution of life and discusses the impact of humans on the environment. Special emphasis is given to water resources, oceans, soils, ecosystems and biodiversity. It is an analysis of the contribution of science and technology in the transition to sustainability. **Sociology of Environment and Communication** ECTS Credits 5 **(compulsory)** The objective of this course is to address the social dimensions of climate change and, more specifically, the nature of communication is by assuming that those who generate the projected level of interaction that politically the environmental problem of climate change. Among them the perception and risk management, the construction of scientific knowledge and common, public participation and decision in context of urgency and complexity. The specific objectives of this unit are exposed in depth review and development process of the disciplinary field of Sociology of the Environment, his story and characterization - calling attention to the role of social sciences and its historic capital, in the understanding of environmental issues, deepen specific area of intersection between the Environment Sociology and Sociology of Communication - once the communication processes assume a strategic dimension in the construction of environmental knowledge, developing, by reference to various aspects of climate change, the specific problems of scientific knowledge and policy; of perception of risk and its effects on behavior; processes; social participation and new conditions for implementing public policies as social facts and communicative. **Seminar on Energy and Climate Change** ECTS Credits 5 **(compulsory)** Seminar on Energy and Climate Change aims to present information and develop case studies on technologies relating to energy impact (in) direct recognition and potential climate change, and analytical tools. It should take into consideration the following points: 1. Fossil fuel: (a) perspective on past production, consumption and prices, (b) prospects for the medium and long term; 2.Fontes energy: renewables, hydrogen, and nuclear; 3.Use energy, with emphasis on mobility and non-fossil fuels, 4. Modelling energy-environment: (a) methods of projection of energy demand, (b) optimization methods, based on the cost-effectiveness, (c) generation of marginal cost curves for CO2 reduction, restrictive scenarios for carbon, 5 . New drivers for the energy-environment relationship: the knowledge society, new energy technologies (eg CCS, smart-grid, smart metering), a new framework of social values.

Institution	University of Coimbra
School	Faculty of Sciences and Technology – Department of Civil Engineering
Address	Rua Luís Reis Santos – Pólo II – University of Coimbra 3030-790 Coimbra - Portugal
Degree	Integrated Master Degree in Environmental Engineering
Length	5 years
Requirement	
Website	https://webserv.dec.uc.pt/weboncampus/2modulecursos.do?idcurso=32
Courses Related to CCS	**01003974 - Global changes and Climatology** ECTS Credits 6.0 **(compulsory)** Characterizes the climate system with respect to variables, processes and functioning, as well as informing the global changes in the Earth system, primarily those induced by human activities. These changes are particularly relevant to the global consequences and climate change. **01005462 - Risk Analysis** ECTS Credits 4.5 **(compulsory)** Introduction to the risk problem in engineering and methods of its quantitative analysis in order to support decision processes.

Institution	University of Évora
School	School of Science and Technology
Address	Rua Romão Ramalho, 59 Cod. Postal: 7002-554 Évora
Degree	Master degree in Earth, Atmospheric and Space Science Specialization: Geological Processes
Length	2 years
Requirement	
Website	http://www.ip.uevora.pt/en/course_catalog/2nd_cycle/detalhe_do_curso/(cursoid)/250/(view)/plano
Courses Related to CCS	**FIS7922 - Seminar in Earth Sciences, Atmospheric and Space** ECTS Credits 4 **(compulsory)** **FIS7927 - Methods and observation techniques in Earth, Atmospheric and Space** ECTS Credits 4 **(compulsory)** **FIS7757 - Resources, Energy and Environment** ECTS Credits 4 **(elective)** **GEO7954/GEO7956 - Geographic Information Systems in Earth, Atmospheric and Space I and II** ECTS Credits 12 **(elective)**

Institution	University of Évora
School	School of Science and Technology
Address	Rua Romão Ramalho, 59

	Cod. Postal: 7002-554 Évora
Degree	Master degree in Earth, Atmospheric and Space Science Specialization: Atmospheric Physics and Climate
Length	2 years
Requirement	
Website	http://www.ip.uevora.pt/en/course_catalog/2nd_cycle/detalhe_do_curso/(cursoid)/250/(view)/plano
Courses Related to CCS	**FIS7931 - Atmosphere and Climate Physics** ECTS Credits 6 **(compulsory)** **FIS7757 - Resources, Energy and Environment (compulsory)** **FIS7924 - Atmosphere and Space Remote Sensing** ECTS Credits 4 **(compulsory)** **FIS7927 - Methods and observation techniques in Earth, Atmospheric and Space** ECTS Credits 4 **(compulsory)** **FIS7765 – Climate, Climate Modeling and Climate Change** ECTS Credits **6 (compulsory)** **GEO7954 Geographic Information Systems in Earth, Atmospheric and Space I** ECTS Credits 4 **(elective)** **FIS7910 - Anthropogenic impacts on the Atmospheric Environment** ECTS Credits **4 (elective)** **FIS7766 - Gases and Aerosols Dispersion in Atmosphere** ECTS Credits **4 (elective)**

Institution	**University of Évora**
School	School of Science and Technology
Address	Rua Romão Ramalho, 59 Cod. Postal: 7002-554 Évora
Degree	Master degree in Earth, Atmospheric and Space Science Specialization: Internal Geophysics
Length	2 years
Requirement	
Website	http://www.ip.uevora.pt/en/course_catalog/2nd_cycle/detalhe_do_curso/(cursoid)/250/(view)/plano
Courses Related to CCS	**FIS7922 - Seminar in Earth Sciences, Atmospheric and Space** ECTS Credits 4 **(compulsory)** **FIS7757 - Resources, Energy and Environment** ECTS Credits **4 (compulsory)** **FIS7927 - Methods and observation techniques in Earth, Atmospheric and Space** ECTS Credits 4 **(compulsory)**

	GEO7954 Geographic Information Systems in Earth, Atmospheric and Space I ECTS Credits 4 **(elective)** **FIS7910 - Anthropogenic impacts on the Atmospheric Environment** ECTS Credits 4 **(elective)** **FIS7766 - Gases and Aerosols Dispersion in Atmosphere** ECTS Credits 4 **(elective)**

Institution	**University of Lisbon**
School	Faculty of Sciences
Address	Edifício C6. Campo Grande 1749-016 LISBOA - PORTUGAL
Degree	Master degree in Environmental Sciences and Technologies
Length	2 years
Requirement	
Website	http://www.fc.ul.pt/ciencias-e-tecnologias-do-ambiente/cta_pedro_obj.html
Courses Related to CCS	**Environmental Law and International Relations** ECTS Credits 5 **(compulsory)** The Law and the environmental Lay. Legal framework of environmental law in Portugal and EU. Law on the Environment and regulatory decrees. Law on Spatial Planning and Urbanism. Legislation of air and water waste. The environmental impacts and legislation on environmental quality in the production system. Licensing of economic activities. The legal regime for breaches. Law framework of protected areas, national ecological reserve and national agricultural reserve. The environmental non-governmental organizations. International conventions: biodiversity, climate change, desertification, forests and wildlife trade. Biosecurity. Agencies and international organizations for the environment. The agenda XXI and the world conferences on environment. **Environmental Economy** ECTS Credits 5 **(compulsory)** Environmental economics history. The concept of value and ethics of the environment. The environment as capital: the valuation of direct and indirect environmental values. The economic approach to environmental values. Accounting for ecosystem services. The correction of GDP in line with costs and ecological benefits. The development of decision support matrices: analysis of cost-benefit analysis, the environmental impact assessment and multi-criteria analysis. Financial and environmental evaluation of projects. The environmental taxation. The applications of environmental economics: the exploitation of natural resources, pollution, water air and waste. The market for emissions. Nature conservation and biodiversity. Climate change and economic impacts. Strategies to mitigate the economic impacts of climate change and environmental disasters. The economic and environmental incentives and productivity. Sustainable development and its indicators. The World Bank and the GEF. Community programs in Environment. The World Trade Organization and Environment. The environmental economics and the new international order. **Conversion Technologies and Environmental Requalification** ECTS Credits 5 **(compulsory)** Water and waste technologies. Reforestation. Decontamination and restoration of soils. Bioremediation. Water decontamination. Environmental and organic farming. Sea and oceans technologies. Construction technologies and eco-efficiency. Good agricultural, economic and industrial practices codes. Control of air pollution. The reduction of greenhouse gases. Recycling and reuse.

	Climate Change and Renewable Energy ECTS Credits 5 **(compulsory)** The climate system. Internal and external climate forcing factors. Greenhouse gases emissions into the atmosphere. Carbon cycle. General circulation models of the atmosphere and future climate scenarios. Adaptation and mitigation to climate change. United Nations Framework Convention on Climate Change and the Kyoto Protocol. Kyoto mechanisms and EU standards. Assessment of climate change impacts and adaptation measures. The case of Portugal. Renewable and nonrenewable. Issue of energy in the XXI Century. Energy market and new technologies. The case of Portugal. **New Markets and Environmental Affairs** ECTS Credits 5 **(compulsory)** The reconstructive ecology: ecosystems and landscapes recovery. The urban renewal. The market for water and waste. The recycling and reuse. The market for alternative energy: solar, wind, wave and geothermal. The optimization of energy expenditure. The networks of alternative transport. The reduction of greenhouse gas emissions and gaseous emissions market. Biomaterials and biotechnology. The environmental engineering. **Socio-Economic Impacts of Environmental Policies and Markets** ECTS Credits 5 **(compulsory)** The sociology of the environment. Employment and environment. Public consultations, environmental citizenship and participation. Access to information in environmental matters. The new socio-political forces in the environment. The role of NGO's. Environmental policies and commitments in energy and macroeconomic effects. Effects of the resolutions of the Conferences of Rio and Johannesburg the world economy. Environmental regulation and trade. The environment and cross border issues. The governance of the oceans. The policy of sustainable development worldwide. The new indicators of growth. Globalisation and the environment. The European environment policy. Portugal and environmental policies.

Institution	**University of Lisbon + New University of Lisbon**
School	Faculty of Sciences
Address	Cidade Universitária - Edifício C5, Campo Grande 1749-016 Lisboa - Portugal
Degree	Doctoral degree in climate change and sustainable development policies
Length	3 years
Requirement	180 credits
Website	http://www.alteracoesclimaticas.ics.ul.pt/pub/
Courses Related to CCS	**Adaptation and Mitigation of Climate Change** ECTS Credits 5 **(compulsory)** The main objective of this course is to understand the current state of knowledge and methods in the adaptation and mitigation of climate change. The first part aims to give students the ability to understand the current integrated assessments of impacts and adaptation measures to climate change. In the second part seeks to introduce students in issues relating to mitigation processes. It is given special emphasis to policies and instruments to mitigate climate regimes and the Kyoto Protocol and Post-Kyoto. Will be addressed the following themes: Adaptation and mitigation of climate change, sensitivity, adaptability and vulnerability to climate change, methods and tools for evaluating impacts and adaptation measures to climate change impacts of climate change: water resources, coastal systems and fisheries , agriculture (food, fiber and forest products), human health, ecosystems and biodiversity, industry, urban and rural settlements, tourism and society, adapting to climate change: practices, options and constraints; Scenarios for mitigation of emissions of greenhouse gases and its implications, technological and economic potential for reducing emissions of greenhouse gases; mitigation strategies in various sectors: energy, transport, housing and services, industry, agriculture,

	forestry and waste management; Policies and instruments mitigation; Kyoto climate regimes and post-Kyoto. **Science of Climate Change** ECTS Credits 5 **(compulsory)** The aim of this semester course is to understand the foundations and the main aspects of the science of climate change. The main focus is on the scientific basis of current concerns about anthropogenic climate change and aims to give students the ability to assess the current situation and future climate scenarios. The course begins with an analysis of the climate system and discusses the study of climate modeling and the construction of scenarios of climate change on various spatial scales. Will be addressed the following topics: The climate system Energy balance in the atmosphere, dynamics of the atmosphere and oceans, the Earth's climate history. Paleoclimatology; The carbon cycle and atmospheric carbon dioxide, changes in the concentrations of constituent gases in the atmosphere and radiative forcing; Observations of climate change: the soil surface, atmosphere, snow, ice and the mean sea level; Modeling System climate; projections of global climate, regional climate projections. **Economy and Market Regulation** ECTS Credits 5 **(compulsory)** This course introduces the fundamental concepts and methodologies of economics to deal with the impacts, mitigation and adaptation measures to climate change, with special emphasis on the instruments of economic value and market-based (market oriented). The main topics include: the foundations of economic science, the economic system, the role of economic approaches to climate change, the market to function when the prices are wrong, the need for regulation, market-oriented tools, techniques cost-benefit analysis, economic modeling and assessment of impacts of climate change, economic measures for mitigation and adaptation - the role of market-based mechanisms and fiscal. **Ethics, Public Policy and Environmental Diplomacy** ECTS Credits 5 **(compulsory)** This course will analyze the formation processes of public policy environment, in response to different events members and their representations, the global environmental crisis. Be taken into account the different models of institutionalization and grids criteria for measuring quality performance as well as the interaction of these policies with the political and administrative cultures prevailing in different national contexts studied. Special attention will be given to the role of the European Union, either as an international actor, or as reference for the horizon will shape domestic environmental policies in different Member States. The theme of climate change will be considered transversally, not forgetting his role in resetting the priorities of the agenda of the international system and environmental diplomacy. **History, Development and Environment** ECTS Credits 5 **(compulsory)** Although the phenomenon of climate change is usually identified as an issue of recent concern intends to realize the importance of Environmental History for the thorough understanding of the interactions between environment and society. To familiarize students with this expanding field of discipline, it is expected they will be able to recognize environmental factors as central in the unfolding of human history, a perspective not common in more traditional histories. After a general introduction to the discipline (objects, schools, methods), it follows a detailed study of each of the environmental issues already identified as most pressing for the effects of climate change nationally and globally. Are examined in key historical events such as floods, fires and drought, all matters which the models indicate that most of the Mediterranean societies will face more sharply in the near future. Tourism, leisure and recreation will also be considered, not only because they have significant environmental impacts, and by his own vulnerability to climate change. The aim is to understand the role of all these phenomena in the redefinition

	of social forms throughout history. Thus offers students a comprehensive view - both for different geographies, such as the multiple historical contexts - which functions as an essential tool to learn to look at the current issues related to Climate Change. Besides its own Environmental History, will still be treated the various historical forms of knowledge about the environment. Students will therefore an introduction to the history of environmental sciences from the earliest scientific theories on climate change, to the most recent forms of production developed in the IPCC scientific consensus. **Earth and Ocean Systems** ECTS Credits 5 **(compulsory)** This course aims to give a panoramic view of planetary dynamics and identify the principles of responsible and sustainable environmental future. It is described in an integrated system of the planet and its major flows of energy and resources. Addresses the evolution of life and discusses the impact of humans on the environment. Special emphasis is given to water resources, oceans, soils, ecosystems and biodiversity. It is an analysis of the contribution of science and technology in the transition to sustainability. **Sociology of Environment and Communication** ECTS Credits 5 **(compulsory)** The overall objective of this course is to address the social dimensions of climate change and, more specifically, the nature of communication is by assuming that those who generate the projected level of interaction that politically the environmental problem of climate change. Among them the perception and risk management, the construction of scientific knowledge and common, public participation and decision in context of urgency and complexity. The specific objectives of this unit are exposed in depth review and development process of the disciplinary field of Sociology of the Environment, his story and characterization - calling attention to the role of social sciences and its historic capital, in the understanding of environmental issues, deepen specific area of intersection between the Environment Sociology and Sociology of Communication - once the communication processes assume a strategic dimension in the construction of environmental knowledge, developing, by reference to various aspects of climate change, the specific problems of scientific knowledge and policy; of perception of risk and its effects on behavior; processes; social participation and new conditions for implementing public policies as social facts and communicative. **Seminar on Energy and Climate Change** ECTS Credits 5 **(compulsory)** Seminar on Energy and Climate Change aims to present information and develop case studies on technologies relating to energy impact (in) direct recognition and potential climate change, and analytical tools. It should take into consideration the following points: 1. Fossil fuel: (a) perspective on past production, consumption and prices, (b) prospects for the medium and long term; 2.Fontes energy: renewables, hydrogen, and nuclear; 3.Use energy, with emphasis on mobility and non-fossil fuels, 4. Modelling energy-environment: (a) methods of projection of energy demand, (b) optimization methods, based on the cost-effectiveness, (c) generation of marginal cost curves for CO2 reduction, restrictive scenarios for carbon, 5 . New drivers for the energy-environment relationship: the knowledge society, new energy technologies (eg CCS, smart-grid, smart metering), a new framework of social values.

Institution	**University of Porto**
School	Faculty of Chemical Engineering
Address	Rua Dr. Roberto Frias, 4200 - 465 Porto Portugal
Degree	Integrated Master Degree in Chemical Engineering

Length	5 years
Requirement	300 credits
Website	http://www.fe.up.pt/si/cursos_geral.FormView?P_CUR_SIGLA=MIEQ
Courses Related to CCS	**EQ0108 - Gaseous Emissions Control and Management** ECTS Credits 6 **(compulsory)** Air Quality Management. Atmospheric pollution: past, present and future. Pollutant classification, units for expressing concentrations. Global impacts of atmospheric pollution: climate change, depletion of stratospheric ozone, acid deposition and radiations. Strategies for air quality managing. Air quality monitoring: monitoring networks. European Union and Portuguese legislations. Atmospheric pollutants: characteristics, emission sources, control, impacts and guidelines (suspended particles, sulphur compounds, carbon monoxide, nitrogen compounds, volatile organic compounds, tropospheric ozone, noise, other atmospheric pollutants). Evolution of atmospheric pollutant concentrations in the North of Portugal. Control of Atmospheric Emissions Strategy on attack to an emission air pollution problem. Control processes. Introduction to air pollution control devices. Control devices for gaseous contaminants. Control devices for particulate contaminants.

Institution	**University of Porto**
School	Faculty of Engineering
Address	Rua Dr. Roberto Frias, 4200 - 465 Porto Portugal
Degree	Doctoral Program in Sustainable Energy Systems
Length	3 years
Requirement	
Website	http://www.fe.up.pt/si/cursos_geral.formview?p_cur_sigla=PDSSE
Courses Related to CCS	**PDSSE0001 - Energy, Environment and Sustainability** ECTS Credits 7,5 **(compulsory)** Sustainability: Concept and approaches. The CO_2 and the global warming issue. Concept of energy and its implications. The urban (demand side) sustainable projects. Environment: concept and context for energy use. The climate change issue. How to access the effects of the energy as the major environmental stress factor. **E**nergy. Concept, energy forms and sustainability. Energy conversion. Energy efficiency. Energy. Co-generation. The new energy paradigm: decentralised, renewable and demand side oriented. Impact assessment and strategic environment impact assessment. Impact of energy systems. Energy for sustainable cities: potential and rationale for cities as "control volumes" for sustainability. Sustainable buildings: Life cycle analysis. Environmental Performance of Buildings: Concept, Methodologies and Case studies. Indicators for sustainability. The qualitative and the invisible sustainability. Trends and expectations. Critical issues on energy for the future.

Institution	**University of Cordoba**
School	Graduate Studies Institute
Address	Avda. Medina Azahara, 5 14071 – Córdoba – España Phone: (0034) 957212599

	e-mail: master@uco.es
Degree	Master in Climate Change - Natural resources and Sustainability
Length	1 year
Requirement	60 credits (44 ECTS courses +16 ECTS thesis) *each credit = 28 hours of study - in conformity with the European Credit Transfer System, ECTS
Website	http://www.uco.es/idep/masteres_universitarios/masteres/oferta.php
Courses Related to CCS	**100348 - CAMBIO GLOBAL: CONVENIOS E INICIATIVAS INTERNACIONALES – 4 ECTS (elective)** **100359 - EFECTOS DEL CAMBIO GLOBAL EN LOS ECOSISTEMAS – 4 ECTS (elective)** **100350 - EVALUACIÓN Y MEDIDAS DE ADAPTACIÓN AL CAMBIO GLOBAL - 4 ECTS (elective)** **100356 - SOCIEDAD Y CAMBIO GLOBAL – 4 ECTS (elective)**

Institution	**Autonomous University of Barcelona (UAB)**
School	ICTA – Institute of Environmental Science and Technology Faculty of Science
Address	Edifici C Campus de la UAB 08193 Bellaterra (Cerdanyola del Vallès) Barcelona · Spain Tel. (+34) 93 581 29 74 Fax. (+34) 93 581 33 31 e-mail: icta@uab.cat
Degree	Master in Environmental Studies (spec. Global and Climate Changes)
Length	2 Semester
Requirement	60 ECTS
Website	http://www.uab.cat/masteroficial/estudis-ambientals/
Courses Related to CCS	**40423 – Climate change** – 10 ECTS credits / complusory 1. Introduction: Principles of Climate Change: Natural vs Anthropogenic causes of climate change, Palaeoclimatology - files and proxies, Principles of the ocean thermohaline circulation, global climate change theories: solar variation, the Milankovitch theory, dynamics, and marine transport of heat in the gateway oceans, the ocean carbon cycle and biogeochemical fluxes. 2. Methods in paleoceanography - case studies: the reading of the sedimentary record: development of time scale; Radiogenic isotopes; biology major carrier signal, stable isotopes, trace elements, SST and salinity reconstruction, rebuilding PCO2. 3. Main themes: The role of carbonate in the overall regulation and evolution of the Earth system, the extinction of biodiversity, mass and climate change: introduction; Cenozoic evolution of global climate: Greenhouse and Icehouse Worlds, Extreme climates of the past: Late Paleocene Thermal Maximum Aperture Oligocene Glacial Maximum, Late Quaternary ice ages, abrupt climate change: discontinuities and instabilities in the ocean-climate system, ENSO: present and past, changes in sea level causes, rates and amplitudes. 4. Open questions: Climates of the last millennium: directions for the future, numerical modeling of climate:? test the sensitivity of the climate-ocean warming and Atlantic hurricanes in recent decades; What can we learn from past changes in the Earth system to understand better the consequences of ongoing ocean acidification;? future climate.

	40422 - Past, Present, and Future Global Change – 10 ECTS credits / compulsory 1. Historical perspective of global change: what is climate and what is not? A thorough analysis of the distinctions between climate and global change from a variety of past timescales. 2. The modern ocean and ways in which impacts are delivered and observed. Issues to be addressed include seawater composition, air-sea interaction, ocean circulation, and marine biological productivity. 3. Global change and ecosystems impacts, with focus on the marine environment. A more detailed analysis of whole marine ecosystems, including phytoplankton on up to highest trophic levels. Particular emphasis on fisheries. 4. Global change and ecosystems impacts, with focus on local terrestrial environment. Local terrestrial impacts will be explored in detail, with particular emphasis on land use changes and recent human influences. Terrestrial carbon cycling will be deciphered through analysis of vegetation and ecosystem systems. 5. The module will include a 3-day field trip to the Catalan Pyrenees Mts., in order to explore first-hand local impacts and land use changes as functions of global change processes.

Appendix III: Database of Doctorate and Master Programs in Africa

Institution	**University of Cape Town (South Africa)**
School	Faculty of Engineering & the Built Environment (EBE)
Address	**Physical address** Faculty of Engineering and the Built Environment Room 600, 6th level Menzies Building Upper Campus Library Road University of Cape Town Rondebosch Email: ebe-faculty@uct.ac.za Tel: 021 650 2699 Fax: 021 650 3782
Degree	MSc.in Engineering in Energy & Development Studies MSc. in Engineering in Sustainable Energy Engineering
Length	
Requirement	200 NQF* credits (80 NQF credits/courses +120 NQF credits/supervised dissertation) * NQF system is based on the guideline that 10 notional hours of learning is equal to one credit.
Website	http://www.ebe.uct.ac.za/home/
Courses Related to CCS	**MEC5059Z Energy Modelling (20 NQF credits) – elective** Course outline: The syllabus will include applications of energy modelling such as energy demand projections, price projections, energy supply planning, policy planning, environmental impact assessment, climate change mitigation assessment, and integrated resource planning. Different type of models such as simulation and optimisation models will be outlined. Linkages between energy modelling, energy statistics and scenario planning will be discussed. Examples of existing energy modelling software and modelling systems will be demonstrated. Important considerations in energy modelling, such as energy-economic relationships or technology advances, will be discussed. Students will engage in exercises on modelling for energy utilities or national energy systems. After having being exposed to most energy modelling issues, students will select a project which may involve researching a particular issue in energy modelling, or involve the modelling of a particular situation. **MEC5090Z Energy & Climate Change (20 NQF credits) – elective** Course outline: Causes of climate change: greenhouse effects, carbon cycle, current status and climate variability. Future changes and impacts of climate change: emissions and concentrations, stabilisation prospects, temperature effects, ecological and socio-economic impacts. Energy development and use and climate change: GHG emissions from energy supply and use, non-GHG emissions from energy supply and use. Climate change debate and Assessment: Agenda 21, UNFCCC, Kyoto Protocol, obligations and commitments of countries, IPCC reports. Energy options for mitigation of climate change: supply, building, transport, industry erosion, waste management, and human health. Energy technology transfer: transfer trends, transfer strategies. Sustainable policies and measures: domestic, international, UNFCCC and KP instruments.

Appendix IV: Database of Doctorate and Master Programs in Oceania

Institution	University of Canterbury
School	School of Biological Sciences
Address	University of Canterbury Private Bag 4800 Christchurch 8140 New Zealand
Degree	MSc. Zoology, Ecology or Plant Biology
Length	2,5 years
Requirement	
Web site	http://www.biol.canterbury.ac.nz/biol_postgraduate.shtml
Courses Related	**BIOL474-11W - 0.2500 EFTS** **Conservation Biology** This course covers aspects of biology that are useful in applied conservation situations. In other words, what parts of science can help to preserve biodiversity? Topics covered include: what is rarity; extinction rates past and present; limiting factors in endangered species management; adaptive management using NZ birds as case studies; species concepts and conservation; genetics of threatened species; reserve design in theory and practice; conservation and climate change. **BIOL479-11W - 0.2500 EFTS** **Global Change Biology (only Zoology and Ecology)** This course will address major issues concerning the impact of human activities on the Earth system. These will include the role of terrestrial and marine ecosystems in carbon and nutrient cycling, the impacts of past climate change on biota, the significance of biodiversity loss on ecosystem processes and strategies to mitigate climate change.

Institution	University of Canterbury
School	College of Science
Address	Department of Geography University of Canterbury Private Bag 4800 Christchurch 8020 New Zealand
Degree	MSc. Geography
Length	2,5 years
Requirement	
Web site	http://www.geog.canterbury.ac.nz/postgrad.shtml

Courses Related	**GEOG408-11S2 - 0.2500 EFTS** **Cryospheric Processes and Climate Change** This course explores the nature and processes of the response of the cryosphere - the Earth's snow and ice - to climate change. Various scientific dimensions of the issue are explored, including glacier mass balance, snow pack behaviour and variability and periglacial processes. The focus is on the cryosphere in New Zealand and Antarctica. Sensitivity and response to changing climate conditions is a central theme. The course includes a field trip to the Franz Josef Glacier and the Craigieburn Mountains.

Institution	**University of Victoria**
School	Faculty of Law
Address	Victoria University of Wellington Government Buildings 55 Lambton Quay Wellington 6011
Degree	Master of Laws
Length	One-year full-time, or up to three-year part-time
Requirement	
Web site	www.victoria.ac.nz/law
Courses Related	**ENVI 522 – Environmental Law** A practical survey of the law and theories of law as they affect environmental management. Students will be introduced to the basics of environmental legal philosophy and principles applying to the making of law about environmental matters, as well as the basics of the NZ legal system and where environmental laws, the courts and government regulation fit into that system. Key statutes such as the Resource Management Act and Hazardous Substances and New Organisms Act will be introduced and their basic workings examined by way of case studies and practical exercises. The new emissions trading legislation and other law relating to climate change will also be surveyed. **ENVI 528** **Climate Change Issues** An examination of the history and science of climate change, conceptualising the policy issues, climate policy and action.

Institution	**University of Victoria**
School	School of Biological Sciences
Address	Room KK 507 New Kirk Building Victoria University of Wellington Wellington 6012
Degree	Master of Marine Conservation
Length	One-year full-time, or up to three-year part-time
Requirement	

Web site	http://www.victoria.ac.nz/sbs/
Courses Related	**BIOL 419 – Principles of Marine Conservation** A course detailing principles and skills relating to human impacts on the marine environment and their measurement. Topics include: populations and extinction risks; physical pollution; exploitation of marine bioresources, including fisheries ecology; bioinvasions and disease; global climate change and the future of the world's oceans.

Institution	**University of Victoria**
School	School of Sciences
Address	School of Geography, Environment and Earth Sciences Room CO 311 (Level 3) Cotton Building Victoria University of Wellington Wellington 6012 New Zealand
Degree	Master of Science in Physical Geography
Length	One-year full-time, or up to three-year part-time
Requirement	
Web site	http://www.victoria.ac.nz/sgees/study/postgraduate-study/physical-geography/default.aspx
Courses Related	**PHYG 414** **Climate Change: Lessons from the past** The course investigates the physical dimension of natural hazards and risks by studying the occurrence of and global trends in natural hazards and risks by understanding their nature and identifying the risk they represent in a global context. The human dimension is considered by studying the assessment and management of human vulnerability in the face of those identified natural hazards and risks.

Institution	**University of Waikato**
School	Faculty of Law
Address	Te Piringa - Faculty of Law The University of Waikato - Te Whare Wānanga o Waikato Last modified: 07 Jun 2011 11:37am
Degree	Master of Laws
Length	Minimum: two full-time semesters Maximum of eight consecutive semesters of part-time study
Requirement	The LLM degree comprises the equivalent of four Level 5 papers. The four papers amount to the equivalent of one year's full-time work. The papers may be taken over a minimum of two full-time semesters, or a maximum of eight consecutive semesters of part-time study. The papers offered are all internally assessed. There are no final examinations. An approved paper at a comparable level in another faculty may be substituted for one of the law papers.

Web site	http://www.waikato.ac.nz/law/research/concentration-on-environment,-resources,-and-energy-law
Courses Related	**LAWS571C Special Topic:** **International Trade Regulations: Emerging Issues (30 points)** This paper will examine the legal aspect of international trade including the current negotiations at the World Trade Organization known as the 'Doha Development Agenda'. The course will further focus on two special and timely topics; the emerging issues of regionalism, namely trade and investment developments outside the WTO; and trade-related aspects of environmental protection particularly climate change. On the former, special regard will be given to the ongoing debates on Australia New Zealand Closer Economic Relations, NZ free trade agreements in particular the one with China and the ongoing negotiations to include the United States among other countries in the Trans-Pacific Strategic Economic Partnership Agreement.

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Appendix V: Summary Table of Mapped Doctorate and Master Degrees – The Americas

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Argentina	University of Palermo	Faculty of Law	MSc. Environmental Law	Science and Environment – Elective
Brazil	Pontifical Catholic University of Rio Grande do Sul	Faculty of Engineering	MSc PhD (Engineering and Materials Technology)	Materials and Processes for Carbon Capture and Storage Materials and Technologies for Mitigation of Environmental Impacts
Brazil	University of São Paulo	Geosciences Institute	MSc PhD (Geosciences)	Climate Changes in Earth's present and past
Canada	University of Alberta	Department of Earth and Atmospheric Sciences	Master of Arts Master of Science Doctor of Philosophy (Earth and Atmosferic Sciences)	EAS 457: Global Change EAS 471: Atmospheric Modelling EAS 493: Human Dimensions of Environmental Change EAS 593: Advanced Human Dimensions of Global Change
Canada	University of British Columbia	Faculty of Applied Science and The Clean Energy Research Centre	* Master of Engineering (M.Eng.) on Clean Energy Engineering	CEEN 523 Energy and the Environment (compulsory) CEEN 501 Thermal Energy Systems (compulsory)
Canada	University of British Columbia	Institute of Resources Management and Environmental Studies	Master of Art Masters of Science (Resources Management and Environmental Studies)	RMES 520 Climate Change in the 21st Century

Canada	University of Calgary	Geosciences	Master of Science (M.Sc.) on Geosciences – *spec.* on *Reservoir Characterization*	GLGY 613 - Flow in Porous Media (or ENPE 525 – Waterflooding and Enhanced Oil Recovery)
Canada	University of Calgary	Schulich School of Engineering - Department of Chemical and Petroleum Engineering	M.Eng. / M.Sc. / Ph. D (spec. in Chemical Engineering) *M.Eng. (*spec. in Petroleum Exploration Engineering)	Chemical Engineering 647 - Thermal Recovery Methods Chemical Engineering 621 - Reservoir Simulation Chemical Engineering 643 (Environmental Engineering 641) - Air Pollution Control Engineering Chemical Engineering 647 - Thermal Recovery Methods. Chemical Engineering 629 - Secondary and Tertiary Recovery
Canada	University of Calgary	Schulich School of Engineering - Department of Electrical and Computer Engineering	Master of Engineering Master of Science Doctor of Philosophy (Electrical Engineering)	Electrical Engineering 669 (formerly Electrical Engineering 619.52) - Renewable Energy and Solid State Lighting for the Developing World Electrical Engineering 581 - Renewable Energy and Solid State Lighting for Human Development
Canada	University of Regina	Faculty of Engineering	Master of Applied Science Master of Engineering Doctor of Philosophy (Petroleum Systems Engineering)	ENPE 831 Advanced Enhanced Oil Recovery (3)

Canada	University of Saskatchewan	School of Environment and Sustainability	Master in Sustainable Environmental Management (M.SEM.)	ENVS 802.3 – Human Dimensions of Environmental Change (compulsory) ENVS 831.3 – Current Issues in Land Reclamation and Remediation (restricted set of electives) ENVS 898.3 - Environmental Economics and Policy Making (restricted set of electives) GEOE 412.3 **–** Reservoir Mechanics (elective) GEOL 463.3 — Petroleum Geology
Canada	University of Saskatchewan	School of Environment and Sustainability	Master of Environment and Sustainability (M.E.S.)	ENVS 802.3 – Human Dimensions of Environmental Change (compulsory) ENVS 803.3 – Research in Environment and Sustainability (compulsory) GEOE 412.3 – Reservoir Mechanics (elective) GEOL 463.3 – Petroleum Geology (elective)
Chile	Pontifical Catholic University of Chile	School of Engineering	Master in Energy Engineering	IEN 3620 Hydrogen Production and uses (elective)
USA	Harvard University	Graduate School of Arts and Sciences - Department of Earth and Planetary Sciences (EPS)	Doctor of Philosophy (Earth and Planetary Sciences)	EPS 132. Introduction to Meteorology and Climate EPS 134. Global Warming Debates: The Reading Course
USA	Princeton University	School of Engineering and Applied Science – Department of Civil and Environmental Engineering	Master in Engineering Master of Science Doctor of Philosophy (Engineering and Water Resources)	CEE 599 - Topics- Enviro Eng'ing & Water Resources

USA	University of California, Los Angeles	Department of Atmospheric and Oceanic Sciences	Master Ph.D. (Atmospheric and Oceanic Sciences)	M235. Ocean Biogeochemical Dynamics and Climate (4) (elective)
USA	University of Delaware	College of Earth, Ocean and Environment – Department of Geography	Master of Science Doctor of Philosophy (Geography)	GEOG152 – Climate and Life (4hrs) GEOG236 - Conservation: Global Issues (3hr) GEOG417 - Seminar in Climate Change (3hr)
USA	University of Washington	College of the Environment - Department of Earth and Space Sciences	M.S. Ph.D. (geological sciences and geophysics)	ESS 559 Climate Modeling (3) (elective) ESS 585 Climate Impacts on the Pacific Northwest (4) (elective) ESS 586 Current Research in Climate Change (2, max. 20) (elective) ESS 587 Climate Dynamics (3) (elective) ESS 588 The Global Carbon Cycle and Climate (3) (elective)

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Appendix VI: Summary Table of Mapped Doctorate and Master Degrees – Europe

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Denmark	University of Copenhagen	Faculty of Law	Master of Law (LLM)	Climate Change and the Law (10 ECTS) International Energy Law and Sustainability (10 ECTS)
Denmark	Technical University of Denmark	Department of Chemical Engineering	MSc. Petroleum Engineering Technological Specialisation Course MSc. in Chemical and Biochemical Engineering	28415 Oil and gas production (5 ECTS) – compulsory optional course (Technological Specialization Courses) 28515 Enhanced Oil Recovery (5 ECTS) - compulsory optional course (Technological Specialization Courses)
France	University of Paris X – Nanterre la Défense		MSc – Professional Management, Economics (Speciality: Economics and politics of energy and environment)	→ specific courses were not mapped
Ireland	University College Dublin	College of Engineering, Mathematical and Physical Sciences	Master Energy Systems Engineering	*Compulsory:* Energy Systems & Climate Change Chemical Processes of Sustainable and Renewable Energy Fossil Fuels, Carbon Capture & Storage *Elective:* Power System Engineering Energy in Transport

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Norway	University of Oslo	Department of Economics	Master of Philosophy in Economics (spec. Environmental, Resource- and Development economics)	ECON4910: Environmental Economics (10 credits) – optional compulsory course
Norway	Norwegian University of Science and Technology (NTNU)	Faculty of Engineering Science and Technology Department of Petroleum Engineering and Applied Geophysics	MSc in Petroleum Engineering - MSG1 MSc. in Petroleum Geosciences (MSG2) PhD.	TPG4150 - Reservoir Recovery Techniques (7.5 ECTS) – compulsory for MSG1/ optional for MSG2 TPG4117 - Unconventional Oil and Gas Reservoirs (7.5 ECTS) – optional for specialization in Reservoir Engineering PG8604 - Enhanced Oil Recovery (7.5 ECTS) – Study level: Doctoral degree level
Norway	Norwegian University of Science and Technology (NTNU)	Faculty of Engineering Science and Technology Department of Energy and Process Engineering (EPT)	MSc. in Natural Gas Technology	→ Specialization option: Thermal power Cycles including CO2 capture
Norway	Norwegian University of Science and Technology (NTNU)	Faculty of Engineering Science and Technology	PhD in Energy and Process Engineering	→ Research fields Area 1: Thermal Energy • Airpolution and CO_2 capture
Netherlands	Delft University of Technology (TUD)	Faculty of Civil Engineering and Geosciences (CiTG) Department of Geotechnology	MSc Applied Earth Sciences - track Petroleum Engineering and Geosciences (specializations: Petroleum Engineering / Reservoir Geology)	AES1340 - Applied Reservoir Engineering & Simulation, part I (2 ECTS) - Compulsory AES1350 - Applied Reservoir Engineering & Simulation, part II (2 ECTS) – Compulsory only for spec. Petroleum Engineering WM0916TA - Special Topics Geotechnology and Sustainable Development (2ECTS) – Elective for spec. Petroleum Engineering

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Netherlands	Delft University of Technology (TUD)	Faculty of Civil Engineering and Geosciences (CiTG) Department of Geotechnology	MSc Applied Earth Sciences – track Resource Engineering (Spec. Geotechnical and Environm. Engineering)	EGEC-M/EG - (Miskolc) Environmental Geology & Geophysics (2007)- Compulsory EGEC-W/UW - (Wroclaw) Underground Waste Management (2ECTS) – Compulsory
Netherlands	University of Amsterdam (UvA)	Master School of Life and Earth sciences	MSc. Earth Sciences – Environmental Management MSc. Earth Sciences – Geo-Ecological Dynamics	AW4230 – Climate Change (6 EC of 12 EC) – Optional from the "Optional compulsory courses list" for Environmental Management / Elective for Geo-Ecological Dynamics Paleo-ecology and Global Change (6 EC) - Optional from the "Optional compulsory courses list"
Netherlands	University of Amsterdam (UvA)	Amsterdam Graduate Law School	LLM International and European Law - Public International Law	M2420 - International Environmental Law (5 EC) - Elective
Netherlands	University of Groningen	Faculty of Law	LL.M in International Law and the Law of International Organizations	International Environmental Law (seminar, 6 credits) – Optional from the "Optional compulsory courses list" Energy Law (5 credits) - Elective
Netherlands	University of Groningen	Faculty of Law	LL.M in European Law	International Environmental Law (seminar - 6 credits) – Elective Energy Law (5 credits) - Elective European Environmental Law (6 credits) - Elective

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Netherlands	University of Utrecht	Faculty of Geosciences	MSc. Earth Sciences - Geology (specialization Sedimentary Systems)	GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS) – Compulsory (specialization in Sedimentary Systems) GEO4-1412 – Astronomical climate forcing & time scales (7.5 ETCS) – Compulsory (specialization in Sedimentary Systems) GEO4-1420 - Organic geochemistry (7.5 ETCS) - Elective
Netherlands	University of Utrecht	Faculty of Geosciences	MSc. Earth Sciences - Geochemistry	GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS) GEO4-1420 - Organic geochemistry (7.5 ETCS) - Compulsory GEO4- 4423 – Hydrology, climate change and fluvial systems (7.5 ETCS) - elective GEO4-1412 – Astronomical climate forcing & time scales (7.5 ETCS) – Elective
Netherlands	University of Utrecht	Faculty of Geosciences	MSc. Earth Sciences - Hydrology (spec. Earth Surface Hydrology)	GEO4- 4423 – Hydrology, climate change and fluvial systems (7.5 ETCS) – Compulsory for spec. on Earth Surface Hydrology GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS) - Elective GEO4-1420 - Organic geochemistry (7.5 ETCS) - Elective GEO4-1412 – Astronomical climate forcing & time scales (7.5 ETCS) – Elective

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Netherlands	University of Utrecht	Faculty of Geosciences	MSc. Earth Sciences - Biogeology	GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS) - Elective GEO4-1412 – Astronomical climate forcing & time scales (7.5 ETCS) – Optional from a 2/3 optional-compulsory courses list B-MABP - Advanced Botanical Paleoecology – Extreme Climate Transitions - Optional from optional-compulsory courses list
Netherlands	University of Utrecht	Faculty of Geosciences	MSc. Earth Sciences - Physical Geography (specializations: Coastal Dynamics and Fluvial Systems / Natural Hazards and Earth Observation)	GEO4- 4423 – Hydrology, climate change and fluvial systems (7.5 ETCS) – Optional from a 3/6 optional-compulsory courses list GEO4- 4430 Advanced Course in Quaternary Geology and Climate Change (7.5-15 ETCS) - Elective GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS) - Elective GEO4-1420 - Organic geochemistry (7.5 ETCS) - Elective
Netherlands	University of Utrecht	Faculty of Geosciences	MSc. Earth Sciences - Physical Geography (specialization: Quaternary Geology and Climate Change)	GEO4- 4423 – Hydrology, climate change and fluvial systems (7.5 ETCS) –Compulsory GEO4-4430 Advanced Course in Quaternary Geology and Climate Change (7.5-15 ETCS) - Elective GEO4-1405 - Paleo oceanography and climate variability (7.5 ETCS) - Elective GEO4-1420 - Organic geochemistry (7.5 ETCS) - Elective

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Netherlands	University of Utrecht	Graduate School of Natural Sciences and Faculty of Science	MSc. Energy Science	GEO4-2311 – SUSD - Energy and Resources Policies (7.5 ECTS) - Compulsory GEO4-2307 –SUSD - Research Methods for Energy and Materials (7.5 ECTS) - Compulsory NS-MO501M - NS-Simulation of Ocean, Atmosphere and Climate (7.5 ECTS) – Elective NS-MO440M - NS-Topics in Climate Science (7.5 ECTS) – Elective
Netherlands	University of Utrecht	School of Law Faculty of Law, Economics & Governance	LLM (Master of Laws) Public International Law	RGMAIN450 - International Environmental Law (7.5 ECTS) - Compulsory RGMAIN750 - International Law of the Sea (7.5 ECTS) – Optional (Choice of one course out of three options)
Netherlands	VU University Amsterdam	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology	MSc Environment and Resource Management – specializations: Environmental Studies / Energy Studies	468020 - Environmental Economics (6 credits) - Compulsory for both specializations 468022 - Environmental Problems: Case Studies (6 credits) - Compulsory only for spec. in Environmental Studies 450188 - Climate and Policy (6 credits) – Compulsory

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Netherlands	VU University Amsterdam	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology	MSc Palaeoclimatology & Geo-ecosystems	450188 - Climate and Policy (6 credits) – Compulsory 450004 - Climate Modelling (6 credits) - Compulsory 450146 - From Source to Sink: Chemical and Physical Cycles (6 credits) - Compulsory 450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits) – Compulsory 450185 - Modern Climate Systems (3 credits) - Compulsory 450313 - Modern Geo-ecosystems (3 credits) – Compulsory 450266 - Practical: Palaeoclimate Change and Environmental Impacts (3 credits) - Compulsory 450330 - Sedimentary Environments and Climate Archives (6 credits) - Compulsory
Netherlands	VU University Amsterdam	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology	MSc. Earth Sciences (spec. Applied Environmental Geoscience)	450185 - Modern Climate Systems (3 credits) - Compulsory 450313 - Modern Geo-ecosystems (3 credits) – Compulsory 450146 - From Source to Sink: Chemical and Physical Cycles (6 credits) - Compulsory 450266 - Practical: Palaeoclimate Change and Environmental Impacts (3 credits) - Compulsory 450330 - Sedimentary Environments and Climate Archives (6 credits) - Compulsory 450004 - Climate Modelling (6 credits) - Elective 450188 - Climate and Policy (6 credits) – Elective

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Netherlands	VU University Amsterdam	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology	MSc. Earth Sciences (spec. Earth Sciences and Economics - *Theme: Climate and Geo-ecosystems*)	450185 - Modern Climate Systems (3 credits) – Compulsory 450313 - Modern Geo-ecosystems (3 credits) – Compulsory 450188 - Climate and Policy (6 credits) – Compulsory 60422150 - International Environmental Economics (6 credits) - Compulsory 450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits) – Compulsory 450330 - Sedimentary Environments and Climate Archives (6 credits) - Optional from the "Optional Compulsory courses list" - theme Climate and Geo-ecosystems
Netherlands	VU University Amsterdam	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology	MSc. Earth Sciences (spec. Earth Sciences and Economics - *Theme: Water and Ecology)*	468020 - Environmental Economics (6 credits) - Optional from the "Optional Compulsory courses list" - theme Water and Ecology 470502 - Spatial Ecology and Global Change (6 credits) - Optional from the "Optional Compulsory courses list" - theme Water and Ecology 450188 - Climate and Policy (6 credits) – Elective 450004 - Climate Modelling (6 credits) - Elective 450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits) – Elective

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Netherlands	VU University Amsterdam	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology	MSc. Earth Sciences (specialization: Earth Sciences and Economics - *Theme: Energy)*	468020 - Environmental Economics (6 credits) - Optional from the "Optional Compulsory courses list" - theme Energy 60422150 - International Environmental Economics (6 credits) - Optional from the "Optional Compulsory courses list" - theme Energy 450188 - Climate and Policy (6 credits) – Elective 450004 - Climate Modelling (6 credits) - Elective 450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits) – Elective
Netherlands	VU University Amsterdam	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology	MSc. Geosciences of Basins and Lithosphere	450146 - From Source to Sink: Chemical and Physical Cycles (6 credits) – Compulsory 450188 - Climate and Policy (6 credits) – Elective 450004 - Climate Modelling (6 credits) - Elective 450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits) – Elective
Netherlands	VU University Amsterdam	Faculty of Earth and Life Sciences Graduate School Earth, Environment and Ecology	MSc. Hydrology (specialization: Hydrogeology or Ecohydrology)	450188 - Climate and Policy (6 credits) – Elective 450004 - Climate Modelling (6 credits) - Elective 450187 - Man and Climate: From Hominids to Modern Civilisation (3 credits) – Elective
Netherlands	VU University Amsterdam	Faculty of Economics and Business Administration Department Economics	MSc in Spatial, Transport and Environmental Economics	468020 - Environmental Economics (6 credits) - Optional from the "Optional Compulsory courses list – Core courses" 60422150 - International Environmental Economics (6 credits) - Optional from the "Optional Compulsory courses list"

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Netherlands	VU University Amsterdam	Faculty of Economics and Business Administration Department Economics	MSc in Economics (specialization Spatial Economics)	60422150 - International Environmental Economics (6 credits) – Compulsory (for Specialization in Spatial Economics)
Poland	University of Warsaw	Faculty of Economic Sciences	Master of Arts in Development Economics (MADE)	2400-ITC-2 International Environmental Cooperation (5 ECTS) - optional course
Portugal	New University of Lisbon	Faculty of Sciences	Doctoral degree in climate change and sustainable development policies	Adaptation and Mitigation of Climate Change ECTS Credits 5 (compulsory) Science of Climate Change ECTS Credits 5 (compulsory) Economy and Market Regulation ECTS Credits 5 (compulsory) Ethics, Public Policy and Environmental Diplomacy ECTS Credits 5 (compulsory) History, Development and Environment ECTS Credits 5 (compulsory) Earth and Ocean Systems ECTS Credits 5 (compulsory) Sociology of Environment and Communication ECTS Credits 5 (compulsory) Seminar on Energy and Climate Change ECTS Credits 5 (compulsory)

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Portugal	University of Coimbra	Faculty of Sciences and Technology – Department of Civil Engineering	Integrated Master Degree in Environmental Engineering	01003974 - Global changes and Climatology ECTS Credits 6.0 (compulsory) 01005462 - Risk Analysis ECTS Credits 4.5 (compulsory)
Portugal	University of Évora	School of Science and Technology	Master degree in Earth, Atmospheric and Space Science Specialization: Geological Processes	FIS7922 - Seminar in Earth Sciences, Atmospheric and Space ECTS Credits 4 (compulsory) FIS7927 - Methods and observation techniques in Earth, Atmospheric and Space ECTS Credits 4 (compulsory) FIS7757 - Resources, Energy and Environment ECTS Credits 4 (elective) GEO7954/GEO7956 - Geographic Information Systems in Earth, Atmospheric and Space I and II ECTS Credits 12 (elective)

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Portugal	University of Évora	School of Science and Technology	Master degree in Earth, Atmospheric and Space Science Specialization: Atmospheric Physics and Climate	FIS7931 - Atmosphere and Climate Physics ECTS Credits 6 (compulsory) FIS7757 - Resources, Energy and Environment (compulsory) FIS7924 - Atmosphere and Space Remote Sensing ECTS Credits 4 (compulsory) FIS7927 - Methods and observation techniques in Earth, Atmospheric and Space ECTS Credits 4 (compulsory) FIS7765 – Climate, Climate Modeling and Climate Change ECTS Credits 6 (compulsory) GEO7954 Geographic Information Systems in Earth, Atmospheric and Space I ECTS Credits 4 (elective) FIS7910 - Anthropogenic impacts on the Atmospheric Environment ECTS Credits 4 (elective) FIS7766 - Gases and Aerosols Dispersion in Atmosphere ECTS Credits 4 (elective)

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Portugal	University of Évora	School of Science and Technology	Master degree in Earth, Atmospheric and Space Science Specialization: Internal Geophysics	FIS7922 - Seminar in Earth Sciences, Atmospheric and Space ECTS Credits 4 (compulsory) FIS7757 - Resources, Energy and Environment ECTS Credits 4 (compulsory) FIS7927 - Methods and observation techniques in Earth, Atmospheric and Space ECTS Credits 4 (compulsory) GEO7954 Geographic Information Systems in Earth, Atmospheric and Space I ECTS Credits 4 (elective) FIS7910 - Anthropogenic impacts on the Atmospheric Environment ECTS Credits 4 (elective) FIS7766 - Gases and Aerosols Dispersion in Atmosphere ECTS Credits 4 (elective)
Portugal	University of Lisbon	Faculty of Sciences	Master degree in Environmental Sciences and Technologies	Environmental Law and International Relations ECTS Credits 5 (compulsory) Environmental Economy ECTS Credits 5 (compulsory) Conversion Technologies and Environmental Requalification ECTS Credits 5 (compulsory) Climate Change and Renewable Energy ECTS Credits 5 (compulsory) New Markets and Environmental Affairs ECTS Credits 5 (compulsory) Socio-Economic Impacts of Environmental Policies and Markets ECTS Credits 5 (compulsory)

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Portugal	University of Lisbon	Faculty of Sciences	Doctoral degree in climate change and sustainable development policies	Adaptation and Mitigation of Climate Change ECTS Credits 5 (compulsory) Science of Climate Change ECTS Credits 5 (compulsory) Economy and Market Regulation ECTS Credits 5 (compulsory) Ethics, Public Policy and Environmental Diplomacy ECTS Credits 5 (compulsory) History, Development and Environment ECTS Credits 5 (compulsory) Earth and Ocean Systems ECTS Credits 5 (compulsory) Sociology of Environment and Communication ECTS Credits 5 (compulsory) Seminar on Energy and Climate Change ECTS Credits 5 (compulsory)
Portugal	University of Porto	Faculty of Chemical Engineering	Integrated Master Degree in Chemical Engineering	EQ0108 - Gaseous Emissions Control and Management ECTS Credits 6 (compulsory)
Portugal	University of Porto	Faculty of Engineering	Doctoral Program in Sustainable Energy Systems	PDSSE0001 - Energy, Environment and Sustainability ECTS Credits 7,5 (compulsory)

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
Spain	University of Córdoba	Graduate Studies Institute	Master in Climate Change: Natural resources and Sustainability	100348 - Cambio Global: Convenios E Iniciativas Internacionales (4 Ects - Compulsory) 100359 - Efectos Del Cambio Global En Los Ecosistemas (4 Ects - Elective) 100350 - Evaluación Y Medidas De Adaptación Al Cambio Global (4 Ects - Elective) 100356 - Sociedad Y Cambio Global (4 Ects - Elective)
Spain	Autonomous University of Barcelona (UAB)	ICTA – Institute of Environmental Science and Technology	Master in Environmental Studies (spec. Global and Climate Changes)	40423 – Climate change – 10 ECTS credits/ compulsory 40422 - Past, Present, and Future Global Change – 10 ECTS credits / compulsory

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Appendix VII: Summary Table of Mapped Doctorate and Master Degrees – Africa

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
South Africa	University of Cape Town	Faculty of Engineering & the Built Environment (EBE)	MSc.in Engineering in Energy & Development Studies MSc. in Engineering in Sustainable Energy Engineering	MEC5059Z Energy Modelling (20 NQF credits) – elective MEC5090Z Energy & Climate Change (20 NQF credits) – elective

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Appendix VIII: Summary Table of Mapped Doctorate and Master Degrees – Oceania

Country	Institution	School/Department	Degrees offered	Courses with topics on CCS and Environmental Changes
New Zealand	University of Canterbury	School of Biological Sciences	MSc. Zoology, Ecology or Plant Biology	BIOL474-11W - 0.2500 EFTS Conservation Biology BIOL479-11W - 0.2500 EFTS Global Change Biology (only Zoology and Ecology)
New Zealand	University of Canterbury	College of Science Department of Geography	MSc. Geography	GEOG408-11S2 - 0.2500 EFTS Cryospheric Processes and Climate Change
New Zealand	University of Victoria	Faculty of Law	Master of Laws	ENVI 522 Environmental Law ENVI 528 Climate Change Issues
New Zealand	University of Victoria	School of Biological Sciences	Master of Marine Conservation	BIOL 419 Principles of Marine Conservation
New Zealand	University of Victoria	School of Sciences	Master of Science in Physical Geography	PHYG 414 Climate Change: Lessons from the past
New Zealand	University of Waikato	Faculty of Law	Master of Law	LAWS571C Special Topic - International Trade Regulations: Emerging Issues (30 points)

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Appendix IX: List of All Surveyed Universities

THE AMERICAS	
Argentina	University of Buenos Aires University of Cordoba National University of Technology University of Salvador (Universidad del Salvador) University of Palermo
Brazil	Pontifical Catholic University of Rio Grande do Sul University of São Paulo State University of Rio de Janeiro Federal University of Rio de Janeiro Pontifical Catholic University of Rio de Janeiro Federal University of Rio Grande do Sul
Canada	University of Alberta University of British Columbia University of Calgary University of Regina University of Saskatchewan University of Waterloo
Chile	Pontifical Catholic University of Chile
Colombia	University of Andes National University of Colombia
Ecuador	Pontifical Catholic University of Ecuador Central University of Ecuador
Mexico	National Autonomous University of Mexico University of Guadalajara
United States of America	University of Tennessee University of Chicago University of Washington Princeton University University of California, Los Angeles University of Delaware Stanford University Harvard University
Uruguay	Republic Univesity University of Montevideo
Venezuela	Central University of Venezuela

EUROPE	
Austria	University of Vienna
Belgium	Catholic University of Louvain University of Antwerp University of Ghent
Czech Republic	Czech Technical University in Prague
Denmark	Aarhus University Aalborg University Technical University of Denmark University of Copenhagen
Finland	University of Eastern Finland University of Helsinki
France	Aix-Marseille University (University of Provence/ University of the Mediterranean/ Paul Cézanne University/ University of Avignon) INSA Lyon (National Institute of Applied Sciences of Lyon) Lille University of Science and Technology Toulouse 1 University Capitole University of Bordeaux (I, II, III, IV) University of Lyon University of Paris-Sorbonne (Paris IV) University of Paris X – Nanterre la Défense
Germany	Heidelberg University Technische Universitaet Darmstadt University of Leipzig University of Mannheim University of Munich University of Rostock University of Tübingen
Greece	Aristotle University of Thessaloniki University of Athens University of Macedonia
Ireland	UCD University College Dublin University of Limerick (Limerick) University College Cork (Cork) Dublin City University (Dublin) Trinity College Dublin (Dublin) National University of Ireland - Galway Dublin Institute of Technology (Dublin) National University of Ireland - Maynooth Institute of Technology Blanchardstown
Italy	University of Bari University of Bologna University of Brescia University of Cagliari University of Catania University of Florence University of Genoa

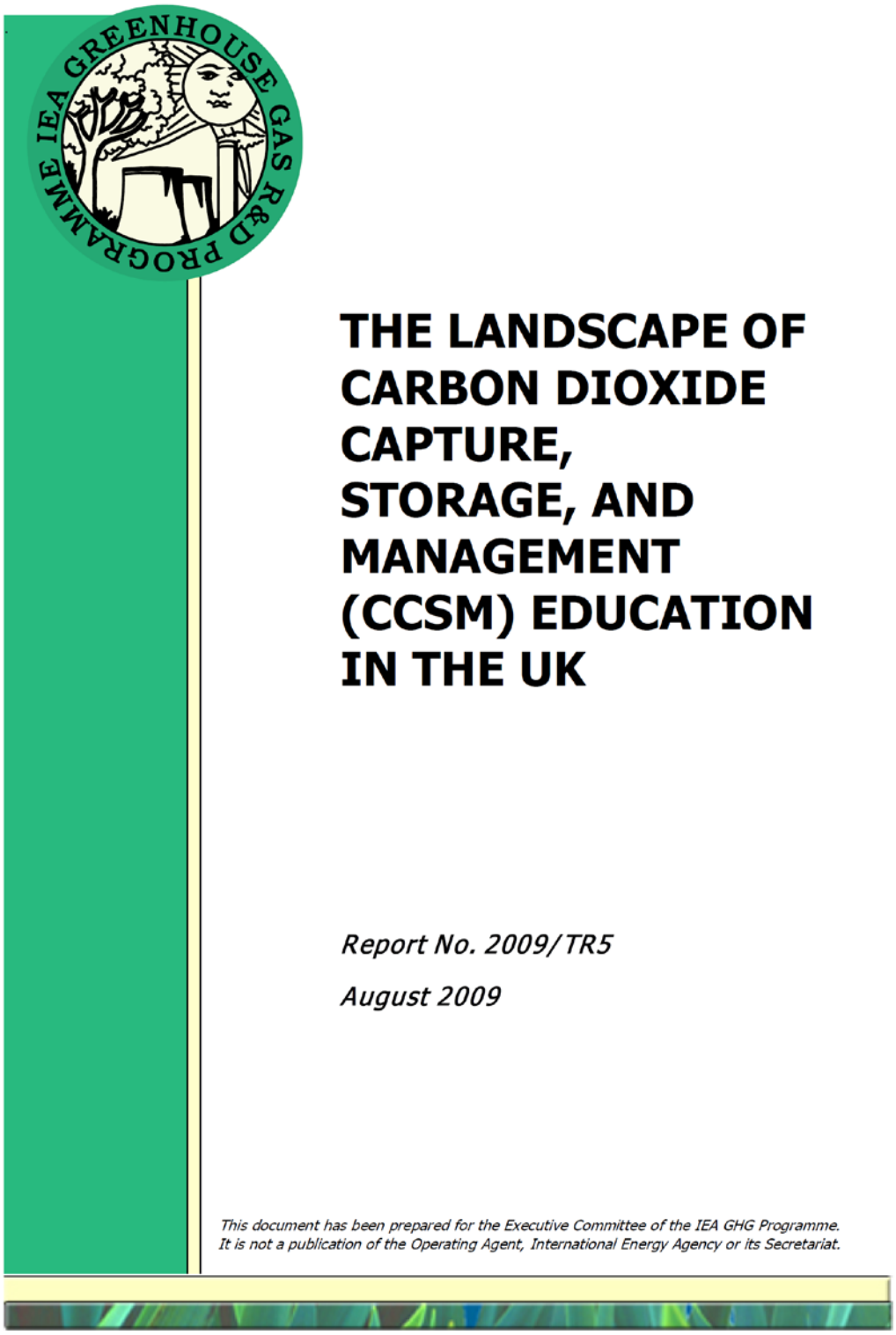
EUROPE	
	University of Milan University of Milan-Bicocca University of Naples Frederico II University of Palermo University of Parma University of Rome Tor Vergata
Netherlands	University of Amsterdam VU University Amsterdam (Free University Amsterdam) University of Groningen Leiden University Maastricht University University of Utrecht Erasmus University Rotterdam Tilburg University Delft University of Technology Eindhoven University of Technology University of Twente
Norway	The University Centre in Svalbard University of Agder University of Bergen University of Oslo University of Tromsø
Poland	Lublin University of Technology Nicolaus Copernicus University Technical University of Radom University of Bielsko-Biała University of Warmia and Mazury in Olsztyn University of Warsaw
Portugal	Catholic University of Portugal New University of Lisbon University of Algarve University of Aveiro University of Coimbra University of Évora University of Lisbon University of Minho University of Porto
Romania	Universitatea Babeş-Bolyai, Cluj-Napoca
Spain	University of Cordoba Autonomous University of Barcelona International University of Andalucía (Seville) Autonomous University of Madri
Sweden	Linköping University Stockholms universitet Lunds universitet Kungliga Tekniska Uppsala Universitet Swedish University of Agricultural Sciences

ASIA	
Japan	The University of Tokyo Hokkaido University Kyoto University
Korea	Korea University

AFRICA	
South Africa	University of South Africa University of Cape Town University of Pretoria

OCEANIA	
New Zealand	University of Canterbury University of Victoria University of Waikato Lincoln University University of Auckland

ANNEX 1 – UK Report: "The Landscape of CCSM Education in the UK"



ANNEX 2 – Australian Report: "Mapping of CO_2 Capture, Storage, and Management (CCSM) Graduate Programs in Australia"

Prepared for Carbon Sequestration Leadership Forum (CSLF)

CCS in the Academic Community Task Force

Mapping of CO_2 Capture, Storage, and Management (CCSM) Graduate Programs in Australia

Draft 20 June 2011