FEEM Scientific Advisory Board

FEEM Research

Organisation and Activities

2011-2013

November 2010

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Executive Summary

This document summarizes the proposed research activities to be carried out at FEEM in the years 2011-2013. The research plan has been built on the indications of Eni's Board of Directors and has incorporated the suggestions and recommendations of the Scientific Advisory Board. In particular, it is proposed that the research activities of FEEM are re-organized around the following **two research programmes**:

- **Climate Change and Sustainable Development**
- **Energy: Resources and Markets**

By focusing on these two research streams, FEEM will be able to exploit its comparative advantage in terms of human capital, expertise and reputation, and to address some of the most pressing issues whose understanding commands economic research of the highest quality.

Regarding the integration of the other research programmes currently in place, the Scientific Advisory Board recommends to continue high value research only conditional to FEEM having specific skills and knowledge in such activities and on the premises that those can be gradually incorporated into the two major streams of research.

The research stream "**Climate Change and Sustainable Development"** is one where FEEM has been able to generate an enormous amount of research in the past several years, and where its expertise and international standing are top ranking. The research activities in the next three years are meant to consolidate this status, by providing top quality socio-economic analysis in key areas like:

1. Climate Change Integrated Assessment Modelling
2. Climate Change Policy
3. Climate-related Innovation and Technological Change
4. Natural Hazards and Extreme Climate-related Events
5. Management of Natural Resources
6. Sustainability and Growth Beyond GDP

In addition, the program will promote innovative research into emerging research areas like climate engineering, climate finance and governance, and will aim at maximizing the synergies across the various dimensions of global environmental challenges, such as the interaction between climate, water and land use management.

The research area "**Energy: Resources and Markets"** is expected to generate sound economic reasoning and analysis in a strategic area for action in the coming decades. FEEM expertise on energy has traditionally been centred on the environmental or regulation aspects, and although such synergies will continue to be exploited, substantial effort will also be channelled towards the analysis of energy problems that are only marginally related to the environment. Specifically, the following research topics will be given priority:

1. Energy Markets Globally
2. Determinants of Energy Consumption
3. Energy Technologies and Innnovation (Supply)

In particular, the relation between the fundamental drivers and the demand for energy services, and the needed adjustments on the supply side, will be assessed globally, with a particular focus on fast growing economies such as China. The impacts of these changing patterns on the global energy markets, including prices, will also become a central topic of research.

Similarly, a focus will be given to the role of technological change, both on the production and consumption sides, and its impact on the management of energy resources and the implementation of energy policies. The analysis will focus on the medium-long term (e.g. to 2030 and beyond), and will involve the creation of dedicated databases and methodological instruments.

In terms of resources, the proposed research plan entails different efforts for the two programmes. The climate one has secured considerable financial and human assets that will allow it to grow over the next few years, whereas the energy group will require dedicated investments in human capital, knowledge, methodological instruments, in order to fully develop and achieve the proposed research goals. Initially, the strong synergies between the two groups and the rest of research at FEEM will be fully utilized to ensure efficiency and to jump start research in new areas. Over time, this interface will naturally give way to specialization in the key outlined research topics.

The cooperation with external partners will continue to be emphasized, and actually further promoted by making the most of international collaboration with top institutions such as MIT, Princeton University, Columbia University, Harvard University, and also in developing countries such as China, which will provide complementary knowledge on for example more technical issues like those related to energy engineering and energy data. The interface with industry and the public decision making will also be strengthened. Similarly, dissemination of the research activities, an area where FEEM has greatly contributed in the past, will continue by means of publications, conferencing and by using innovative media tools, and will aim at addressing an even larger and more diverse audience.

The proposed plan has the potential to raise the standard of the research carried out at FEEM beyond that of its considerable past. The areas which have been identified as key provide several challenges that wait to be explored and for which analytical and rigorous thinking can generate insights that are both original and useful. This will allow FEEM research to be of the highest quality and to allow a better understanding of the key global issues that require both a short and long term strategic thinking, with significant societal benefits.

1. Historical background

Fondazione Eni Enrico Mattei (FEEM) has recently started its third decade of activity. Established in 1989, and in full operation since 1990, FEEM has grown to become a leading international research centre in economics, providing timely and objective analysis on a wide range of environmental, energy, and global economic issues.

Since its establishment, research activities have been carried out under the coherent umbrella of different research programmes, which were re-organised at least three times throughout this period of over twenty years.

In early years, when FEEM worked hard in building its credibility, international reputation, and its relevance for policy institutions both at the national and international level, research was organised within **three research programmes**:

- Sustainable Development
- Political Economy
- The Firm and the Environment.

At the beginning of its second decade, now with a strong reputation in the academic community mainly due to its activities in environmental economics and policy, and with a significant number of researchers involved in a high number of EU research projects, FEEM activities have been consolidated into **seven research programmes**:

- Climate Change Modelling and Policy
- Sustainability Indicators and Environmental Valuation
- Natural Resources Management
- International Energy Markets
- Knowledge, Technology and Human Capital

- Corporate Social Responsibility and Sustainable Management
- Privatisation, Regulation, and Corporate Governance.

In 2008, FEEM decided to streamline the research organisation through the conversion of the seven research branches into **three research programmes**:

- Sustainable Development
- Institutions and Markets
- Global Challenges.

Activities on environmental and energy issues were grouped into the Sustainable Development programme. Other topics were grouped into Institution and Markets programme. The Global Challenges programme was newly created to develop new research topics. This choice was not only guided by scientific reasons. It also responded to the need of reviewing the internal organisational structure to ensure the support and the needs of the research programmes more efficiently. .

These three research programmes are FEEM status quo. A description of each programme is as follows:

- **RESEARCH PROGRAMME ON "SUSTAINABLE DEVELOPMENT"**

Research on sustainable economic development has been addressed since the establishment of FEEM. The first project was launched in 1990, at a time when very limited research was carried out on this topic around the world. From these initial intuitions, FEEM developed several new strands of environmental research, ranging from sustainable energy to natural resource management and biodiversity. The Sustainable Development Research Programme covers a considerable number of key topics for research in the field of economics and the environment, often strictly interrelated among themselves and both individually and jointly addressed by various FEEM research projects. In particular, the European Commission has funded a large number of projects. The Sustainable Development Research Programme aims to advance research in this field through the development of innovative conceptual, analytical and modelling tools, with the twofold goal of providing a contribution to science and policy, while informing the public debate. Key research topics are:

- Climate change modelling and policy
- Coalitions and networks for International environmental agreements
- Economics of biodiversity and ecosystem services
- Environmental valuation
- Forestry, land-use and land cover change
- International carbon markets and the financing of climate policy
- Sustainability indicators

- Sustainable energy
- Water management

- **RESEARCH PROGRAMME ON "GLOBAL CHALLENGES"**

Economic development has been investigated at FEEM not only from an environmental perspective, but also by considering other fundamental aspects, such as knowledge and human capital. Since 1993, FEEM has addressed the study of knowledge and human capital accumulation from an economic perspective. In 2001 the programme broadened the scope to launch a systematic investigation of the relationship between multiculturalism and economic growth, with special emphasis on the dynamic gains for innovation and creativity stemming from local and global multicultural interactions. This line of policy-relevant research has recently become the backbone of the research programme entitled "Global Challenges," tackling fundamental topics such as the emerging global urban system, the new sources of competitiveness in the global economy, and culture and diversity in capitalism. The Global Challenges Research Programme aims to take up the new challenges that the global economy is posing to the traditional paradigms of economic and policy analysis. Key research topics are:

- Competing models of capitalism
- New sources of competitiveness in the global economy
- The emerging global system

- **RESEARCH PROGRAMME ON "INSTITUTIONS AND MARKETS"**

In 1994, FEEM launched a research programme entitled "The Economy, Firm and Institutions," addressing important issues such as incentives, information and market failures, the role of lobbies and organised interests in collective decision-making, and the mechanics of self-regulation in financial markets. Within this strand of research, FEEM has developed a series of cutting-edge projects, which evolved and consolidated FEEM's scientific reputation in corporate governance, privatization, and regulation. Current research conducted within the programme "Institutions and Markets" seeks to understand the complex interactions among firms and their stakeholders, and how State intervention shapes this symbiotic relationship in a changing world. The basic recognition underlying this research programme is that markets live on foundations laid by institutions, i.e. the broad set of formal and informal norms defining the structure of incentives for the economy and society. Key research topics are:

- Corporate governance
- Corporate social responsibility
- Energy policy and regulation
- Privatizations and Institutions
- State capitalism 2.0

2. External Assessments and Directions from the Boards of Directors

In 2008, a new FEEM Board of Directors took over. It recommended that FEEM research should focus on its comparative advantages regarding energy and environment issues, whilst maintaining its plurality of perspectives.

Also, in 2008, an independent review of FEEM activities was carried out, covering activities performed between 2001 and 2007. The Review Panel was formed by Raymond Kopp (Resources for the Future), Massimo Motta (Università di Bologna), and Robert Stavins (Harvard University). They assessed if and how FEEM has achieved two main objectives: (1) to generate new knowledge on sustainable development, with a specific focus on energy, environmental, climate, and corporate governance issues; and (2) to contribute to broadened awareness and understanding of these issues by bridging academia, decision makers, and civil society.

As also stressed in the last meeting of FEEM Scientific Advisory Board (SAB) on May 20th, 2010, the Review Panel was surprised by the fact that FEEM was covering research areas beyond energy, environment, and natural resources, which represent the mission of FEEM and its comparative advantage internationally. They questioned whether or not it was optimal for FEEM to move into other research topics, in which FEEM has no comparative advantage (Professor Stavins noted that in the US FEEM is very well known in the academic community for its activities in environmental economics and policy, but it is not well known in other fields).

Whilst acknowledging that it is for the FEEM Scientific Advisory Board to decide which lines of research FEEM should pursue, given the central environmental and energy issues at FEEM, the Review Panel recommended that research should focus on environmental and energy research projects. The newly developed areas of research may allow FEEM to 'diversify' into new fields. However, this should be a marginal activity that does not jeopardise FEEM's strong and well-established focus and reputation on these issues.

FEEM's mission statement is as follows: "The Foundation exists to foster and encourage - through studies, research, training and information initiatives – a broader awareness and understanding of economic, energy and environmental issues, at both local and global levels." It is therefore crucial to be precise and as focused as possible when defining the goals and projects of the institution, and to be sure that these are understood and shared by all members of the institution's management.

Based on this statement and on the report prepared by the Review Panel, in 2009 Eni's Board of directors recommended to structure FEEM's research activities into two main research programmes: one on climate, environment and sustainable development, the other one on energy issues.

3. Proposal to the Board of Directors

Given FEEM's mission statement, the recommendation of Eni's Board of Directors, and the results of the 2008 Panel Review, the Scientific Advisory Board proposes to re-organise FEEM research activities into the following **two research programmes**:

- **Climate Change and Sustainable Development**
- **Energy: Resources and Markets**

A detailed description of the two research programs is described in the following sections of this document. The richness and amplitude of ongoing and future activities in the above two fields, and the international recognition of FEEM's research in these two areas, are probably the best justification of FEEM's focus on the above two research programmes.

Regarding the integration of the other research programmes not related to climate, sustainable development and energy, the Scientific Advisory Board recommends continuing good quality research only provided that FEEM has specific skills and knowledge and that such activities can be gradually incorporated into the two major streams of research.

RESEARCH PROGRAMME ON "CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT"

Brief motivation

Climate change economics represents a key research area that FEEM has developed during the last twenty years. In particular, on the development of two integrated assessment models, probably the best tools for climate change projections and policy analysis, on the role of endogenous technological change and innovation, and on the monetary assessment of climate change impacts, FEEM has reached a leading position in the international research community.

This research programme aims at keeping the research focus where FEEM has conquered this comparative advantage, improving and extending the research in order to keep the pace with the international research community. At the same time, the idea of widening the research scope to new themes are becoming increasingly crucial, as for example: the socio-economic implications of negative emissions technologies, the role of finance in coping with mitigation and adaptation initiatives, the role of institutions and governance in shaping climate change negotiations, and the potential for local, rather than global, mitigation actions.

Although climate change encompasses issues that compose the sustainable development challenge, specific attention will also be devoted to the sustainable management of natural resources and to the use of indicators to measure sustainability.

FEEM's international leading role in climate change research is reinforced through its top journal publications, attending major conferences, participating in the IPCC process. One of FEEM's priorities for the next three years is to strengthen international relationships with some of the top international research institutes.

At the same time, research cannot be confined to the academic sphere. Specific attention will continue to be devoted to reaching the media, policy makers and public opinion. Specific attention will also be devoted to understanding the role of scientific knowledge in guiding governance, how this differs in various countries, and the cultural and institutional factors that affect the role of scientific research in shaping public decisions.

Research Areas

Research within the "Climate Change and Sustainable Development" programme will be divided into six main research areas, which entail several sub-activities and for which several projects are ongoing, see Table 1.

Research Areas	***Research Activities***	***Ongoing Project (Total Contribution: € 7,142,168)***
1. Climate Change Integrated Assessment Modeling	1a. Mitigation technologies for climate stabilisation	**EU FP7: Climate Cost, AMPERE, PASHMINA, Global IQ, CIRCE, PURGE** **ERC Grant: ICARUS** **MIUR: CMCC**
	1b. Towards a more comprehensive integrated assessment of climate impacts and policies	
	1c. Impacts and Adaptation	
	1d. The role of uncertainty for mitigation and adaptation	
2. Climate Change Policy	2a. Economic analysis of climate policy and governance	
	2b. Climate and finance	
3. Climate-related Innovation and Technological Change	*3a. Empirical work: Patents, diffusion models*	**EU FP7: PASHMINA**
	3b. Electronic prediction markets on energy technologies	

	3c. Expert elicitations *3d. Modeling technological change*	**ERC Grant: ICARUS**
4. Natural Hazards and Extreme Climate-related Events		**EU FP7: EPI-WATER, PREEMPT**
5. Management of Natural Resources	*5a. Water management* *5b. Forestry land use and land use cover, agriculture and food*	**IWRM-NET:WATERT2ADAPT**
6. Sustainability and Growth Beyond GDP	*6a. Sustainability Indicators* *6b. Cultural diversity, globalisation and sustainable development* *6c. Corporate Social Responsibility*	**EU FP6: SUS.DIV** **EU FP7: INGINEUS, IN-STREAM, LIAISE, PASHMINA, Global IQ**

Table 1. Summary of research areas and ongoing project of the Climate Change and Sustainable Development programme.

The remaining of the document articulates, for each theme, future research activities, existing and forthcoming projects, dissemination, and outreach activities.

1. Climate Change Integrated Assessment Modelling

Research on the challenging issue of climate change builds upon twenty years of work. On the mitigation side, FEEM is positioned at the forefront of international research through the use of the in-house developed energy-economy-climate WITCH model, a regional integrated assessment hard-link hybrid model. On the impact side, FEEM is currently investigating the general equilibrium effects of climate change on the world economy, through the use of ICES, a recursive-dynamic computable general equilibrium (CGE) model also developed by FEEM researchers. On the adaptation side, FEEM has developed a fully endogenous adaptation sector within the WITCH model (AD-WITCH), also accounting for innovation and its role in shaping dynamic adaptation strategies.

1a. Mitigation technologies for climate stabilisation

On the mitigation side, the WITCH model is specifically designed to assist in the study of the socio-economic dimensions of climate change and to help policy makers understand the economic consequences of climate policies. WITCH is an Integrated Assessment model designed to evaluate the impacts of climate policies on global and regional economic systems and to provide information on the optimal responses of these economies to climate change. Countries included within the model are grouped into twelve regions, which strategically interact using a game theoretic set-up. Note that irrespective of the grouping into twelve regions, regional disaggregation can easily be performed. The top-down component of WITCH consists of a dynamic economic growth model. In the model, the energy component of the aggregate production function has been expanded to depict the energy sector and to model the carbon mitigation options for the main greenhouse gases. The model can track all of the actions which impact the level of mitigation such as: R&D expenditures, investment in carbon-free technologies and adaptation, purchases of emission permits, or expenditures for carbon taxes This allows the evaluation of the equilibrium responses stimulated by different climate policy tools.

Future Research Areas

Three major modelling extensions will be required for the model to remain at the forefront of research. A broader set of technologies, with a specific focus on negative emissions technologies, will be required in next generation models in order to perform a proper investigation of sustainable development scenarios. Transportation has been singled out in many studies. It is the key sector where the decarbonisation match will take place. Hence, a better description of fleet dynamics and proper consideration for penetration potentials of alternative transportation modes are essential ingredients to provide a clear concept for the future of transportation. The role of international trade and potential links to climate related negotiations are increasingly discussed. A better description of trade and potential fall-backs of unilateral agreements is called for in this type of modelling.

Related Projects: ongoing and forthcoming

FEEM is part of all major international efforts that aim to assess the cost of alternative stabilisation policies, under alternative assumptions concerning technology availability and diffusion, and countries willing to participate in climate agreements with a focus on major future emitters. In particular, FEEM is part of the next Energy Modelling Forum exercise (EMF 24) and of the Asian Modelling Exercise, both voluntary-based model comparison efforts. FEEM is also part of the Integrated Assessment Modelling Consortium (IAMC), an international consortium gathering all major integrated assessment models, which aims to unify the modelling community research directions and what are seen as the

main research gaps to be covered for the next (5th) IPCC Assessment Report. Finally, FEEM coordinates the Climate Policy Outreach consortium, a network funded by Europe Aid to deliver clear and robust policy messages on international climate policy, particularly in Asia.

FEEM is also a key partner of the two major ongoing European modelling comparison efforts: Full Costs of Climate Change – ClimateCost; and Assessment of Climate Change Mitigation Pathways and the Evaluation of the Robustness of Mitigation Cost Estimates (AMPERE), both funded within the FP7.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
Climate Cost				EU FP7	200,400
AMPERE				EU FP7	320,800

Dissemination and Outreach Activities

The FEEM modelling team has developed and will continue to work on interactive online tools, such as the WITCH Policy Simulator, which studies effects on the environment and energy as well as the economy of different mitigation policy scenarios (www.policysimulator.org). Since its start in April 2010, the WITCH Policy Simulator has accumulated approximately 1,000 visits, 3,600 page views and an average time on site of more than 8 minutes.

WITCH modelling has been widely used to evaluate climate policies in different contexts, among others: the OECD analyses "Economics of Climate Change Mitigation" and "Economics of Climate Change Adaptation" and within projects funded by governmental (e.g. U.K. Met Office) and non-governmental (e.g. Environmental Defense Fund) organisations.

During the next three years, the established reputation will increasingly reach larger audiences. Finally, thanks to the involvement of FEEM members in the IPCC assessment report, it is guaranteed that FEEM research will remain at the forefront of international research and policymaking.

1b. Towards a more comprehensive integrated assessment of climate impacts and policies

The sustainability of solutions to climate change needs to be evaluated by looking at the whole picture. Solutions need to be assessed by including their environmental and social external costs, for example the effect on food prices is a result of higher land costs generated by the large scale adoption of biofuels. To this aim, FEEM modelling tools need to be extended and linked to land use, forestry cover, atmosphere, biosphere modules, and various complex feedback phenomena in order to fully capture the whole picture.

Future Research Areas

Two important extensions are primary. The first is a full coupling of the two FEEM modelling tools with a global circulation model developed within the Euro Mediterranean Center for Climate Change (CMCC). The second is the coupling with the forestry-land use model developed at the research institute IIASA. Both extensions are crucial in order to keep the two models at the forefront of the international research standards.

Related Projects: ongoing and forthcoming

FEEM is part of the Euro-Mediterranean Center for Climate Change project (CMCC), which intends to create necessary scientific and organisational backgrounds for its successful establishment. CMCC is a research organisation that studies climate variability, its causes and its consequences, using numerical models ranging from Global Earth Systems to Regional models within the Euro-Mediterranean area.

FEEM finances the opening of the economy-climate modelling box to decision-makers known as the HEXE project, which specifically aims at coupling FEEM economic models (WITCH and ICES) with the environmental ones developed within the Euro Mediterranean Center for Climate Change (a Global Circulation Model and a Land Use Model).

FEEM is also a key partner of three FP7 projects which aim to enlarge the Integrated Assessment models in order to deal with sustainable development: the PAradigm SHifts Modelling and Innovative Approaches - PASHMINA, the Impacts Quantification of global changes - Global IQ , and the Full Costs of Climate Change- ClimateCost projects.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
PASHMINA				EU FP7	406,800
Global IQ				EU FP7	462,600
ClimateCost				EU FP7	200,400
CMCC				MIUR	1,631,980

Dissemination and Outreach Activities

The main dissemination task enables the policy makers' understanding of modelling tools, therefore increasing the impact of modelling work on the decision making process. In order to satisfy this aim, simplified and open source, modelling material will be posted online. This will allow policy makers and the public to experiment with modelling assumptions and to test the robustness of models.

1c. Impacts and Adaptation

The ICES (Intertemporal Computable Equilibrium System) model is a dynamic equilibrium model developed with the main purpose to assess the final welfare implication of climate change impacts on world economies. Its general equilibrium structure - in which all markets are interlinked - is tailored to capture and highlight the production and consumption substitution processes at play in the social-economic system as a response to climate shocks. In doing so, the final economic equilibrium explicitly considers the "autonomous adaptation" capacity of economic systems. The idea behind the use of ICES is to provide a climate change impact assessment going beyond the "simple" quantification of direct costs, to offer an economic evaluation that summarises second and higher-order effects.

As far as adaptation is concerned, FEEM has developed a fully endogenous adaptation sector within the WITCH model (AD-WITCH), also accounting for innovation and its role in shaping dynamic adaptation strategies. This model has been used both by the OECD and by the Copenhagen Consensus project.

Future Research Area

In addition to the extensive work on impact evaluation, the following evaluations are important extensions for the future: impacts on fisheries, impacts due to environmental migration, impacts on forest net primary productivity, and impacts on human health.

As far as adaptation is concerned, the next step will be to develop the model in order to mimic adaptation investments in foreign countries and test for the optimal mix of mitigation, domestic adaptation, and foreign investment in adaptation under alternative international assumptions.

Related Projects: ongoing and forthcoming

FEEM is a key partner in two FP7 projects covering research on impact assessment and adaptation: Full Costs of Climate Change – ClimateCost, which was previously described because it also deals with mitigation, and Climate Change and Impact Research: the Mediterranean Environment - CIRCE

FEEM is also a partner of the EC project on "Public health impacts in URban environments of Greenhouse gas Emissions reduction strategies" (PURGE). This project aims to quantify the positive and negative impacts on health and well-being of greenhouse gas reduction strategies in urban areas of Europe, China and India, and to develop and present the evidence in ways that are most relevant to major policy decisions in areas such as: energy, housing/building environment, transport, and food.

Again, like in many other projects, the common denominator is the assessment of specific climate policies and the cooperation with researchers in China and India.

Name of Project	Period Covered			Source of Finance	Total Budget
	2011	2012	2013		
ClimateCost				EU FP7	200,400
CIRCE				EU FP7	518,054
PURGE				EU FP7	250,100

Dissemination and Outreach Activities

FEEM will organise the Fourteenth Annual Conference on Global Economic Analysis "Governing Global Challenges" 16th- 18th June 2011 at San Giobbe, School of Economics and Business, Ca' Foscari University of Venice, Italy, along with Purdue University and Ca' Foscari University of Venice. This will be a major event in the modelling community with more than 300 participants.

1d. The role of uncertainty for mitigation and adaptation

Uncertainty plays a key role in the economics of climate change. Discussions surrounding the implications for climate policy are far from settled. The importance of this research theme is emphasised by the decision of the IPCC Bureau to include it as a separate chapter within the third Working Group report. The recent review of the Interacademy Panel further emphasised the importance of appropriately treating uncertainty in climate change policy analyses. A number of publications (available at www.witchmodel.org) document the amount of work FEEM has already developed to include uncertainty in the analysis of climate policy, even though several important extensions are planned for the future. Research in this area is indeed still at the beginning.

Future Research Areas

Two major themes will be developed. The first being the effect of climate responses uncertainty on the optimal mix of mitigation, innovation and adaptation strategies, where both innovation and pre-emptive adaptation can be seen as real investment options to avoid climate uncertainty. Second, in order to better capture uncertainty affecting the future cost of mitigation action it is crucial to model the uncertain effectiveness of R&D which affects the diffusion of new technologies.

Related Projects: ongoing and forthcoming

Two FP7 projects are related to modelling uncertainty in Integrated Assessment models: PASHMINA and ICARUS. In addition, FEEM will be initiating and coordinating the Uncertainty Modelling Forum, a new voluntary modelling assessment that is being established to provide model comparison with a specific focus on uncertainty.

Name of Project	Period Covered			Source of Finance	Total Budget
	2011	2012	2013		
PASHMINA				EU FP7	406,800
ICARUS				ERC	920,000

Dissemination and Outreach Activities

Thanks to the involvement of FEEM members in the IPCC 5th assessment report, FEEM research will remain at the forefront of international research and will be widely disseminated. Publications and workshop will be planned to present the outputs of FEEM's research.

2. Climate Change Policy

Research on the design of international climate agreements has a twofold goal. One goal is to advance knowledge in the area of coalition and network formation applied to international climate negotiations. Innovative research on coalition and network formation is carried out both at the theoretical level and at the level of applications within the modelling tools developed and used by FEEM researchers to analyse the energy, economy and climate systems. The other goal is, the analysis of international policy credibility, national pledges, negotiations and the role of institutions that can serve as a guide to the political progress in climate negotiations.

2a. Economic analysis of climate policy and governance

By means of the two modelling tools, FEEM will extensively analyse credible policies for a positive outcome of the climate negotiation process. In particular, the feasibility of global climate action and the relationship between current governments' pledges and stabilisation targets will be the object of future research. Specific attention will be devoted to investigating the size and type of carbon trade restrictions that could reduce international transfers, hence increasing the potential for internationally linked carbon markets, while enhancing policy efficiency. As international credibility will be central for any long term investments towards a carbon free world, an important issue for governments is to invest heavily in building institutions that make it easier for countries to negotiate commitments, monitor behaviours, and stabilise expectations. FEEM models will explore the gains for governments by building more effective international regulatory institutions and will also explore how the cost of such efforts compares with other credibility-enhancing strategies. Variables such as the investment in international institutions will be added explicitly to FEEM integrated assessment models as an endogenous factor and coupled with game-theoretic analysis of individual country behaviour

because the presence of capable institutions makes it easier for countries to enter into reliable contracts.

Related Projects: ongoing and forthcoming

FEEM will contribute to the European Climate Foundation and UNEP Report on Pledges. FEEM is also planning to seek EU funding in order to develop this research area as institutions, governance and real policy processes which are becoming increasingly relevant to solve the negotiations impasse.

Dissemination and Outreach Activities

FEEM is building a strong network composed by the Climate Policy Initiative, the Harvard Project on International Climate Agreements, within the International Center for Climate Governance aiming to strengthen this research area and disseminate results to the public and policy makers.

Through active participation to the Conference of Parties, FEEM also aims to reach negotiators and policy makers that are active on the climate policy arena and to provide material to substantiate the discussion.

FEEM in collaboration with the Euro-Mediterranean Centre on Climate Change (CMCC) and within the International Center for Climate Governance (ICCG), publishes a weekly column "Climate Policy News." It covers the main weekly carbon issues including price data, news, review of publications and events, and a bi-monthly report "International Climate Policy and Carbon Markets" for a deeper analysis the carbon market evolution and international and domestic climate policy measures around the world.

2b. Climate and finance

Ambitious climate policies will require radical technological transformation. In particular, the energy sector will evolve in a completely different way, with zero or low carbon technologies gradually replacing fossil fuel based systems. What are the financial implications of these deep changes? What is the amount of resources that has to be mobilised to finance Research and Development (R&D) in new technologies? What role can revenues from carbon taxes or emission permit auctions play to support the transition to a low-carbon world? And how do international financial flows in carbon markets and fossil fuels markets change if a stringent climate policy is implemented? These are the key questions to be investigated during the next three years within the section of the Climate and Sustainable Development research programme devoted to Climate and Finance.

Related Projects: ongoing and forthcoming

FEEM is currently self-financing the only project covering this research area: The future finance of climate change – FINCLIM. It is also working with the Climate Policy Initiative (CPI) on this specific topic and is preparing a section of Chapter 16 of the IPCC 5th Assessment Report devoted to finance issues.

Dissemination and Outreach Activities

FEEM in collaboration with the Climate Policy Initiative is planning to organise a series of events in order to investigate whether international climate finance is adequate and productive. As research and work related to various aspects of climate finance are ongoing in many places, there is the need to reinforce knowledge exchange between experts to enhance the speed with which climate finance can be successful for the transition to a low-carbon growth future.

3. Climate-related Innovation and Technological Change

Research on new energy technologies, innovation, and how to trigger technological change is one of FEEM's leading research areas. It is obviously cross-cutting with the "Energy: Resources and Markets" programme. The Strategic Energy Technology (SET) Plan demonstrates that it is of crucial importance for the EU policy-making process.

The dynamics of knowledge creation has been widely explored in the traditional innovation economics literature, both at the firm and aggregate level. A number of theoretical and empirical analyses attempted to discern the determinants of technical change and their effects. More recently, the endogenous growth models literature revived the interest for technical change and its contribution to economic growth. In addition to the innovation phase, the process of technology adoption that follows has also been studied through a series of models. The necessity of extending these debates to innovation and diffusion of energy technologies arises from the fact that technological advances in these fields can potentially reduce the costs of complying with a stringent climate change policy, easing the anthropogenic pressure on the environment whilst allowing for development and growth. Although crucial, the dynamics of innovation, adoption and diffusion of energy technologies are yet to be fully understood. In particular, the lessons learned from the rich innovation literature, ranging from economics to engineering and history, need to be extended and confirmed with respect to technologies that can help ease the energy security issue, climate change and other environmental challenges. In addition, validation of previous results is necessary in light of the double externality problem, which characterises climate change-related innovation. On the one hand, pollution levels are too high because the polluters do not bear the full cost of their actions. On the other hand, innovation levels are lower than optimal because the innovators can rarely fully appropriate the benefits deriving from the new technology. This is particularly true when talking

about large-scale technologies, as power generation technologies, where returns on innovation are largely uncertain and far in the future. The interaction of these two externalities on the magnitude and rate of technological innovation still needs to be appropriately addressed.

3a. Empirical work: Patents, diffusion models

The effort to compact and collect new data relevant for energy and climate innovation studies will lead to a number of significant empirical contributions to the current literature. These will be relevant both with respect to innovation in general, as well as climate change and energy innovation in particular. Novel research questions that will be addressed in the next three years are:

- ✓ the substitutability or complementarity dynamics of private versus public R&D and on general purpose versus energy R&D;
- ✓ the differential impact of environmental policy instruments on technology innovation, diffusion and transfer
- ✓ the interaction between climate policy, on one side, and innovation policy on the other side, with particular focus on the effect of protection of IPRs on the diffusion and transfer of adaptation and mitigation technologies
- ✓ the contribution of international and inter-sectoral R&D and innovation spillovers contribute to global learning with respect to environmentally-friendly innovation
- ✓ the role of technological specialisation and absorptive capacity in favouring the environmentally-friendly sustainable adoption and adaptation of new energy technologies (a necessary condition to solve global warming issues while improving the well-being of citizens in developing countries)
- ✓ the role of uncertainty on innovation and technology diffusion.

Empirical answers to these issues will shed light on the peculiarity of innovation and diffusion dynamics in climate-related technologies, filling the gaps currently present in the economic literature. In addition, they will provide valuable insights to the modelling community with respect to the appropriate ways to represent technological change dynamics in climate economy models.

We are also interested in enlarging the understanding of the value of innovation and R&D investment through a survey of inventors and patent holders in the field of climate related technologies.

Related Projects: ongoing and forthcoming

The main source of finance for the Innovation research area is the European Research Council funded project on Innovation for Climate Change mitigation: a study of energy R&D, its Uncertain effectiveness and Spillovers – ICARUS. It spans the period 2010-2013 and will cover most of the research on technological change.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
ICARUS				ERC	920,000

Two projects that would deal with empirical estimates of innovation are currently under evaluation, the Innovation in Energy technologies - InnovE project, that would be financed by the state government of Baden-Wuerttemberg, Germany, and based on a partnership with the Centre for European Economic Research (ZEW); and the InnoMod and InnoTEC projects, that would be financed by the French Environment and Energy Management Agency (ADEME), and based on a partnership with Université de Grenoble.

Dissemination and Outreach Activities

The network with the Energy Research, Development, Demonstration, & Deployment (Erd3) Policy project at Harvard, the Centre for European Economic Research (ZEW), and the OECD allow FEEM to reach an increasing number of final users with its research results.

The International Workshop on "Innovation in Energy Technologies: What can we Learn from Patent Data" organised by FEEM in May 2011, is one example of a series of dissemination events to come.

3b. Electronic prediction markets on energy technologies

Electronic prediction markets (EPMs) are online markets where participants can trade virtual contracts, whose payoffs are tied to a future event. The emerging prices can be analyses as market-aggregated forecasts, because they combine all the relevant knowledge distributed among people, stakeholders, customers, employees, etc.

Because potential trading profits provide an incentive for information discovery, prediction markets have been used to forecast elections, for example, the market run by the University of Iowa, to predict movie revenues, corporate sales and project completion. Firms have also started to use markets to predict research and development outcomes and to identify which new technologies should be chosen for investment in future capabilities. The online versions of prediction markets allow the analysts to reach a wider group of participants, while speeding up the entire compilation process, with no need to repeat expensive weakly polls or costly expert and market studies.

EPMs have been compared to traditional methods of market research, and they have demonstrated to be as precise as surveys or expert analysis in evaluating decision options and predicting events.

Future Research Areas

In collaboration with the Belfer Center for Science and International Affairs at the John F. Kennedy School, Harvard University, FEEM is planning to set up the first Electronic Prediction Market for energy technologies. Its main purpose is to collect information on the following topics: evolution of carbon-free technologies in the next twenty years, the possibility that innovative technologies will substitute traditional technologies, the role of R&D investments in encouraging the technology innovation processes, and the future power generation mix.

The status of this research area is preliminary and the process of fund raising has just started.

3c. Expert elicitations

Expert elicitation processes are increasingly applied in different research fields and projects, to deal with complex phenomena characterised by lack of data. Judgments and information obtained from the experts are applied to overcome uncertainty limits of analytic modelling, and to support decision-making processes. Uncertainty has a determining role on the outcome of current and future innovation processes, but it is very hard to quantify this uncertainty. Elicitation processes with top European experts can be used to assess subjective probabilities associated with the potential breakthrough on innovative technologies as a response to RD&D programs.

Future Research Areas

In the next three years, FEEM will carry out a set of surveys aimed at collecting both quantitative data and qualitative information on the technical characteristics of different carbon-free technologies, such as Solar Photovoltaic and Concentrated Solar Power, Second and Third Generation Biofuels, Batteries for Electric Vehicles, Carbon Capture and Storage, Fourth Generation Nuclear, Bioenergy. Most of these technologies are still in the lab or demonstration phases: they have high potential for emission reduction but costs are not yet competitive with respect to the traditional (fossil-based) incumbent technology. Top European experts (coming from the academic, private or public policy sectors) are submitted to specific questionnaires during face-to-face or web-conference interviews. The collected data will contribute to produce probabilistic estimates on the role of R&D investments to overcome technological limits, abate costs and ensure market penetration.

Related Projects: ongoing and forthcoming

The main source of finance for the Innovation research area is the European Research Council funded project on Innovation for Climate Change mitigation: a study of energy R&D, its Uncertain effectiveness and Spillovers – ICARUS. It spans the period of 2010-2013 and will cover most of the research on technological change.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
ICARUS				ERC	920,000

Dissemination and Outreach Activities

This research will benefit from a set of international collaboration with the following top institutes working on expert elicitation on energy breakthrough technologies: the Belfer Center for Science and International Affairs at the John F. Kennedy School, Harvard University, the Climate Decision-Making Center at Carnegie Mellon University and The University of Massachusetts Amherst. As these institutes all work on interviewing US experts alone, FEEM's focus on Europe is a perfect complement and a series of comparison analysis that are planned for the future.

The International Workshop on "The Role of Nuclear Power in Meeting Future Climate and Energy Challenges" co-organised with the Belfer Center for Science and International Affairs at the John F. Kennedy School, Harvard University, for spring 2011, is the first example of such collaborations.

3d. Modeling technological change

The results of numerous studies indicate that the costs of controlling climate change will be significantly lower if advanced technologies are developed and widely diffused. By introducing or improving endogenous technical change dynamics in FEEM integrated assessment models, it becomes possible to study the effect of climate policy on innovation and the effect of innovation on the costs of climate policy. The exercises carried out with this numerical model will be very valuable to policy makers because they will give indications on the technologies that should be prioritised in the transition towards a low carbon economy and on how to allocate R&D funds across sectors and technologies.

Future Research Areas

To date, the treatment of uncertainty when modelling technological change has been very simplified. In most cases, it consists of running a range of scenarios with different technology assumptions and then, by comparing these scenarios, the value of different technology options is inferred. However, this value is biased because it does not consider the link between R&D expenditure and technology improvement, thus omitting the R&D cost component. Experts' opinions on the potential relationship between R&D funding and the success probability of selected technologies can increase the reliability of the assessments of technology values. Expert elicitation can also be used to assign subjunctive probabilities to the different technology paths in relation to the amount of resources spent on each given technology option and thus to perform a stochastic, rather the deterministic assessment. A

second area in which there is scope for modelling improvements is the estimation of key parameters and variables related to the diffusion of different technologies such as learning rates, knowledge stocks, elasticities, absorptive capacity. A third research area concerns the role of institutional factors, such as IPR protection, in hindering or promoting different technologies. In fact, diffusion determinants play quite a different role depending on the type of technology or innovation considered. On this regard, WITCH makes it possible to analyse technology diffusion of already commercialised technologies as well as future breakthroughs. The model can be used to study knowledge diffusion and the role of IPRs in low risk sectors (e.g. innovation for improving energy efficiency) as well as in more risky R&D programs (e.g. R&D in breakthrough technologies). Moreover, the broad geographical coverage that characterises the WITCH model allows analysing diffusion drivers and barriers at the regional level.

Related Projects: ongoing and forthcoming

The main source of finance for the Innovation research area is the project funded by European Research Council on Innovation for Climate Change mitigation: a study of energy R&D, its Uncertain effectiveness and Spillovers – ICARUS. It spans the period of 2010-2013 and will cover most of the research on technological change. The Paradigm Shift Modelling and Innovative Approaches, (PASHMINA) project is funded under the FP7 and partly covers the improvement of induced technical change dynamics in the WITCH model. Finally FEEM, recognises the crucial role of modelling technological change by self-financing part of the research through the Modelling Technical Change for Climate Policy Analysis (TechChange) project.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
ICARUS				ERC	920,000
PASHMINA				EU FP7	406,800

A forthcoming project dealing with the modelling of innovation and technical change is the Innovation in Energy technologies - InnovE project, that will be financed by the state government of Baden-Wuerttemberg, Germany, and based on a partnership with the Centre for European Economic Research (ZEW)

Dissemination and Outreach Activities

A number of outreach activities, aimed at creating a common international platform for assessing the role of technological change in climate policies, will be organised:

- ✓ R&D Portfolio Analysis: Tools and Methodologies, sponsored by the Office of Policy and International Affairs and the Climate Change Technology Program at the U.S. Department of Energy. The meeting will be held on December 2 & 3, 2010 in Washington, D. C.
- ✓ International Workshop on Uncertainty and Innovation, Snowmass, August 2011, in cooperation with William D. Nordhaus (Professor at Yale University) and Erin Baker (associate Professor at the University of Massachusetts).

4. Natural hazards and extreme climate-related events

Natural hazards are recurrent and ordinary phenomena triggered by atmospheric, geologic and hydrologic processes. They become disasters when the imposed hardship exceeds the affected community's ability to cope while relying on its own resources, strengths and upturn capability. Hence disasters are results of an inopportune combination of exposure to hazard, high vulnerability and limited coping capacity.

Over the past decades, the world witnessed a striking increase of the economic losses caused by the natural hazards. Although the observed increase in magnitude of the impacts of the disasters is primarily associated with increased wealth and population in risk prone areas, indirect evidence suggests that at least to some extent the greenhouse gas emissions play a role. In the coming decades, anthropogenic climate change will very likely lead to more frequent and intense meteorological and climate extreme events and thus further amplify the disaster losses, if no preventive actions are taken.

Future Research Areas

The long-term aim of this research area is to conduct policy applied research helping to understand drivers of risk and vulnerability, to develop practical methods for impact and integrated risk assessment, and to evaluate climate proof disaster risk reduction programme.

Natural disasters are a major obstacle to sustainable development and poverty reduction in developing world. The area's team will collect evidence about the ties between rural poverty, environmental degradation and natural disaster risk, and explore how a shifting climate will exacerbate these ties. Working closely with international organisations (such as United Nation's International Strategy for Disaster Reduction), global civil society organisations and alliances (e.g. International Union for Conservation of Nature, Partners for Resilience Alliance and Partnership of Environment and Disaster Risk Reduction) and local communities, we aim at enhancing capacity to integrate the expected impacts of climate change and disaster risk reduction into efforts to combat poverty and promote sustainable development.

Finally, the research area's priority will include knowledge exchange and networking among social scientists conducting research on disaster risk and welfare effects of natural disasters, in current and future climate(s). The research network SOLACE (Social Costs of, and Resilience to, Natural Disasters) has been designed to advance interdisciplinary and cross-institutional discussion about natural disasters, disaster risk reduction, and international policy through a series of workshops, research meetings, publications and synchronization of the ongoing research activities.

Related Projects: ongoing and forthcoming

FEEM coordinates a key European effort in dealing with water and natural hazards related to climate change, the Evaluating Economic Policy Instruments for Sustainable Water Management in Europe-EPI-WATER project.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
EPI-WATER				EU FP7	477,300
PREEMPT				EU	110,633

FEEM is also part of the European Topic Centre Climate Change impacts, vulnerability and adaptation - ETC-CCA, a European Topic Centre of thematic expertise contracted by the European Environment Agency (EEA) to carry out specific tasks identified in the EEA strategy. It leads the tender Climate Adaptation – modelling water scenarios and sectoral impacts - ClimWatAdapt, funded by the European Commission Directorate General Environment.

FEEM also coordinates the DG Humanitarian Aid and Civil Protection project PREEMPT: Policy-relevant assessment of socio-economic effects of droughts and floods. Six project are currently under evaluation, for a total of almost 2 million Euros if all were to be financed, representing a clear expansion of the research area.

Dissemination and Outreach Activities

A set of events will be organised during the next three years. The first is the international workshop on the Economics of Natural Disasters: Bridging Disaster Risk Reduction and Climate Adaptation, to be held in February 10-11, 2011 at the FEEM Venice headquarters and informing on main research issues dealing with drought risk and vulnerability assessment, drawing on the projects PREEMPT, Water2Adapt, EPI-Water.

5. Management of Natural Resources

5a. Water management

Research on water management is focused on decision and policy-making processes and their relationships with research developments. In particular, FEEM researchers have developed a modular framework for managing participatory processes (PP) named NetSyMoD, "Network Analysis - Creative System Modelling - Decision Support", which has found a number of interesting applications in water management.

For many years the main focus of FEEM research regarding water resources and coastal zones has been on the role of decision support systems (DSS) in pursuing integrated - transdisciplinary- approaches, a principle now deemed necessary to drive the integration of sectoral and national policies for a sustainable use of natural resources.

Future Research Areas

Within this framework, FEEM will produce a set of tools for researchers and water management administrators, particularly tested in the water sector. Researchers are also finding useful applications in other contexts in the field of sustainable development. Water scarcity, sea-level rise and coastal management will also be addressed by FEEM modelling work in the analysis of climate change impacts.

Related Projects: ongoing and forthcoming

FEEM coordinates the project Resilience enhancement and water demand management for climate change adaptation - WATER2ADAPT, funded under the IWRM-NET funding initiative, by the German Federal Ministry of Education and Research, Ministerio de Ciencia e Innovación (Spain), ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale (Italy), and Foundation for Science and Technology (Portugal).

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
WATER2ADAPT				IWRM-NET	70,000

5b. Forestry land use and land use cover, agriculture and food

Sustainable management of land is of key relevance for its main implications and feedbacks on several sectors and environmental problems. From food to timber, from biofuels to afforestation, the recurring issue is land scarcity. Analysing these trade-offs, with specific attention to the problem of water scarcity is of critical importance.

Future Research Areas

Proponents of bio-carbon sequestration activities stress that land-use changes and forestry (LULUCF) initiatives, if properly designed, can bring important multiple benefits in terms of climate change mitigation, biodiversity conservation, rural development and poverty reduction in developing countries. However, several important methodological issues are still at the center of the policy debate and will be investigated in the next three years: baselines, monitoring, permanence and insurance. The role of water scarcity and irrigation, the implications for food prices under different scenarios of agriculture technological change, and the effect of climate change will also be investigated.

The current research area is yet to be developed. Funding as well as dissemination strategies will be developed in the next year.

6. Sustainability and Growth Beyond GDP

This research stream at FEEM intends to enhance the use of an integrated approach to the analysis of sustainable development issues, exploiting multidisciplinary research skills. Much of FEEM research in this area investigates sustainability indicators at the regional and local levels. It also covers sustainable development analysis at a regional scale (e.g. Europe and China) as well as from a cultural and sociological perspective.

6a. Sustainability Indicators

Current FEEM research on sustainability indicators attempts to provide the qualitative and quantitative assessments necessary for linking key well-being and sustainability indicators with mainstream economic indicators, providing much needed insight into the synergies and trade-offs between economic growth and environmental sustainability.

Future Research Areas

A first development of the FEEM sustainable indicator is to use regional-local data and change the scale of the analysis to move beyond the country level. This would be particularly important as research on local sustainability, zero-carbon cities and sustainable urban planning are becoming increasingly interesting to policy makers. These research topics will be a natural evolution of FEEM research on sustainability performed so far. Finally, a further research area will be to extend current modelling tools used to evaluate climate or energy policy in order to include beyond GDP or consumption measures of policy costs, by looking at equity and wealth distribution, leisure time, gender inequality, etc.

Related Projects: ongoing and forthcoming

FEEM is self-financing the project on the Sustainability Index - FEEM SI. FEEM also has a major role in two related FP7 projects: Integrating MainSTREAM Economic Indicators with Sustainable Development Objectives - IN-STREAM and Linking Impact Assessment Instruments to Sustainability Expertise – LIAISE.

Sub tasks within the PASHMINA and Global IQ projects are linked with the growth beyond GDP research theme.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
IN-STREAM				EU FP7	178,380
LIAISE				EU FP7	505,500
PASHMINA				EU FP7	406,800
Global IQ				EU FP7	462,600

Fund raising activities are underway to finance future research on this topic.

Dissemination

The FEEM-SI web site, www.feemsi.org, represents a successful dissemination tool. Further research on this area will increase the attractiveness of the web site for the media and the public at large.

6b. Cultural diversity, globalisation and sustainable development

This research stream at FEEM first addresses cultural diversity and economic development, with special emphasis on the dynamic gains for innovation and creativity that stem from local and global multicultural interactions and a specific focus on the impacts on EU competitiveness and growth. FEEM's current projects focus on the impact of globalisation and the rapid growth of the emerging economies in the world on global sustainable development.

Future Research Areas

The shift from global production networks to global innovation networks calls for a new understanding of the role played by formal and informal actors at micro and macro levels. It also highlights new emerging economies whose overshadowing growth over the EU need deeper investigation. In a long-term perspective, the rise of alternative capitalism models in India, South America and Asia, where cultural and religious dynamics shape the way economics and finance are addressed, is already affecting traditional market-based economies. Research in these regions

attempts to understand how and if fresh paradigms are likely to mark a new deal in models of capitalism and how they will positively or negatively affect sustainability in these regions. A connected and crucial research question looks into how globalisation and the rapid growth of emerging economies is going to impact the competitiveness and the strategies of European Union firms, industries and regions.

Related Projects: ongoing and forthcoming

FEEM coordinates two related EU projects: Sustainable Development in a Diverse World - SUS.DIV and Impact of Networks, Globalisation, and their Interaction with EU Strategies - INGINEUS. FEEM is also part of the EU projects MICRO-DYN and ENGIME.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
SUS.DIV				EU FP6	448,958
INGINEUS				EU FP7	530,000

6c. Corporate Social Responsibility

Strongly rooted in the social pillar of sustainability, this research area is monitoring the evolution of the Social Responsibility concept, together with the implementation of tools to integrate sustainability policies and measures within organizations and local contexts. The efforts focus on a variety of organizations mainly related to the energy, financial, and public sectors and, recently, they have been extended to not for profit and food sectors. Self-regulatory frameworks and guidelines, integrated assessment methodologies, stakeholder engagement approaches, local development models are the main used tools.

Future Research Areas

Particular efforts will be devoted to the constant update of SR tools such as self-regulatory frameworks and guidelines, integrated assessment methodologies, stakeholder engagement approaches, local development models. IN addition, the Social Responsibility concept, typically over-crossing environmental, social and economic issues, implies an interaction of the “Corporate Social Responsibility” Research Area with the other FEEM research themes.

RESEARCH PROGRAMME ON "ENERGY: RESOURCES AND MARKETS"

Motivation

Energy is expected to be a strategic area for action in the coming decades; the growing energy needs due to the globally rising population and standards of living will call for a substantial increase in additional energy supply. Conversely, energy will be key to ensure development and growth where it is most needed.

Although resources suffice to meet the demand, the question is where and in which way this transition will occur, and under which conditions it can be made safe, affordable, and sustainable. Energy infrastructure will have to be built and renewed according to the degree of economic development, the behaviour of global energy markets, the status and prospect of technology, the level of regulation and so forth. On the other hand, the role of energy efficiency, the volatility of energy prices, the relative costs of energy technologies might act to reduce the growth in energy demand in specific sectors or countries.

In addition, there is a growing awareness of the implications of energy production and use on the environment, especially on climate, which needs to be accounted when analysing long lasting capital investments in the energy sector. Sustainable energy solutions encompass not only the deployment of efficient and clean technologies, but also the establishment of policy, institutional and market structures that promote balanced energy policy-making between energy security, economic development and environmental protection.

Despite a growing body of research, the need for economic analysis in the field of energy remains of prime importance. The many contrasting factors complicate the analysis of the energy sector, but for the very same reason motivate the need for original and innovative research, which requires rigorous, methodological based analysis. In this respect, economics offers a valuable approach that, when integrated with engineering and policy analysis, can generate original and useful insights on the functioning of energy markets.

FEEM's capacity and expertise in the field of environmental economics provide the institution with a potential advantage also in the area of energy. Indeed, FEEM's involvement in energy related projects has been substantial, especially in the past, though lately it has primarily focused on the environmental area.

The three coming years provide an important opportunity for expanding the work and the capacity of energy economics at FEEM, well beyond what has been done in the recent past. The research programme can count on a strong leadership in the area of climate change, which will provide fundamental synergies given its inextricable relationship with energy. However, the research

programme will need to expand beyond the interface with the "Climate Change and Sustainable Development" programme by applying economic analysis to issues that are peculiar to the energy sector alone.

The main objective of the research plan is thus to carry out socio-economic analysis and establish expertise in the energy sector at large. The effort will need to be able to combine the short term perspective typical of markets and investors, with the long term one which characterizes public policy making and environmental management. The development of dedicated databases and methodological instruments will provide a cross-cutting element of aggregation between the various research areas.

The main research areas are presented in Table 1. The research areas cover the intersection between the energy sector (distinguished into energy demand, resources and supply) and its relevance with respect to the economy, the environment and the sphere of decision-making.

	Energy and the economy	**Energy and the environment**	**Energy Policy**
Energy Demand	Determinants of energy consumption	The environmental impacts of energy demand	Energy policy and economic development
Energy Resources	Energy markets globally	Resource Management	Governance and institutions for energy
Energy Supply	Energy technologies and innovation	External costs of energy	Politics and policy of energy supply

Table 1. The research areas

This categorisation is intended to highlight the research topics that are more strategic to FEEM, taking into account its current and expected knowledge base and capacity. Several research areas are related to the research programme of Climate and Sustainable Development and reflect the actual (and foreseen through already committed projects) strong interconnections between the two programmes. In addition, new areas of research, which are only marginally related to climate and

sustainable development, have been included in the research plan with the aim of progressively differentiating the two programmes.

We begin by providing a short description of the main goals of each research area.

Description of research Topics

1. Energy Demand

1a. Determinants of energy consumption

There is a need to better understand and represent the patterns of energy consumption at the global and regional levels. Different patterns of consumption and growth in emerging economies are also likely to have important repercussion on the international energy markets and technology development. This research area is meant to fill this gap by focusing on the fundamental drivers of energy demand. It will analyze the most important socio-economic determinants, such as the pattern of urbanization, changes in the demographics, the growth and distribution of income, and lifestyle, as well as on market conditions such as relative price changes of energy goods. It will put a special emphasis on dynamic, fast growing economies such as China, India and Brazil, and will use a wide array of tools such as econometric models of demand, economic growth models, input output tables, household surveys etc. The analysis will shed light on the determinants of demand in the medium to long term and will also be useful for improving the representation of the economic heterogeneity into larger scale analysis such as energy-economy modeling.

1b. The environmental impacts of energy demand

Over the past years, climate has been the most analysed environmental impact of energy. This is due to the fundamental role played by energy in generating greenhouse gas emissions and the growing awareness of the risks associated with climate change. This research area is meant to be brought one step forward by jointly evaluating the relationship between energy consumption and global warming, local air pollution, land use and water utilisation. All these environmental factors are or will be expected to become major priorities either as global challenges or as local problems, whose importance will rise with increasing wellbeing. Both the impacts and the mitigation opportunities of growing energy consumption in terms of CO2, soot, food and water quality will be assessed, by means of an integrated approach which is key in understanding the tradeoffs between competing effects of energy demand on the environment.

1c. Energy policy and economic development.

This research area will analyse the relationship between energy policy and economic growth and development, with a specific focus on the developing countries. It will focus on which policy tools are best suited to improve energy access, accounting for their degree of implementability, including approaches like the Chinese use of securing energy markets in exchange for building the infrastructure needed for development. It will also analyse the role of policies aimed at promoting economic development - such as urbanization - on the patterns of energy consumption, and will deal with the issue of energy poverty and of untapping energy demand in poor countries such as in Africa.

2. Energy Resources

2a. Economy: Energy markets globally (with a special focus on new resources in the gas market).

Energy markets are becoming progressively more integrated, with important consequences in terms of market efficiency, security of supply, decision-making and so forth. This research area aims at analysing the global energy markets with a particular focus on the role of trading energy sources. The strategic incentives faced by energy exporters will be analysed in the context of current and future global policies such as those on CO2 or on renewables. It will also account for the uncertainty related to energy technology performance and to the supply of conventional and unconventional fossil resources. Accounting for policy and technology uncertainty is essential with regard to the prospects for natural gas, and in particular of LNG, whose flexibility allows it to quickly respond to changes in policies and markets. The increased accessibility of new sources such as shale gas will be assessed in its capacity to reduce the dependence of key countries such as the US, and potentially China, on imports, with potential repercussions on the energy markets at large. In addition, this research area will assess the interplay between energy and carbon markets, since both influence one another.

2b. Environment: Resource Management.

Managing resources efficiently is a key objective of a sustainable energy policy. The growing energy demand will increase the environmental pressure of extractive industries such as the energy ones. It is thus important that economic cost benefit analysis correctly accounts for the environmental and health impacts of energy resource management. This research area will focus on quantifying the environmental effects of energy resource management. This is important since new energy sources such as shale gas, characterised by new environmental challenges, may be developed over the course of the next decades. In addition, revenues from natural resources also have the potential to generate substantial economic well-being, but only under the right governance. Institutional and political economy analysis of the relations between energy sources and economic growth is yet another interesting area of investigation.

2c. Policy: Governance and institutions for energy (with a focus on EU policy).

The globalisation of energy markets, the relevance of global environmental problems such as climate and land use change, and the need to ensure the affordability and security of energy supply requires an increased level of cooperation between strategic players. This research topic will aim at examining the role of energy governance in various contexts. At the international level, it will focus on the scope for institution building in order to better manage the global energy challenges. Improved global energy governance might play a key role in achieving progress in international climate policy as well. At the European level, the analysis will focus on the scope for collaboration and integration of the single member states that can be achieved through a common energy policy. This will take account of issues such as market liberalisation and competitiveness, security of supply and sustainability. The analysis will extend beyond the EU to also include the countries of the Mediterranean region, and their role in supplying both fossil and clean energy. Finally, this research topic will also analyse the role of special interests in determining policies aimed at promoting conventional and renewable energy sources.

3. Energy Supply

3a. Energy technologies and innovation.

Whether or not we expect a transition to a low carbon supply of energy to occur in the following decades, assessing the portfolio of investments in energy technologies needed to match the growing energy demand is extremely important. This research area will focus on evaluating the role of energy technologies and technological change under a set of plausible future scenarios, which reflect differentiated and uncertain levels of regulation of pollution and technology development around the world. The assessment will evaluate the economic resources that are needed to build the required infrastructure, and will also link to the issue of the most efficient funding mechanisms to achieve the transition towards a well functioning energy supply. This research area will closely interact with the engineering and expert analysis of energy technologies in order to provide a realistic potential for improving their competitiveness.

3b. External costs of energy

Many policies, through regulation or market based, have and will promote deployment of technologies that would not otherwise be commercial. The potentially large-scale deployment of these technologies is likely to generate adverse consequences whose assessment should be included when setting policy targets. This research topic will examine the external costs of energy technologies and feedstock with a particular focus on energy options such as: renewables, carbon capture and sequestration, nuclear power, carbon dioxide removal technologies. This will help inform decision

makers about the trade-offs between promoting different technology options and will improve energy-economy modelling by better representing the full costs of energy sources.

3c. Politics and policy of energy supply (including energy security).

Geopolitics is expected to continue to be strictly interconnected to the energy issue given the concentration of resources. However, the way it will affect energy markets and policies is uncertain, and will depend on both how and where the demand will materialize, as well as whether additional and more widely distributed sources such as non-conventional fossil fuels will develop. Similarly, the level of economic development and associated democratization will have an impact. This research area will investigate the politics of energy supply accounting for all these evolving conditions. The inclusion of the issue of energy security will be central given the high interdependence of both energy markets and policies.

4. Implementation.

In order to provide guidance towards a realistic implementation of the research plan, Table 2 shows the different research areas by level of priority.

The priority was chosen on the basis of the current and planned capacity at FEEM, the accumulated expertise, and the relevance of the area towards the general aims of the research plan. A lower priority indicates that activities can start at a later date in order to allow for sufficient capacity building.

	Energy and the economy	**Energy and the environment**	**Energy Policy**
Energy Demand	Determinants of energy consumption	The environmental impacts of energy demand	Energy policy and economic development
Energy Resources	Energy markets globally	Resource Management	Governance and institutions for energy
Energy Supply	Energy technologies and innovation	External costs of energy	Politics and policy of energy supply

Table 2. The research areas by priority (darker=higher).

We divided the nine research areas into three groups of priority, which are listed below together with the current and foreseen capacity needed to carry out each of them. Already financed projects that cover the research topics are also highlighted.

Higher priority:

- In the *"Determinants of energy consumption"* area, FEEM has done specific work in the past on forecasting energy demand and analysing the sensitivity of energy consumption to the major socio-economic drivers such as demographic change and productivity improvements. FEEM has participated in several projects that focused on the behaviour of the demand in major economies, and for example is now providing policy guidance on a newly established energy research centre in China, located at Tsinghua University in Beijing (project EC2). FEEM can also exploit its expertise on urbanisation in developing countries thanks to the projects previously carried out within the "Global challenges" research programme. This is nonetheless a major area of investigation, which is likely to require a significant upfront investment.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
EC2				EC and Italian Ministry for the Environment	244,000[1]

- The *"Energy market globally"* area is very strategic given its broad coverage, because it touches upon many topics at the heart of energy economics, such as energy balances and energy pricing. In terms of planned capacity, FEEM has a leading role in one of the largest European projects on energy security (SECURE), which is near conclusion. This activity is partially foreseen in the new project Global IQ, but dedicated funding will need to be raised to increase the capacity and the expertise in this area.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
SECURE				EU FP7	591,848
Global IQ				EU FP7	462,600

[1] The first year of operation (mid 2010-mid 2011), is to be negotiated in the subsequent years.

- The *"Energy Technologies and Innovation"* area has important synergies with the work carried out by the "Climate and Sustainable Development" programme with respect to technological change and climate finance, and, more generally, to energy-economy modelling. This area features several sponsored projects, outlined in the table below. ICARUS focuses on technical change, AMPERE on energy technologies for climate mitigation, and GLOBAL-IQ has a task on electricity super-grids. The outcome of this analysis is likely to be included in the IPCC 5th assessment report, which has dedicated one chapter on transition pathways and one on financing.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
ICARUS				ERC	920,000
AMPERE				EU FP7	320,800
Global IQ				EU FP7	462,600

Medium priority:

- In the "*Energy Policy and Economic Development*" area, FEEM has one ongoing project (POLINARES), which examines the relationship between natural resource policies and development that focuses on conflicts. Additional work is foreseen in the analysis of the role of clean energy policies and economic growth.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
POLINARES				EU FP7	452,067

- In the "*Resource management*" area FEEM has completed previous work on quantifying the costs due to oil spills. The analysis could be extended to assess the environmental impact of extracting and transporting fossil fuels, in particular unconventional sources such as shale gas, as well as bioenergy such as biofuels, under various scenarios regarding their outlook.

- The "*Politics and policy of energy supply*" area is an important research topic with intersections with the remaining three policy areas. The evolution of the geopolitics of energy can be linked to the activities related to the analysis of global energy markets.

Lower priority:

- "*The environmental impacts of energy demand*" area has important synergies with the "Climate and Sustainable Development" unit, especially regarding the use of land and water. Both areas explore fundraising.

- In the "*External costs of energy*" area, FEEM has done extensive work in the past on quantifying the externalities of energy systems, participating in well-known European cost assessments (NEEDS, CASES). The interaction with energy experts in the elicitation carried out in the Climate and Sustainable Development programme can be used to improve the quantification of these externalities, especially for low carbon technologies such as nuclear power and CCS.

- In the "*Governance and institution for energy*" area FEEM has two ongoing projects, MEDPRO and THINK, with the aim of providing knowledge support to the EU energy policy and making a prospective analysis for the Mediterranean region. The output of the analytical work carried out in the other two high priority research areas is likely to have important policy repercussions leading to an increased capacity and ability to fundraise resources dedicated to policy analysis.

Name of Project	Period Covered			Source of Finance	FEEM Budget
	2011	2012	2013		
MEDPRO				EU FP7	289,800
THINK				EU FP7	23,873

In terms of resources, the program is shown to be initially self sufficient to carry out the work in several research areas, especially those at the higher priority, thanks to the existing and foreseeable projects. In particular, as indicated in Table 3, strong synergies exist with the Climate and Sustainable Development programme, which can be exploited in terms of sharing projects, methodological tools, and human resources.

	Climate Change Integrated Assessment Modeling	Climate Change Policy:	Climate-related Innovation and Technological Change	Natural hazards and extreme climate-related events	Management of Natural Resources	Sustainability and Growth Beyond GDP
Determinants of energy consumption						
Energy market globally						
Energy technologies and innovation						
Energy Policy and Development						
Resource management						
Governance and institution for energy						
Resource management						
The environmental impacts of energy demand						
External costs of energy						
Politics and policy of energy supply						

Table 3. Synergies between the research areas of the two programmes (green indicates existing or potential synergy and the energy areas are listed by priority).

Nonetheless, in order to increase leadership in energy topics that are not directly related to climate and the environment, additional capacity will need to be established. In particular, specific and detailed databases containing information on energy prices, balances and policies will need to be established, especially for those regions where data is not fully reliable, and which often coincide with dynamic economies under rapid transition. Moreover, a series of methodological tools that can address the main topics, such as demand forecast models, general equilibrium models, econometric analysis, and so forth, will need to be either expanded or created.

5. Collaboration and Outreach

One of FEEM's widely recognised strengths is its capacity to carry out networking and dissemination activities. The "Energy: Resources and Markets" programme will make the most of these skills by strengthening current collaboration with other research institutes and by promoting additional partnerships.

Current collaborations that are expected to be further stimulated by the new research plan include the ones with Princeton University and MIT on energy technology and policy, and with the Climate Policy Initiative on investment and financing. In addition, the programme will interact with the network of the Global Energy Assessment, an energy focused initiative coordinated by IIASA.

Collaboration will be particularly important to ensure that the best and most updated engineering and technical expertise is fully incorporated into the economic analysis. In addition, collaboration will be needed to build reliable and up to date energy databases, and to ensure that local expertise is fully accounted for. To this extent, FEEM will plan to establish direct relations with key players, especially in fast growing economies, as in, for example, the case of FEEM's role in the newly established energy centre in China within Tsinghua University. A closer link with the industry will also be encouraged to make sure that the research carried out at FEEM is compatible with the most pressing challenges faced by the energy business.

Dissemination activities will be promoted within several workshops organised each year at the FEEM premises, in addition to weekly seminars. FEEM also co-organises and holds the secretariat of the yearly held International Energy Workshop, a major conference in the field of quantitative analysis of energy modeling that will celebrate its 20th anniversary in 2011, and plans to increase the interaction with the International Association of Energy Economics (IAEE) by hosting the XII congress of the IAEE European associations in September 2012. FEEM will continue to disseminate its research to public decision makers, and will also aim at presenting its research to the industry.

PLANNED FEEM EVENTS - 2011

Date: 26-28 January
Title: LIAISE Annual Meeting
Location: FEEM Milan

Date: 10-11 February
Title: International Workshop on "Economics of Natural Disasters - Bridging disaster risk reduction and climate adaptation efforts and strategies"
Location: FEEM Venice

Date: 7-8 Aprile
Title: "International Workshop on the Role of Nuclear Power in Meeting Future Climate and Energy Challenges"
Location: FEEM Venice

Date:19-20 May
Title: International Workshop on "Innovation in Energy Technologies: What Can We Learn from Patent Data"
Location: FEEM Venice

Date: 30-31 May
Title: International Workshop on "Carbon dioxide removal from the atmosphere: technology and economics"
Location: FEEM Venice

Date: May 31st
Title: 20th Anniversary FEEM Prize Lecture: Martin Weitzman
Location: FEEM Venice or Milan

Date: 16-18 June
Title: Fourteenth Annual Conference on Global Economic Analysis "Governing Global Challenges"
Location: Ca' Foscari University, San Giobbe, Venice

Date: 29 June – 2 July
Title: EAERE 18th Annual Conference (co-organised by FEEM)
Location: Rome

Date: 3-9 July
Title: EAERE-FEEM-VIU Summer School on "Natural Resources Management"
Location: Island of San Servolo, Venice

Date: 7-8 October
Title: International Workshop on FDI and Sustainability
Location: FEEM Venice