CHALLENGES OF DECARBONIZING WORLD ECONOMY BY 2050

International MBA IMBA-EN SEP-2024 S-SMS

Area Economics

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José María Calvo-Sotelo (Madrid, 1964) holds a Master´s of Science degree in Physics from the Complutense University of Madrid (1987), specializing in fundamental physics, and an MBA from Harvard University (1993). He has more than 25 years of professional experience in M&A, finance and strategic planning functions in the power industry, mobile telecommunications and heavy industry, having supervised operations in Europe, the Americas, China and Africa. Mr Calvo-Sotelo has been board member both of quoted (Enel Chile) and privately held companies (Orange Spain). He writes regularly for the Spanish journal theobjective.com on energy and climate change matters (https://theobjective.com/autor/jose-maria-calvo-sotelo/), as well as for IE Insights. José María is fond of classical music, sailing, down-hill skiing and mountaineering in the Sierra de Guadarrama.

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SUBJECT DESCRIPTION

Achieving climate neutrality by 2050 represents a huge industrial and technological endeavour to be accomplished in a comparatively short period of time, because energy transitions affect the value chain of every economic activity and take time. Decarbonising the world in 30 years is more than a long-term planning exercise, it is about the significant challenges that all industries face today as they must adapt their production and business processes to new technologies, which come with huge up-front investments, higher operating costs and unknown technological risks. But it is also about ensuring a fair and safe energy transition, delivering communities out of energy poverty and mitigating the uneven effects that decarbonization may bring about to different regions of the world.

LEARNING OBJECTIVES

By completing this course, the students are expected to achieve the following learning objectives:

1. Understand the science behind greenhouse gas (GHG) emissions and its impact on climate, as well as the building of Earth climate models and socio-economic scenarios to identify "posible climate futures" that depend on the evolution of our societies and the way they grow and increase their consumption of energy. Learn where those GHG emissions are coming from, identifying the major economic activities and geographies behind those sources;

2. Recognise the scale of the challenge of the energy transition, its unprecedented complexity and extension. Learn the facts, supported on numbers that must be comprehensible, comparable and memorable. Analyse the different scenarios for achieving Net Zero emissions by 2050. Get to know the major decarbonization challenges and technological risks for the major sectors: energy, transportation, the built environment, industry, food and agriculture;

3. Dive into what major companies are already doing to advance the decarbonization of their operations and supply chains, learning to spot risks and opportunities. The **Group Project** will consist on the analysis and critique of the decarbonization plans and climate neutrality objectives of a company. The **Practical Cases** will address the challenges and disruption a company faces when implementing the changes to become climate neutral throughout all of its internal processes and with its supply chain;

4. Learn the principal economic policy and regulatory tools (carbon taxes, incentives) at hand for governments to curb carbon emissions and to foster investments in low carbon technologies.

TEACHING METHODOLOGY

IE University teaching method is defined by its collaborative, active, and applied nature. Students actively participate in the whole process to build their knowledge and sharpen their skills. Professor's main role is to lead and guide students to achieve the learning objectives of the course. This is done by engaging in a diverse range of teaching techniques and different types of learning activities such as the following:

Learning Activity	**Weighting**
Lectures	15.0 %
Discussions	10.0 %

Exercises in class, Asynchronous sessions, Field Work	10.0 %
Group work	25.0 %
Individual studying	40.0 %
TOTAL	100.0 %

AI POLICY

In this course, **the use of generative artificial intelligence (GenAI) is permitted**, with the goal of developing an informed critical perspective on potential uses and generated outputs.

However, be aware of the limits of GenAI in its current state of development:

·If you provide minimum effort prompts, you will get low quality results. You will need to refine your prompts to get good outcomes. This will take work.

·Don't take ChatGPT's or any GenAI's output at face value. Assume it is wrong unless you either know the answer or can cross-check it with another source. You are responsible for any errors or omissions. You will be able to validate the outputs of GenAI for topics you understand.

·AI is a tool, but one that **you need to acknowledge using**. Failure to do so is in violation of academic honesty policies. Acknowledging the use of AI will not impact your grade.

Suggested format to acknowledge the use of generative AI tools:

I acknowledge the use of [AI systems link] to [specify how you used generative AI]. The prompts used include [list of prompts]. The output of these prompts was used to [explain how you used the outputs in your work].

If you have chosen not to include any AI generated content in your assignment, the following disclosure is recommended:

No content generated by AI technologies has been used in this assignment.

PROGRAM

SESSION 1 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Introductory session.

Article: Adair Turner: I still think we have a chance of limiting global warming to well below 2 Celsius

Article: Decarbonization is our costliest challenge. (IEEE Spectrum) (CED)

Book Chapters: Energy without the Hot Air, Chapter I.1 Motivations pp.1 through 4(Optional)

Vaclav Smil (first reading) says that "the scale of this problem is huge, it is unprecedented in complexity and extension". As he points out, referring to some figures put out by the consulting firm McKinsey, the scale of the effort is similar to that of World War II but extended over 25 years.

Lord Adair Turner (second reading) tells Martin Wolf of the Financial Times that he thinks "we still have a chance to limit global warming to well under 2º Celsius", and goes on to review the different decarbonization challenges and carbon emissions' mitigation technologies, their readiness level, addressing how solutions must be tailored to the specificities of countries depending on their geographical location, demographics and economic development.

David JC Mackay (optional reading) goes on to say that our analysis must be "emphatically intended to be about facts", because "we need meaningful numbers: these numbers must be comprehensible, comparable and memorable, so that when you figure out the numbers, you can evaluate policies". This is the key to this course: when you go out in the world to do business, to set up a company, you must be able to see and understand the world through this lens of fighting climate change. There is no doubt that decarbonization will affect every aspect of business in the years to come: there are in stock great opportunities but also great risks. And you must be able to identify both.

SESSION 2 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

The science behind: greenhouse gas emissions (GHG), anthropogenic climate change and future climate emissions scenarios.

Multimedia Material: Future climate emissions scenarios

Multimedia Material: Global Carbon Atlas: explore and visualize the most up-to-date data on carbon fluxes (Global Carbon Atlas) (Optional)

Multimedia Material: Our world in data: emissions by sector (Our World in Data) (Optional)

Understand the science behind greenhouse gases (GHG) emissions and its impact on climate over the past 150 years, as well as the building of Earth climate models and socio-economic scenarios to identify "posible climate futures" that depend on the evolution of our societies and the way they grow and increase their consumption of energy. We will study the 2021 AR6 Report of the Intergovernmental Panel on Climate Change (IPCC), the most authoritative scientific source for climate change impacts and possible climate futures.

SESSION 3 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Net Zero by 2050: simulating the decarbonisation scenarios.

Multimedia Material: Climate interactive calculator UK (UK GOV)

Multimedia Material: Climate interactive calculator (MIT EN ROADS)

Article: IEA 2023 Update Net Zero by 2050: net zero emissions guide (IEA)

It looks like a long way to 2050, but energy transitions take place over long periods of time, as they affect the value chain of almost any economic activity. We will study the Net Zero by 2050 scenario built by the International Energy Agency (IEA) in 2022, so far the most comprehensive projection trying to reflect the economic and technological challenges of meeting the targets of the Paris Accord of 2015. We will have a look at what different possible futures await us with two of the best online "climate calculators" to find out that there is no single killer application to achieve a climate neutral world by 2050.

SESSION 4 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

First things first: the electrification of the world economy.

Article: Liebreich: Net Zero Will Be Harder Than You Think – And Easier. Part I: Harder (BloombergNEF)

Multimedia Material: Michael Liebreich on the great acceleration of renewable energies and

electrification

Book Chapters: Report IEA: Net Zero by 2050: a roadmap for the global energy sector (iea.org)

The climate change problem is mostly an energy problem, and its solution will be mostly an energy solution. Therefore, the power industry is the cornerstone of any plans to decarbonise the world. Electrification through renewable and other clean energies is to become the first energy source of the world by 2050, displacing fossil fuels that today represent 80% of all the world energy consumption.

SESSION 5 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Heard on the street I: the challenge of the energy transition for a global power utility.

We will have a chance to discuss with a top manager from a power utility and review together the profound changes and growth challenges that decarbonization has brought to the sector.

SESSION 6 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Transportation´s weight lifting.

Transportation's share of global CO2 emissions is growing: it is the only economic activity in the western world whose GHG emissions have grown over the past 20 years. Sea, land and air call for very different technological solutions, from total electrification of light vehicles requiring improved batteries, to synthetic fuels for aviation, hydrogen for land freight or ammonia for sea freight.

Alongside with renewable energies, the electrification of transportation is expected to make the most significant inroads in the reduction of GHG emissions before 2030.

SESSION 7 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Economic policy and regulatory tools: how to reduce carbon emissions and foster investment in clean technologies through taxes and incentives.

Multimedia Material: Carbon taxes and cap and trade systems

Multimedia Material: Nobel laureate economist William Nordhaus on carbon pricing

Article: The Inflation Reduction Act: here is what´s in it. (McKinsey & Company)

Article: A beginners guide to the EU Emissions Trading System (ETS) (Carbon Market Watch)

(Optional)

Climate "governance" has increased in complexity through a wide array of economic policies and regulatory tools to curb carbon emissions and foster investment in low carbon technologies. The EU Emissions Trading System or the future Carbon Adjustment Border Mechanism (CABM) are examples of policies to curb carbon emissions across industries by imposing a "carbon tax" based on the CO2 footprint of products. The USA 2022 Inflationary Reduction Act (IRA) and EU's Net Zero Industrial Act (NZIA) are examples of ways to incentivise and foster investment in new low carbon technologies, through tax credits and other incentives that help bridge the competitive gap of these technologies versus existing carbon emitting, cheaper technologies.

To learn how these policies are crafted, we look at the methodology behind the so called "marginal abatement cost curve" (MACC) that measures the "green premiums" required by new low-carbon technologies to compete profitably against fossil fuels. The MACC methodology ranks low carbon technologies according to the green premiums they carry, and set the stage for planning their deployment starting from the most cost effective to the ones carrying the highest premiums.

Understanding how these economic policies and regulatory tools affect markets will be key for companies to navigate through the energy transition to a low carbon economy, keeping their finances afloat and making sure they do not lose out to new entrants.

SESSION 8 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Economic Development

Practical case 1: Driving Decarbonization at BMW

Practical Case: Driving decarbonization at BMW (HBS 123008-PDF-ENG)

Multimedia Material: Driving Decarbonization at BMW, Video Supplement (HBS 123706-AVO-ENG)

Technical note: Driving Decarbonization at BMW, Spreadsheet Supplement (HBS 123708-XLS-ENG)

The case describes BMW's electrification and decarbonization strategy, and how the company measured carbon emissions throughout the life cycle of its vehicles and used tools like carbon abatement cost curves to evaluate decarbonization opportunities. In mid-2022, automakers, consumers, regulators, and investors were focusing on the transition from internal combustion engine (ICE) vehicles to electric vehicles (EV). While this would reduce tail-pipe emissions, the production of EVs-and especially their batteries-increased emissions in the supply chain. Under CEO Oliver Zipse, BMW was focusing on life cycle emissions and was pursuing a flexible powertrain strategy by offering vehicles with several powertrain options: gasoline and diesel-fueled ICE, plug-in hybrid electric vehicles (PHEV), and battery electric vehicles (BEV). Meanwhile, competing automakers were announcing deadlines by which they would stop selling ICE vehicles, buoyed by investment analysts and favorable press. BMW's approach was receiving a frostier reception in the stock market. Facing these pressures, how should BMW communicate and convince its stakeholders that its strategy was sustainable for both the environment and BMW's financial performance?

SESSION 9 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Heard on the street II: how are real companies facing the challenge of the energy transition?

Our guest will come from a relevant company or financial institution and will take us through their decarbonisation plans and net zero commitments, and show us how those plans are transforming the way they do business.

SESSION 10 (LIVE IN-PERSON)

Intermediate Test

SESSION 11 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Practical case 2: Arla foods data-driven decarbonization.

Practical Case: Arla Foods (A:) data driven decarbonization (HBS 624003-PDF-ENG)

Practical Case: Arla Foods (B): data driven decarbonization (HBS 624036-PDF-ENG)

The case describes Arla's history, in particular its climate change mitigation efforts, and how it implemented a price incentive system to motivate individual farms to implement scope 1 greenhouse gas emissions mitigation measures and receive a higher milk price. The case, and its data supplement, highlight Arla's use of a data score card and regression analysis model to track CO2 emissions across dairy farms in multiple European countries. Arla implemented a data based price incentive systems to measure, track, and influence climate friendly changes to reduce CO2 emissions across the world's fourth largest dairy cooperative.

SESSION 12 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

PRACTICAL CASE 3: CPP INVESTMENTS -- THE ROAD TO NET ZERO

Practical Case: CPP Investments - The Road to Zero (Product #: 324054-PDF-ENG)

In February 2022, Canadian Pension Plan (CPP) Investments, the investment management organization that managed funds for the CPP, one of the biggest pension plans in the world, announced a net-zero commitment for its portfolio by 2050. Under its CEO, John Graham, it outlined key actions to get there but pleasing stakeholders on all sides was a tough ask. While some lauded the fund's efforts, others questioned its decision not to set interim emissions reduction targets and to continue to finance fossil fuel firms. In practical terms, executing on the firm's sustainable investing approach meant making appropriately weighed investment decisions daily, a complex exercise. In mid-2023, one such investment under consideration was Aera Energy, a California oil and gas asset transitioning to a green business model-renewables and carbon capture and storage.

SESSIONS 13 - 14 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Group Project presentations and discussions

SESSION 15 (LIVE IN-PERSON)

Sustainability Topics:

- Economic Development

Wrap up session: how do you see a carbon free 2050?

Article: Hannah Ritchie's Urgent Optimism for a Better World (IE Insights)

Multimedia Material: Is there a limit to technological progress?

EVALUATION CRITERIA

criteria	percentage	Learning Objectives	Comments
Group Work	30 %		
Class Participation	25 %		

Intermediate tests	30 %		
Practical Cases	15 %		

FAILING GRADE AND REASSESSMENT

When students receive a Fail in a course, they have the opportunity to present themselves for reassessment in order to earn the necessary credits toward graduation.
The reassessment of students should be scheduled between 5 and 10 working days after the review session takes place.
Grades for the reassessment are limited to a Low Pass and Fail.
Both, the initial Fail as well as the grade of the reassessment remain on the transcript. For the purpose of calculating the GPA however, only the grade of the reassessment is to be considered.
Students receiving a failing grade in the reassessment of a course will not be able to continue in the program.

BIBLIOGRAPHY

Recommended

- Kerry Emanuel. (2018). *What we know about climate change.* The MIT Press. ISBN 9780262535915 (Digital)
- David JC MacKay. (2009). *Sustainable energy without the hot air..* UIT Cambridge. ISBN 9780954452933 (Digital)
- Hannah Ritchie. (2024). *Not the End of the World.* Penguin. ISBN 1784745006 (Printed)

BEHAVIOR RULES

Please, check the University's Code of Conduct here. The Program Director may provide further indications.

ATTENDANCE POLICY

Please, check the University's Attendance Policy here. The Program Director may provide further indications.

ETHICAL POLICY

Please, check the University's Ethics Code here. The Program Director may provide further indications.