





UCL Institute for Sustainable Resources 2019 Review

We generate knowledge on the globally sustainable use of natural resources and train future sustainability leaders.

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Director's Report

One of my most rewarding activities in 2019 was to be Co-Chair of the United Nations Environment Programme (UNEP)'s flagship publication, the sixth Global Environment Outlook (GEO-6) which was published at the fourth UN Environment Assembly in Nairobi in March 2019. One of the key insights from that weighty publication was that, if humanity wants a decent and sustainable future, it must transform three of the major systems at the heart of its economies: the energy system, the food system, and the system that provides resources and generates wastes.

This challenge is at the heart of the work of the UCL Institute for Sustainable Resources (ISR). As you go through this report of our work in 2019, you will read, on energy and climate change, of our work defining pathways to decarbonisation, identifying the nature and importance of innovation, exploring human behaviour, understanding the role of different technologies, and how they can fit together into a coherent energy system, and how they can be financed and deployed, in the UK and in low-income countries; and, of course, trying to work out which policies will be most effective in helping the new decarbonised energy system supplant that based on fossil fuels in the shortest possible time.

The mainstream means of food production is no less damaging to the environment than that of energy. It has completely disrupted the global nitrogen cycle, contributed significantly to climate change, and been the main factor in the loss of biodiversity. ISR research is focusing on

where and how to increase agricultural production to meet growing food demand, while minimising the impacts of agriculture on land, water scarcity, water quality, biodiversity and climate change. Another project is exploring the impacts of climate change itself on food production and food security.

Food waste provides the link between this stream of work and the use of resources and generation of wastes more broadly. ISR research in this area is firmly rooted in circular economy thinking, on which we wrote a major review paper for the OECD. Our macro-economic modelling of the steel sector in China has shed new light on how the use of steel there might develop; and the Cities of Making project has generated a rich characterisation of waste streams produced by the commercial and industrial sectors in cities and identified ways to turn them into resources.

This and other work feeds directly into our two Masters programmes, the Economics and Policy of Energy and the Environment, and Sustainable Resources: Economics, Policy and Transitions. Both programmes are in great demand and their alumni are now working in governments, businesses, consultancies and NGOs world-wide. It has been a special pleasure to me to see two new modules – on Behavioural Economics and on Energy, Resources and Development – being taught for the first time in this academic year. And our 30 PhD students are a terrific source of creativity and inspiration.

We publish and teach at the highest levels

– but we are also determined to have impact. Just to give a couple of examples here, Michael Grubb is a Coordinating Lead Author for the next assessment report of the Intergovernmental Panel on Climate Change, and both Jim Watson and I chaired Advisory Groups for the Committee on Climate Change as it prepared its report to the UK Government on whether to adopt a net zero emissions target.

We have achieved a lot in 2019 – but of course there is much more to do. We hope that you will be energised and inspired by what you read of the possibilities for sustainability, as well as its challenges, and become more resolved to make your own contribution in your own way.

Paul Ekins OBE

Director UCL Institute for Sustainable Resources

Professor of Resources & Environment Policy

The Climate crisis will profoundly affect lifelong health, report in *The Lancet* suggests

We are already seeing damage to our health from the climate crisis and it will only worsen without change says Lancet Countdown Report, released in November 2019.

The climate crisis is already damaging our health and could determine the health of a whole generation unless the world meets Paris Agreement targets to limit global warming below 2°C, warns a new report published by the Lancet Countdown, contributed to by several UCL ISR researchers. Several key issues were identified as the main threats to health.

One issue was air pollution. PM2.5, or tiny particles known as particulate matter, which are generated by burning fossil fuels and can cause cardiovascular and respiratory diseases when entering the lungs and bloodstream. This could be a large-scale ongoing global issue. In 2016 there were 2.9 million premature deaths worldwide. If 2016 levels of PM2.5 remained for the next 100 years, the average European lifespan could be cut by 5.7 months.

Crop failures were also identified as a key issue. The report outlines that as temperatures rise, harvests will shrink threatening our food security and increasing food prices. In the last 30 years we have already seen a decline in the average global yield potential of key crops. Children and infants are among the worst affected by malnutrition and related health problems.

We are already seeing the effects of extreme weather with wildfires, droughts and heat waves hitting the global

population's health. As temperatures continue to rise the report suggests that children born today will face increased risk from severe floods, prolonged droughts, and wildfires.

Another growing issue the report identifies is that over the past 30 years the number of days that it is climatically suitable for bacteria that spreads diarrhoeal disease have doubled, and changing weather patterns are also creating favourable environments for cholera bacteria, increasing the likelihood of exposure and infection.



Recommendations

In order to tackle these issues and keep global warming to below 2°C the report calls for bold actions over four key areas:

- > Delivering rapid, urgent, and complete phase-out of coal-fired power worldwide
- > Ensuring high-income countries meet international climate finance commitments
- > Increasing accessible, affordable, efficient public and active transport systems
- > Major investments in health system adaptation to ensure climate health damage doesn't overwhelm health services

The Lancet Countdown on Health and Climate Change is a yearly analysis tracking progress across 41 key indicators,

demonstrating what action to meet Paris Agreement targets—or inaction—means for human health. The project is a collaboration between 120 experts from 35 institutions including the World Health Organisation (WHO), World Bank, University College London, and Tsinghua University. UCL ISR researchers included: Prof Paul Ekins, Dr Carole Dalin and Mr Paul Drummond.

London students call for climate action to be integrated with SDGs

What are the synergies and tradeoffs between achieving the Sustainable Development Goals (SDGs) and addressing climate change? London A-level students shared their views at UCL and IntoUniversity Summer School.

Each year Dr Nick Hughes at UCL ISR hosts a group of A-level students from London schools to take part in a 3-day Summer School. It is jointly organised by the UCL ISR, UCL Energy Institute, and national educational charity IntoUniversity, which supports young people from disadvantaged backgrounds to attain a university place or follow another aspiration.

In the summer of 2019, 20 students came to join members of staff from UCL Institute for Sustainable Resources and UCL Energy Institute. Overall, the discussions of the three days emphasised the importance, for long-term human flourishing, of addressing both climate change and the wider SDG agenda.

The UCL staff found it inspiring to work with such a thoughtful and perceptive group of students and thought they showed great resilience, creativity and curiosity in addressing these important and complex issues.

Three students wrote blogs, now published on our website:

- > The challenge of achieving food security while also limiting climate change to 1.5°C by Rasheed Eytayo-Olonade
- > Challenges of addressing SDG 9 while also limiting climate change to 1.5°C by Eusra Mahadi
- > Can the world address both climate change and sustainable development? by Antonia Antrobus-Higgins

Is there a funny side to the climate crisis?

Dr Matt Winning has found a novel way to communicate the threats of the climate crisis - through comedy.

By day, Dr Matt Winning works as a Research Associate at the UCL Institute for Sustainable Resources, researching the macroeconomic impacts of environmental policies. By night, he is the “attractively impish” (Guardian) comedian who “delivers the funniest lecture you’ll ever receive” and will “make you want to save the planet” (The Sunday Post).

His brand of climate humour uses storytelling lectures, wisely marked with a distressing content warning, to both engage and entertain audiences with the

often depressing facts of climate change. Following the sell-out successes of his solo shows ‘Filibuster’ and ‘Climate Strange’ at the Edinburgh Fringe in 2017 and 2018, Matt performed his new show at the Fringe in 2019 - It’s the End of the World as We Know It (And I feel fine (but not all the time)).

It went down a storm with consistent four star reviews. He’s now touring it around the UK. For dates see mattwinning.com



Healthy planet, healthy people

As the global population rapidly grows, can we create a planet that is fair, safe and healthy for all its inhabitants? Yes we can, says the 6th UN Global Environmental Outlook, published in March 2019 and co-chaired by UCL ISR's Director, Professor Paul Ekins.

GEO-6 report

Our planet is currently home to around 7.7 billion people. This number is predicted to increase dramatically over the coming years to 8.6bn by 2030, 9.8bn by 2050, rising to 11.2bn by 2100. However, our planet is becoming increasingly unhealthy, and this is having a direct impact on human life. More than 12.6 million people died from environmental causes in 2012. That represents nearly one quarter of all deaths worldwide that year.

As we see the negative effects of how we have been living intensify with climate change and pollution, we are now tasked with the greatest challenge for humanity – to build a healthy planet that can sustain 10 billion people safely and humanely. The 6th UN Global Environment Outlook (GEO 6) report says we can get there, but only if the health of our planet is prioritised. To get there, the report suggests we should focus on changing the following fundamental systems: food, energy, waste and resources.

By bringing together a community of hundreds of scientists, peer reviewers and collaborating institutions and partners, the GEO 6 report builds on sound scientific knowledge to provide governments, local authorities, businesses and individual citizens with the information needed to guide societies to a truly sustainable world by 2050.

Food production

As the population increases, we will need to increase food production. Natural disasters, droughts and floods already cause major disruption in our food supply and this is likely to intensify with climate change. Another major problem is food waste. About one third of all food is lost or wasted between production and the plate. In fact, if food waste were a country, it would be the planet's third-biggest emitter of greenhouse gas emissions. To cut emissions and ensure we have enough food, the report says we need to stop waste.

The report recommends that we need to give farmers strong incentives to reduce their greenhouse gas emissions and use their land as efficiently as they can. Further, we need to cut down on food waste across the value chain; this will cut carbon but also means there will be more food available. It also suggests, we need to encourage and empower people everywhere to adopt healthier and more sustainable diets. In many cases, that means eating less meat. By doing this we can reduce agricultural land use and also cut global emissions, because the meat industry is spatially and carbon intensive.

Clean energy

Renewable energy production is currently at a record high. However, about two thirds of our electricity still comes from fossil fuels. Global energy demand will likely grow by

30% by 2040 — the equivalent of adding another China and India to today's energy demand.

The report says our goal should be to completely “decarbonize” our energy supply. To do this the report suggests we need regulations, policies and innovations that push people towards cleaner sources of energy. We need to reduce our energy use, by increasing energy efficiency as well as reducing energy loss and, at the same time, we need to continue to pursue technologies that will allow us to pull carbon out of the atmosphere and store it safely and sustainably.

Managing waste

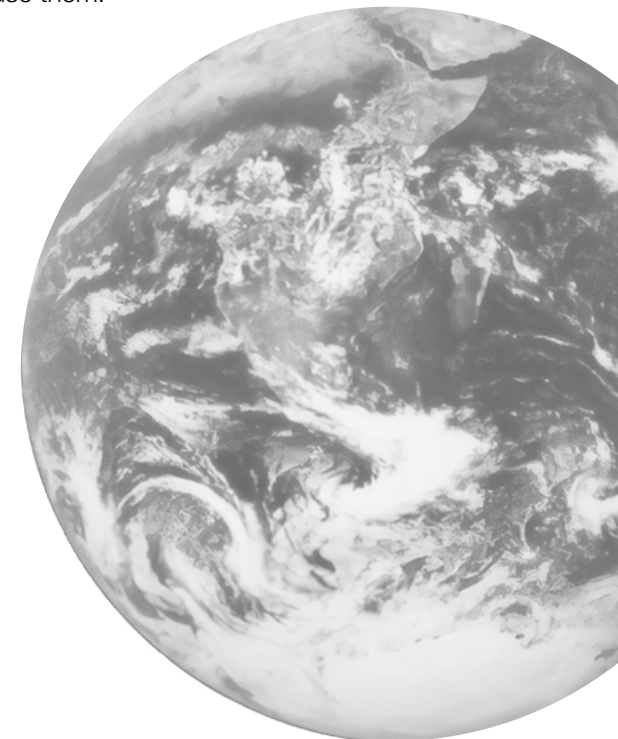
The global market for waste is worth \$410 billion. Safely and legally disposing of waste can be expensive, so some people decide to just ship it to other (usually poorer) parts of the world. The report calls for shifting to a circular economy where waste is turned into a resource. To get there, the report suggests governments need to create incentives for companies to design for the future and should also impose new taxes on the use of virgin materials. Companies need to reduce waste in their value chains and find creative new ways to put their waste to use. They should also design products to be easily recycled or repurposed after consumers are finished using them. Consumers need to be more conscientious about how they buy, how much they throw away, and how they recycle, with retailers and government needing to make it easier for them to change behaviours.

Political will

Professor Paul Ekins, Director of UCL ISR co-chaired this latest UN Global Environment Outlook report. He said:

“What is absolutely clear is that, although the environmental situation is dire in many places, there are solutions and we actually do know how to address these issues, if we have the political will to do it. There is no evidence that it would be prohibitively expensive, or that it would have a negative impact on countries' growth prospects,”

“We're currently on a path that is going to make life extremely uncomfortable for many people,” Ekins says. “But policymakers do have the tools at their disposal to make fundamental changes to the way we use the natural environment, which would mean we could still meet our sustainable development goals. We should ensure they use them.”



Teaching

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Economics and Policy of Energy and the Environment MSc

This joint MSc with the UCL Energy Institute equips graduates to become sustainability leaders and entrepreneurs in business, policy-making and research.

About the programme

Using a wide range of knowledge and expertise the EPEE MSc equips students with the skills and knowledge to become leaders and innovators in business, policy-making and research.

This degree provides a broad understanding of research concepts and methods as well as an in-depth understanding of environmental and resources economics; modelling, methods and scenarios, environmental measurement, assessment and law, global and behavioural economics and the political economy of energy and climate change. Taught by our world-class faculty this MSc allows its graduates to pursue a wide range of varied and challenging careers at the forefront of industry, research and academia.

Studying the EPEE MSc at the UCL Energy Institute and ISR offers a unique opportunity to focus on core areas that have risen rapidly up the public agenda in recent years – environment, climate and energy economics, modelling and policy.

Students will reach a deep understanding of different economic and policy approaches to the resources and environmental problems facing the global community. This combined with a variety of analytical methods to resolve these problems in a broad range of practical contexts gives our graduates excellent grounding from which to launch their careers in their chosen area of expertise.



"I'm currently working as a Sustainability Consultant for CBRE, the largest commercial real estate service company in the world. I advise companies and investors on their sustainability strategies, for compliance, voluntary reporting and risk mitigation. Through the EPEE course I learned to understand the relation between economic theory, legislation and policy, allowing me to explain implications of legislative changes more clearly to my clients. Additionally, I wrote my dissertation on corporate climate change risk in the CDP (Carbon Disclosure Project) and I am now advising a client on their disclosure to the CDP."

Cathy Granneman, Economics and Policy of Energy and the Environment MSc Class of 2019

Key information

- > Programme lead: Lorenzo Lotti
- > Modes of study: full-time and part-time.
- > Location: Bloomsbury

Sustainable Resources: Economics, Policy and Transitions MSc

This MSc teaches students how to analyse and manage the sustainable exploitation of mineral and natural resources, throughout the economy.

About the programme

Sustainable Resources: Economics, Policy and Transitions MSc gives its students a chance to investigate one of the most urgent topics plaguing society: how to use the World's resources in a sustainable way.

This programme allows students to explore the circular economy, resource efficient and sustainable resource management, and the economics and policy of resources.

The curriculum of the Sustainable Resources MSc reflects the global and multi-dimensional nature of this topic. The extraction, supply and management of materials underpins every aspect of our lives. This programme highlights the need for us to make the transition from a highly inefficient and wasteful system towards a more sustainable one in which resources are maintained in a cycle as long as possible.

This multi-disciplinary programme includes economics, political sciences, development planning, engineering and the natural sciences. It equips students to become leaders and innovators in their chosen area of specialisation and allows them to explore where this specialisation might lie in a variety of content, speakers and networking events throughout the year.

Key information

- > Programme lead: Nino Jordan
- > Modes of study: full-time and part-time
- > Location: Bloomsbury



"I have immensely enjoyed my year at the MSc in Sustainable Resources at the Bartlett School. It is a very versatile programme that covers the societal issues around sustainability through modules on resource economics, policy and governance, but also helps you develop a strong quantitative analytical toolkit.

The interdisciplinary approach of the MSc is great since it means that the people on the course come from varied backgrounds and that there is something to learn from everyone. Being surrounded by researchers who are in the top of their fields is truly inspiring, especially since they are very down to earth, encouraging and have a lot of time for the students.

The possibility to select your own modules for the second term means that you can adapt the programme to suit your interests and where you want to go professionally after graduation."

Harald Helander, Economics, Policy and Transitions MSc Class of 2019

PhD

Sustainable Resources MPhil/PhD

The UCL Institute for Sustainable Resources has a large cohort of exceptional MPhil/PhD students working on collaborative projects measuring regional progress towards or away from environmental sustainability.

About the programme

This MPhil/PhD allows students to explore the area of sustainable use of natural resources alongside experienced researchers in a dynamic, multidisciplinary environment.

Students embark on a research project usually lasting three years in a variety of specialist areas, including the sustainable use of water, minerals, marine resources, biomass, and energy.

They use a variety of methods including economics, engineering, environment, human dimensions, modelling, and policy analyses. The main and final product of this programme is the thesis, and your result rests on the examination of this.

Supervision and mentorship is available from world-leading researchers with national and international contacts and collaborations across policy, government, industry and academic sectors. Our students also gain access to networking events, career workshops and exclusive seminars held by ISR and the other institutes within the school.

Our research is built around five intersecting themes:

- > **Abiotic resources**
- > **Biotic resources**
- > **Definitions and indicators of sustainable resource use**
- > **Green economy**
- > **Resource efficiency**



"My PhD at ISR on land degradation in agriculture was largely shaped by the interdisciplinary focus and the big network of this institute. This gave me the opportunity to approach my research project from different angles while directly collaborating with researchers from around the globe."

Tony Carr, current PhD student

Key information

- > Modes of study: full-time and part-time.
- > Location: Bloomsbury

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Energy, Resources
and Development

Econometric assessment

Econometric modelling and evaluation of energy and economic policies focuses on the impact of low carbon pathways on natural capital and ecosystem services, the impacts of economic and climate shocks on traded commodities and the drivers of variability in crop yield.

What we do

Our team has an extensive track record in assessing the impact of energy efficiency measures such as those introduced by the Department for Business, Energy & Industrial Strategy. Our research is based on different branches of econometrics such as structural VARs, Kalman filtering, gravity models and programme evaluation econometrics.

Recent areas of research include:

- Evaluating the impact of “Public Sector Energy Efficiency Loan scheme” on schools, universities and local government buildings
- Analysing the determinants of emissions in the UK industrial sub-sectors
- Assessing the impact of climate change on the yield of agricultural crops in a number of European countries, as well as the impact of climate change on food prices
- Exploring the environmental, social and economic implications of delivering the low carbon pathways to radically cut greenhouse gas emissions by 2050

Biomass and low carbon pathways

As part of the UK Energy Research Centre (UKERC), we assessed the existence of synergies and trade-offs arising from the global demand for biomass in low carbon pathways. We focussed specifically on the amount of required land and water, bearing in mind other competing needs, notably food production.

Evaluating energy consumption and competitiveness

With funding from the Department for Business, Energy & Industrial Strategy we conducted two evaluations focussing on the impact of the “Public Sector Energy Efficiency Loan scheme” and the Climate Change Agreements on energy consumption and competitiveness. We implemented a Difference-in-Difference strategy with an instrumental variable identification and the Synthetic Control Method, a methodology designed to be effective with a small number treated units.

Green economy

Our research contributes to the creation of a green economy that drives sustainability, improves human wellbeing and build a social equity whilst reducing environmental risk and scarcity globally.

What we do

The Green Economy theme overlaps with a number of other specific areas of work going on at ISR. Thus the big Horizon 2020 INNOPATHS (Innovations Pathways, Policies and Strategies for the Low-Carbon Transition in Europe) is a feature of the Innovation area of work, as is the Green Innovation Policy Commission (GIPC), which organised an event on green innovation and infrastructure at the Royal Society in 2019, and is now preparing its final report. In 2019 UCL ISR also collaborated with the UCL Institute for Innovation and Public Purpose to produce a paper on mission-oriented policy road-mapping for the SDGs.

The topic of the circular economy is obviously also critical to the Green Economy, and this also has its own specific theme in the ISR research strategy. In 2019 UCL ISR was commissioned to do a major paper on the circular economy by the OECD, looking at the history and background of the concept, indicators of circularity, circular business models and policies to promote the circular economy, and circular economy experience in China, the European Union and cities. Still on this theme, UCL collaborated with SYSTEMIQ to produce a White Paper exploring the innovative policy concept of Producer Ownership.

Strong sustainability indicator

Over the last two years UCL has been commissioned by the French International Development Agency (AFD) to produce an indicator of strong environmental sustainability, which AFD was increasingly

finding it needed to guide its work in developing countries. This request meshed well with a PhD on the subject being carried out by Arkaitz Usubiaga. Together with Ben Milligan they produced a scoping paper, now published on AFD's website.

In a second phase of the project Alison Fairbrass looked at availability of data in global datasets to apply to developing countries the methodology developed for the EU by Arkaitz. A Technical Manual for calculating the indicator was presented to AFD in Paris in September 2019, and initial results for the EU, and a paper by Alison on global datasets, were presented at a workshop at the European Environment Agency in December. This has served as a proof of concept, and plans are now in hand, in collaboration with AFD and UNEP, to calculate the indicator for developing countries, as part of UNEP's programme of work on Measuring Progress towards the achievement of the environmental objectives of the Sustainable Development Goals (SDGs). The interim outcome of this work will be presented at the fifth United Nations Environment Assembly in February 2021, with the final outcome featuring at UNEP's Stockholm + 50 Conference in 2022.



Macro-economic modelling

Our research studies the inter-linkages between the economy and the environment, focusing on the use and management of scarce resources and assessing the impacts of resource and environmental policies on the economy.

What we do

This theme's portfolio is spread over a number of resource and environmental policy research projects. As part of consultancy work for the OECD, the potential economic and environmental benefits of circular economy policies were explored focusing on the iron and steel sector. We also have ongoing research under the COP21 Results, Implications, Pathways and Policies for Low-Emissions European Societies (RIPPLES) project and the UK Energy Research Centre. These projects focus on the energy systems transition and the macro-economic impacts of global decarbonisation pathways. Special focus is given to the economic impacts of different financial scenarios.



Resource interlinkages and future transformations

ISR is developing macro-economic modelling tools to address resource interlinkages and future transformations at the global, regional and country level. Our Environmental Global Applied General Equilibrium (ENGAGE) model is based on up-to-date international trade data and has detailed modules on food, water, minerals, and energy. The model seeks to fill gaps on analysing policies and transition pathways.

The ENGAGE-materials model was updated to become the most advanced global CGE model able to assess the steel industry as an integral part of the circular economy. ENGAGE-materials include an explicit modelling of production, consumption and trade of the whole supply chain of steel. Ongoing work assesses the potential competitive advantages, economic benefits and environmental gains for China by moving to a circular economy in the steel industry.

Sustainable finance

The sustainable finance work focuses on the financing dimensions of low carbon investment and transition, and the architecture of the financial system to identify points of intervention that climate policy can leverage to spur green finance.

What we do

The finance sector response to pressures around climate change has emphasized disclosure, notably through the recommendations of the Financial Stability Board's Taskforce on Climate-related Financial Disclosures (TCFD). The implicit assumption - that if risks are fully revealed, finance will respond rationally and in ways aligned with the public interest - is rooted in the "efficient market hypothesis" (EMH) applied to the finance sector and its perception of climate policy.

For low carbon investment, particular hopes have been placed on the role of Institutional Investors, given the apparent matching of their assets and liabilities with the long timescales of climate change. Our research explains theoretical frameworks and use empirical evidence to probe some of the limits of the EMH: it follows that transparency alone will be an inadequate response. To some extent, transparency can address behavioural biases, and improving pricing and market efficiency, however the strategic limitations of EMH are more serious. We argue that whilst transparency can help, on its own it is a very long way from an adequate response to the challenges of 'aligning institutional climate finance'.

Understanding the anatomy and the architecture of the financial system, as well as its evolution, is crucial to identifying points of intervention that climate policy can leverage to spur green finance. Our research explores the market for low-carbon finance as a complex system,

where interactions of heterogeneous investors give rise to large scale investment trends. By modelling the investment system as an evolving network of inter-linked investors, our analyses identify the key actors that have directed investment flows in low-carbon technologies, patterns of investors' interactions in terms of co-investments and the processes that drive the evolution of the investment landscape. An understanding of the dynamic interplay of the financial, technology and policy elements in the system is crucial to better inform policy design. These elements will likely influence key actors, leverage existing interconnections and deploy instruments of public finance and policy effectively to accelerate the deployment of low-carbon technologies.

Early findings emerging from our research on Sustainable Finance have been supported by an ERC Starting Grant, led by Dr Nadia Ameli. This project will last for the next five years and will focus on the role of climate finance to meet the Paris climate goals. This research will promote essential guidance for a re-orientation of financial flows towards low-carbon and energy efficiency investments.



Current projects

GREEN-WIN explores the crosscutting role of finance in overcoming barriers to climate adaptation, mitigation and sustainability action with a particular emphasis on avenues for integrating climate/sustainability public policies with the mainstream finance framework and system.

RIPPLES analyses the financial implications of the NDC and 2°C, and where possible 1.5°C, trajectories, in terms of investment required across all sectors, cross-border capital flows, public budgets, and the financial system more broadly.

ERC Starting grant LINKS (starting date 1 September 2019) will study how to transform the financial system and design policies to re-orient financial flows towards low-carbon investments and ensure effective capital allocation.

Outlook

The financial sector continued to achieve outstanding progress in the last years. The European Commission published its Action Plan on sustainable finance to reform prudential, fiduciary duty, benchmarks, ratings, accounting, and products distribution frameworks as well as the EU taxonomy of green sectors and assets, setting harmonised criteria for determining whether an economic activity is environmentally sustainable.

Leading Central banks together with Supervisors also set up a new Network for Greening the Financial System (NGFS) to contribute to the development of environment and climate risk management in the financial sector, and to mobilize mainstream finance to support the transition toward a sustainable economy. These recent initiatives highlight the increasing importance of sustainable finance as the next lever to tackle climate change and the reforms needed to align the financial sector with climate goals.

Behavioural economics for the environment

We are a research unit of staff and students applying behavioural economics theories and techniques to promote sustainable and environmentally-friendly behaviours and choices.



What we do

The natural environment is in danger, and one of the main threats is behaviour. The BEE team focuses on behavioural economics to develop solutions in order to support more sustainable behaviours, tackling climate change and promoting conservation of natural resources and biodiversity.

The team develops cutting-edge research using behavioural and experimental economics insights, providing insights and guidance for policy makers and private stakeholders. They also train and cooperate with professionals, NGOs and policy makers, making an impact with their expertise. Working alongside UCL Sustainability, BEE develops field experiments across the campus and helping to make UCL greener.

This year we have completed:

- > Two field experiments developed with UCL Sustainability on Nudging Recycling Behaviours - Lorenzo Lotti, Yifei Wang, Alberto Bosco

- > Field experiment on nudging printing behaviours - Zitong Wang, Lorenzo Lotti
- > One Lab experiment: "How do community sustainability values promote individual environmental behaviours?" - Mark Collar, Lorenzo Lotti
- > Developing a nudge for effective recreational fisheries management and compliance - Shanali Pethiyagoda, Silvia Ferrini, Lorenzo Lotti
- > Phd Student Scholarship in Behavioural Economics and Sustainable Food Production/Consumption - Arianna Buratto, from September
- > Presenting and providing training to Hubbub foundation - Lorenzo Lotti, Shanali Pethiyagoda, Andrew Brown, Alberto Bosco
- > Contributed to the OECD paper on Circular Economy done by the department, providing the behavioural insights
- > Students in the MSc module presented 6 research projects on how to use behavioural economics for the environment

Innovation

Innovation is critical if the world is to meet the UN's Sustainable Development Goals. Our research spans climate, energy, circular economy and areas of innovation research ranging from technology roadmapping to case studies on business model innovation.

What we do

UCL ISR is an international centre for comparative eco-innovation research, spanning the levels of technologies industries, countries, the EU, and international approaches. We do rigorous data analysis, innovation systems analysis, impact assessments, network analysis, and are involved in participatory approaches. Our methodological advancements address new ways of evidence-oriented analysis, expert involvement, and learning tools.

This year has seen the successful completion of the INNO4SD project, ongoing work with the UN Inter-Agency Task Team's "Guidebook on Science, Technology and Innovation for SDGs roadmaps", and significant progress in the INNOPATHS project. We have also launched the Green Innovation Policy Commission.

We started a collaboration with the Canadian Smart Prosperity Institute (SPI). Funded by the SPI's Economics and Environmental Policy Research Network, the project will involve Will McDowall, Michal Miedzinski and Paul Ekins working with Professor James Meadowcroft at Carleton University to assess Canada's policy mix for enabling sustainability transitions.

We also began a major systematic review of literature on the drivers of energy innovation, led by Professor Michael Grubb, and involving ISR researchers Paul Drummond, Ali Poncia and Will McDowall along with an international author team spanning France, the US, Japan, Germany and the Netherlands.

Mapping high-carbon industries

Innovation is not only about the development of new technologies and business practices. The other side of innovation is the decline of obsolete technologies and skills. As the world shifts to a low-carbon energy system, there is an increasing need to understand the fate of declining industries. Within the INNOPATHS project, the UCL ISR team have been mapping the European regions with a high dependence on high-carbon industries that might be expected to decline over the coming decades. This effort helps policymakers proactively manage the potential intersections of existing patterns of regional inequality with vulnerabilities associated with declining high-carbon employment. This work was presented at the International Sustainability Transitions conference in Ottawa in June 2019.



Energy pathways

ISR conducts various research projects on resource and energy sector interactions. The expected outcome is knowledge about future energy pathways towards sustainable resources in the UK, EU, other countries and at international scales.

What we do

The energy pathways theme examines long-term scenarios for the energy system and explores the implications of these scenarios for people and policymakers. It spans economics, engineering, social and environmental issues, and policy. We work with other themes on cross-cutting issues such as climate policy and the water-food-energy nexus.

Low-carbon energy vectors are the principal focus, with a hydrogen energy programme and projects on carbon capture and storage, greenhouse gas removal technologies and renewable electricity generation. Fossil and biomass resources have been an area of interest for several years, and we have increasing interest in modelling waste management and the circular economy.

Over the last year, we have supported the UK Government with their net zero energy systems analysis. This underpinned their decision to adopt an ambitious net zero target for 2050 to replace the previous 80% emissions reduction target. Our review of the capability of UK TIMES to represent net zero pathways has been shared with several stakeholders. We led a major new EPSRC project on electricity interconnection with Europe. Our focus in the coming year is on new projects, particularly Phase 4 of the UK Energy Research Centre (UKERC), which will include redeveloping our UK, European and global energy system models.

Interconnection in a Changing EU Electricity system

The GB electricity system is connected to France, Netherlands, Belgium, and Ireland. Our ICE project (Value of Interconnection in a Changing EU Electricity system) was funded by the EPSRC in 2018, with the aim of understanding both the potential impacts of Brexit and the implications of greatly increased interconnection capacity in the future.

Markets have been coupled over the last six years, which means final prices are calculated in each market, at the same time, using the same system. This maximises the efficiency of the flows and minimises electricity prices. We have developed several new metrics and used these to evaluate how the value of interconnectors has been increased by coupling. In a no-deal Brexit, markets could become uncoupled. We worked with the University of Strathclyde to model the future impacts on the value of interconnectors of uncoupling markets in Europe, for the first time.

We redeveloped our European energy system model to provide long-term electricity generation and demand scenarios for Europe, to underpin interconnector modelling. We interviewed key stakeholders to compare views on future interconnectors, and created a business model to compare the public and private values of interconnectors.



Climate Policy

Climate policy requires rigorous analysis of electricity markets and of transformations of entire economies. ISR engages in research on financing low carbon economies with a specific angle on behavioural economics.

What we do

As well as conducting research on financing low carbon economies with a specific angle on behavioural economics, ISR is also involved in research comparing the results of the Paris Agreement and assessments of national commitments. This will result in improved evidence on how actors engage and how climate policy ought to be developed over the next few years.

In 2019 ISR completed modelling for the Horizon 2020 COP21-RIPPLES project, exploring the financing implications of the low carbon transition. The TIAM model was used to compute energy scenarios which then fed into both our General Equilibrium models. Researchers also used a DSGE model of finance which estimated potential impacts of the investment surge on interest rates, and how different international financial architectures could affect the costs to developing countries.

Moving away from coal in the UK

Michael Grubb stepped down from his role chairing the UK Panel of Technical Experts on Electricity Market Reform, but the expertise on how the UK got coal out of its electricity system has proved of high international interest. It has formed a core element of talks in India, China and Korea and engagement with visiting delegations from these countries - as well as closer to home with presentations in several European countries. An academic paper on the topic, with Prof Newbery from

Cambridge, was published in The Energy Journal.

As our analysis underlines, it is a classic 'three pillar' story of energy efficiency, combined with fundamental regulatory reform to drive industrial innovation in renewables at scale, along with robust carbon pricing to shift the economics of operation from coal to natural gas. A capacity market ensures system adequacy, and has also proved far cheaper than expected, encouraging further innovation in small-scale and demand-side options.

There is nothing quite as compelling as a practical example; the UK demonstration that it is possible to move from a coal-dominated to a coal-free system within one generation has clear and visible impact on policymakers – and analysts – internationally.



Water & food nexus

The use of all resources is increasingly recognised as being interlinked, as conceptualised through the water-energy-food nexus debate. ISR pushes the boundaries of this debate through integrating minerals and land into nexus research.

What we do

The water and food resource nexus team at ISR is constantly growing. This research team consists of academic staff, researchers and postgraduate students. Working together they research issues related to agricultural production and its environmental impacts on a global scale.

The FOODIES project, led by Carole Dalin, is developing worldwide integrated indicators of the environmental sustainability of food production and trade, focusing on the impacts of agriculture on land, water scarcity, water quality and climate change. This is an Independent Research Fellowship project funded by the Natural Environment Research Council (NERC). Mark Jwaideh is carrying out a PhD studentship on this topic, particularly looking at water quality impacts.

The BIOTA project (funded by NERC), co-led by Carole Dalin and Tim Newbold, aims to reveal the interactions between global biodiversity change and human food security. Two postdoctoral researchers have joined the team: Monica Ortiz and Charlie Outhwaite, respectively working on trade linkages and spatial analysis. The team has produced two review papers and one article paper to be submitted in Autumn 2019.

The water and food resource nexus team is also involved in important research on planetary and human health, with contributions to the Lancet Countdown report and one postdoctoral position to be filled at ISR within the Wellcome Trust funded Sustainable and Healthy Food Systems (SHEFS) project.

Sustainable Agriculture Matrix

Where and how to increase agricultural production to meet growing food demand is critical for the sustainability and resilience of food systems and society. The resources required to produce each calorie or gram of protein varies largely across crop types and regions, which, in turn, affect nutrition, farmer welfare, and the resilience of food supply.

The Sustainable Agriculture Matrix is a tool to which Carole Dalin and colleagues have contributed, notably via a series of funded workshops held at SESYNC.

Based on the indicator system and associated database developed by the Sustainable Agricultural Matrix the team developed a SAM-CMT (Crop Mixes and Trade) model to assess the impacts of crop mixes on domestic production, international trade, and sustainability. Building on the SAM Workshop output and this new model, the team proposes to coordinate a highly interdisciplinary and cross-sectoral team to study the complex dynamic interactions of environmental, economic, and social dimensions of sustainability.

The project lead, Xin Zhang, has presented this tool in a meeting at the United Nations' Food and Agriculture Organization in Washington D.C. on June 21, 2019.

Urban transitions

Understanding the flows of energy, material resources and water in cities and devising new pathways for a more sustainable use of resources is the key to more sustainable futures.

What we do

Urban areas concentrate half of the world's population, consume 70% of the resources and one third of the energy globally (UNEP, 2013). It is expected that by 2050, 70% of the world's population will live in urban areas. Cities are also spaces of innovation and exploration. Understanding the flows of energy, material resources and water in cities and devising new pathways for a more sustainable use of resources is the key to more sustainable futures. The challenge requires profound changes in how the cities are planned and how infrastructural, social and economic systems operate within them.

UCL ISR is at the forefront of the research in urban sustainable transitions. The work in cities covers three main focus areas:

> Understanding urban food systems. We are working closely with the Ellen MacArthur Foundation and other organisations to increase the circularity of the food system in cities, a crucial step to more sustainable urban areas.

> Characterising industrial and commercial waste in cities, sectors traditionally out of the focus of sustainability initiatives, which in fact generate a large proportion of the waste produced by cities and where there is potential to transition towards more circular use of resources.

> Mapping existing segregation, collection and waste treatment infrastructure and identifying the main infrastructural gaps for the transition towards sustainable circular cities.

Two aspects transversal to all three areas are also the role of planning policy and new urban business models and understanding the potential of those to shape more sustainable resource flows in cities.

Cities of making

After 3 years of research the JPI Urban Europe and EPSRC project Cities of Making (CoM) (www.citiesofmaking.com) is coming to an end. The project has a focus on urban manufacturing and making and understanding the potential role of productive activities to close the loop of cities. It has introduced a novel approach to understanding city-systems which combines socio-economic, spatial and resource dimensions.

The main outcome of the research is policy tools to better understand the nature of urban making and help to promote more

sustainable resource pathways in cities. The research has also provided a rich characterisation of waste streams produced by the commercial and industrial sectors in cities and identified ways to turn those into resources, with pilot application of the CoM tools to major urban regeneration projects in London and elsewhere in Europe, including the largest urban regeneration project in Europe, Old Oak and Park Royal in London.

Find out more:

www.citiesofmaking.com



Resource futures

The main focus of the resource futures theme is to apply theories, concepts and methods used in foresight and futures studies in research on sustainability transitions and sustainable use of natural resources. An overarching objective is to engage in a critical reflection on opportunities, risks and uncertainties of a variety of transition pathways by combining qualitative and quantitative research methods, and by seeking collaboration with policy and business stakeholders.

What we do

The resource futures research group is an interdisciplinary group bringing together researchers working on resource futures from across ISR.

The activities comprise five open research and policy engagement streams:

- > Imagining resource futures - What are dominant and emerging frames and imaginaries of resource futures? How are visions and perceptions of resource futures and transition pathways constructed by actors? What is the role of innovation in enabling transition?
- > Modelling resource futures – What resource futures emerge from current models used in research on sustainable resources (e.g. integrated energy models, input-output models)? What are assumptions underpinning model-based future scenarios and trends? How can insights and findings from social sciences be used in modelling?
- > Future resource policy and governance – What governance modes and policy instruments are needed to enable a transition to a sustainable future? How can they provide incentives and enable the sharing of risk and embracing of uncertainty in policy-making?
- > Influence of resource futures - How do expectations and perceptions about

resource futures affect policy and business strategies, decisions and innovation practices relevant for sustainable use of resources?

> Co-designing resource futures – How can research support and engage with policy and business actors in building evidence-based visions and scenarios?

Innovation policy roadmapping

Michal Miedzinski and Paul Ekins have collaborated with Mariana Mazzucato (IIPP) to develop a framework for mission-oriented innovation policy roadmapping for the Sustainable Development Goals (SDGs). Michal Miedzinski and Will McDowall are leading authors of the Inno4SD's guide on "Science, Technology and Innovation Policy Roadmaps for the SDGs". Michal is providing contributions to the UN Inter-agency Task Team's "Science Technology and Innovation for SDGs roadmap" as a member of the World Bank-led expert team.

Energy, Resources and Development

Energy, Resources and Development focuses on the livelihood, social and policy dimensions of energy and natural resources in low- and middle-income countries.

What we do

We use social research methods and policy analysis to examine the governance of energy and natural resource use in developing countries and the outcomes for different social groups. This theme has used the UN's Sustainable Development Goals (SDGs) as a framework for analysing the interlinkages between different types of resources – from land to water, and energy to infrastructure – and the impacts on people, planet and prosperity.

Recent research and teaching activities have focused on:

- > Mapping the interlinkages between sanitation and the SDGs. Working with colleagues from UCL Engineering, Development Planning, Science Policy, and Health, the research reveals all 17 SDGs call for action to improve access to sanitation. Finding evidence of multiple actual and potential synergies, the research calls for multi-stakeholder partnerships to deliver holistic, appropriate solutions that meet the needs of local populations.
- > Examining the socio-economic impacts of sugarcane in expansion areas of Brazil. Drawing on the UN Human Development Index and the Social Responsibility Index of São Paulo, this research has developed a method to examine the relationship between the presence of sugarcane processing mills and socio-economic development at the municipal level in the state of Mato Grosso do Sul.
- > In January 2020, a new module for the Economics and Policy of Energy and Environment (EPEE) MSc was launched

to focus on Energy, Resources and Environment in Developing Countries. The module covers key theories and frameworks for understanding energy, resources and development, and uses case studies to illustrate the importance of local contexts in shaping the outcomes of energy and resource governance.

Modern energy for all

The provision of access to modern energy services for all is a key global challenge and SDG 7 aims to ensure access to affordable, reliable, sustainable and modern energy for all by 2030. Since 2015, we have been working with universities in Colombia to understand the energy opportunities and challenges for off-grid communities in Chocó – one of Colombia's poorest regions.

Our research has shown that electrification brings multiple benefits to people and their communities, providing not only lighting, refrigeration and entertainment services, but also opportunities for income generation. However, such opportunities are constrained by poor infrastructure, low capacity and limited resources. Our research has shown that the benefits of electrification cannot be assumed, particularly where programmes to deliver access have a narrow focus on the delivery of energy infrastructure alone. Rather, if electricity is to provide the multiple development benefits on offer it should be delivered as part of wider development programmes that place community needs at the centre.

Public seminars

Each month we host a guest lecture open to students, staff and interested members of the public.

We have a wide range of speakers with diverse areas of expertise ranging from sustainable finance to nuclear energy. Our seminar series allows us to effectively engage with industry experts as well as offering an opportunity for our students and staff to network with others interested in similar Sustainable Resources issues.

A highlight from last year was a joint event with the Institute for Innovation and Public Purpose looking at Innovation for Public and Private Purposes with Mariana Mazzucato and John Elkington. Another was a talk from Maja Göpel: The Digital Anthropocene: the Need for a European Way, emphasising our need to adapt in an ever increasingly digital age.

Our public seminars are advertised monthly through our website and mailing list. To sign-up visit ucl.ac.uk/sustainable. We also record each event and post on the Institute for Sustainable Resources YouTube channel.



- > Nuclear Energy: Challenges and Opportunities in a Fossil-Free Future. Speakers Paul Spence and Paul Dorfman, 21st November 2019.
- > Legitimacy and democracy: Energy governance in Portugal and the UK. Speakers Siddharth Sareen and Bregje van Veelen 28th October 2019.
- > The Digital Anthropocene: the Need for a European Way. Speaker Maja Göpel, 3rd July 2019.
- > Global challenges to food security. Speakers Chris Rapley, David Norse, Peter Hazell and Jason Neff, 2nd July 2019.
- > New Economic and Moral Foundations for the Anthropocene. Speaker Eric Beinhocker, 5th June 2019.
- > Environmental policy and the rebound effect. Speaker David Font Vivanco, 13th May 2019.
- > The Dynamics of Hope and Panic: lessons from the IPCC special report. Myles Allen, 1st May 2019.
- > Capital stranding cascades: The impact of decarbonisation on productive asset utilisation. Emanuele Campiglio, 27th March 2019.
- > Innovation for Public and Private Purpose. Speakers Mariana Mazzucato and John Elkington, 20th March 2019.
- > A resource-efficient pathway towards a greenhouse gas-neutral Germany. Harry Lehman, 21st February 2019.
- > Mexico's landscape on Energy and Society: the transition within the transition. Karla Graciela Cedano Villavicencio. 6th February 2019.

Partnerships

At the Institute for Sustainable Resources we seek to make real world impact with our knowledge and research.

What we do

Our research areas such as circular economy, sustainable finance and eco-innovation are highly applied and enable us to work closely with external partners such as the UN Environment Programme, the Ellen MacArthur Foundation and the Green Alliance.

We can advise governments, municipalities and international organisations on green growth, climate change and energy policy; help businesses become more sustainable or circular; consult on materials and resource use, such as plastics and water; and train your workforce in sustainable business practices.

Knowledge Exchange with BEIS

To transfer knowledge between UCL and external organisations, we encourage our staff and students to take on work placements in industry and government.

This year, Research Associate Oliver Broad spent three days per week working with experts within the Central Modelling Team at the UK Department for Business, Energy and Industrial Strategy (BEIS). He worked on reviewing and improving the representation and use of biomass within the UK TIMES model, a whole energy system model of the UK developed and curated by researchers at UCL. Bioenergy is of mutual interest to UCL and BEIS as it is expected to play a key role under net zero futures, but it encompasses a wide range of uncertainties that need to be better understood going forward and are not yet captured by UKTM. This was a great opportunity for mutual learning between

government experts and UCL and to contribute our knowledge to strengthen and inform the policy-making process.

Professional training: Bringing our knowledge to Armenia

This year, Senior Lecturer Dr Lorenzo Lotti designed and delivered a custom-made training programme to a large energy company in Armenia. Energy Invest Holding wanted to provide their employees with updated knowledge on environmental economics, energy innovation and natural resource policy and, in the long term, become a forerunner in Armenia's renewable energy sector. We created a challenging 3-day learning programme covering the latest thinking around those topics and paired the theoretical aspects with team work, discussions and contextual exercises. The programme was loosely based on one of our Masters courses, Economics & Politics of Energy and the Environment.

Global engagement

ISR contributes substantially to global scientific discussion. Paul Ekins was one of two Global Co-Chair's of UNEP's flagship publication, the sixth Global Environment Outlook (GEO-6), which was published at the fourth UN Environment Assembly in March 2019. He is now co-chairing UNEP's follow up programme, GEO for Business. He also co-chairs the Expert Working Group on Natural Capital of the Green Growth Knowledge Platform, a partnership between OECD, the World Bank, UNEP and the Global Green Growth Institute of Korea.

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