

International Exergy Economics Workshop  
University of Sussex, 13-15 July 2016



Programme version 5: 12<sup>th</sup> July 2016



## Welcome

To be effective in mitigating climate change, technical and policy initiatives to reduce energy demand must have significant impacts at the economy-wide level. This means they must contribute to the relative or absolute *decoupling* of energy consumption from economic output (GDP). However, the feasibility, difficulty and cost of decoupling is disputed. While global primary energy consumption is growing more slowly than GDP, very few countries have achieved absolute decoupling. Moreover, where this has been observed it has partly been driven by the 'outsourcing' of energy intensive manufacturing to other regions.

This apparently strong link between energy consumption and economic activity raises important questions for economic theory and for energy and climate policy. The orthodox view is that increased energy consumption provides a relatively small contribution to the growth in economic output, implying that decoupling should be feasible. In contrast, some ecological economists claim that the improvements in productivity over the last century have largely been achieved by providing workers with increasing quantities of energy, both directly and indirectly as embodied in capital equipment and technology. In this view, energy contributes more to economic growth than is suggested by its small share of total costs, implying that decoupling will be challenging. The success of climate policy depends in part on which of these views is correct - or more precisely, which more accurately describes the situation for different countries and periods of time.

[Exergy economics](#) is an emerging field of research that has the potential to throw new light on this important question. The approach hinges upon the thermodynamic concept of *exergy* as 'available energy', and the use of *second-law* rather than first-law measures of thermodynamic efficiency. A key objective of this approach is to estimate the *useful exergy inputs* into national economies - where useful exergy is defined as the exergy outputs of end-use conversion devices, such as the mechanical drive from an engine or the high-temperature heat from a furnace.

The core claim of these researchers is that **it is useful exergy that drives economic activity**. Increases in output can therefore be achieved by either increasing use of primary energy, or improving second-law conversion efficiencies. Bob Ayres and Benjamin Warr suggest that improvements in the latter provide a surrogate for all forms of technical change that contribute to economic growth. Hence, far from being a minor contributor to economic growth, the combination of increased exergy inputs and improved thermodynamic efficiency become the dominant driver.

This strand of research is novel and has potentially far-reaching implications. Despite such potential to offer new insights into the relationship between energy consumption, economic growth and environmental sustainability, it has until now been an underused technique, sitting outside mainstream energy-economics. However, given the need to reduce carbon emissions and indeed address the broader energy trilemma, it makes sense to develop all the tools in the box, to provide a more effective input to policymaking. It is important, therefore, that exergy economics as a discipline is developed further, placed upon firmer foundations, subject to critical scrutiny and recognised more widely. Following a previous [International Workshop on Exergy Economics](#) in May 2014, a network of researchers has been developing this field with the aim of 'proving the concept'. This has led to numerous research strands and an increasing number of publications. However, in order to be developed further and placed upon firmer foundations,

there is a need for a critical dialogue with the broader energy, economic and modelling communities.

To meet this need, the [Centre on Innovation and Energy Demand](#) (CIED) and the [Centre on Industrial Energy, Materials and Products](#) (CIE-MAP) have organised a two-day **Workshop on Exergy Economics**, to be held at the University of Sussex in July 2016. By inviting a select number of energy modellers, economists and policy analysts to this workshop, we aim to have an interactive event that explores questions which focus on critical reflection, including:

1. What is the state-of-the-art and strengths and weaknesses of current exergy economics research?
2. What are the conflicts and synergies between exergy economics and mainstream energy economics?
3. What are the contributions of exergy economics to climate change and sustainability analysis?
4. What are the potential policy implications of this work?
5. What future research directions in this area appear most promising?

A key objective of this workshop is to identify potential research collaborations that can form the basis for future funding bids.

We hope you will enjoy the workshop, and look forward to welcoming you to Sussex in July.

Best wishes

Steve Sorrell

Professor of Energy Policy, SPRU, University of Sussex

**\*\*New information\*\* 1 July 2016**

**1. Contact details during the Workshop:**

Paul Brockway: [p.e.brockway@leeds.ac.uk](mailto:p.e.brockway@leeds.ac.uk) ; 07722 960209 (mobile)

Nora Blascok: [N.Blascok@sussex.ac.uk](mailto:N.Blascok@sussex.ac.uk); 01273 876736 (landline); 07796 005285 (mobile)

**2. Information for presenters**

Conference projectors are 16:9 aspect ratio. Please bring any presentation files on a USB memory stick and arrive 5 minutes before your session starts to get them pre-loaded. If you have a Mac (so cant copy onto a USB stick) then please email by 13<sup>th</sup> July to [p.e.brockway@leeds.ac.uk](mailto:p.e.brockway@leeds.ac.uk)

### Wednesday 13<sup>th</sup> July

Time	Event	Location at University of Sussex
<18:00	Check in to accommodation	York House (24 hour reception)
18:00	Registration and chance to meet	Conference Centre, 3 <sup>rd</sup> floor Bramber House
19:00	Evening meal	Conference Centre, 3 <sup>rd</sup> floor Bramber House

### Thursday 14<sup>th</sup> July

Time	Event	Main Speakers
09:00	Welcome: Aims and Objectives	Steve Sorrell
09:15	<u>Plenary Session (Chair – Steve Sorrell)</u> Foundations of Exergy Analysis Exergy and Economics	Paul Brockway Tiago Domingos
10:30	Coffee break	
11:00	<u>Parallel Sessions 1</u> Three parallel sessions on specific themes identified from the submitted abstracts. Up to four presentations in each session	<u>Chairs:</u> John Barrett Tania Sousa Nina Eisenmenger
12:30	Lunch	
13:30	<u>Plenary Session: (Chair – Tiago Domingos)</u> Energy and mainstream economics The Welfare Effects of Energy Services and Technologies (1700-2010)	Michael Kumhof Roger Fouquet
15:00	Coffee break	
15:30	<u>Affinity Groups – Critical Reflection</u> Facilitated session in groups (identified by post-its / sign up at coffee break) to discuss key issues relating to exergy economics: e.g. barriers, conflicts with mainstream, weaknesses etc	<u>Facilitators:</u> Joao Santos Matt Heun Jon Cullen
17:00	Close	
19:00	Dinner at The Nightingale Room, Brighton	

### Friday 15<sup>th</sup> July

Time	Event	Main Speaker
09:00	<u>Plenary Session (Chair: Tim Foxon)</u> Energy and Directed Technological Change: Lessons from Economic History  Exergy Economics: On Growth and De-growth	David Stern (via Skype) Bob Ayres
10:30	Coffee	
11:00	<u>Parallel Sessions 2</u> Three parallel sessions on specific themes identified from the submitted abstracts. Up to four presentations in each session	<u>Chairs:</u> Matt Heun Peter Taylor Tania Sousa
12:30	Lunch	
13:30	<u>Future research directions</u> Breakout groups to discuss the development of specific research proposals	<u>Session leads:</u> Paul Brockway Steve Sorrell Nina Eisenmenger
14:30	Summary and close	Tania Sousa
15:00	Workshop End / Coffee	

## Parallel sessions

### Day 1 – Parallel sessions 11.00-12.30

#### Session 1A: Human development & energy services and needs:

- Chair – Nina Eisenmenger

Speaker	Title	Start time
Lina Brand	Improving human well-being within environmental limits: the role of energy services and human needs	11.00
Matt Heun	Societal exergy and useful work analysis for developing nations: South Africa and Ghana	11.30
Jonathon Cullen	Linking useful exergy to energy and material services	12.00

#### Session 1B: Visions and Policies for the Future:

- Chair – John Barrett

Speaker	Title	Start time
Kai Whiting	Pandora and Thanatia: a thermodynamic vision of the mineral resource depletion	11.00
Lukas Bunse	The macroeconomic impacts of reducing energy use: Digging into the debate	11.20
Sarah Livermore	Energy demand modelling for Government	11.40
Tim Foxon	Energy and Economic Growth: Why we need a new pathway to prosperity	12.00

#### Session 1C: Energy Efficiency and Technology

- Chair: Tania Sousa

Speaker	Title	Start time
Luis Gabriel	Exploring the exergy intensity and efficiency of mineral resources	11.00
Ana Gonzalez Hernandez	"How do we get exergy analysis used by process plant managers, to unlock plant-level resource efficiency opportunities?"	11.20
Zeus Guevara	Three-level energy decoupling (Portugal 1995-2010)	11.40
Sofia Henriques	Energy savings in European Manufacturing: an historical perspective" (1870-2013)	12.00

## Day 2 – Parallel sessions 11.00-12.30

### Session 2A: Probability, Uncertainty and Estimation in Modelling Energy and Economics

- Chair – Matt Heun

Speaker	Title	Start time
Reinhard Madlener	Uncertainty and estimation in energy-economic models	11.00
Joao Santos	From theory to econometrics to policy: Insights and cautionary tales from macroeconomic growth modeling with the CES production function under an ecological economics framework	11.20
Julius Frieling	Estimation of substitution elasticities in three-factor production functions: Identifying the role of energy	11.40
Vlasios Voudouris	Beyond mean models of energy/energy and economic growth	12.00

### Session 2B: National Accounting and Modelling for Energy, Materials and Economics

- Chair – Peter Taylor

Speaker	Title	Start time
Jack Miller	National exergy accounting: A quantitative comparison of methods and implications for energy-economy interaction analysis	11.00
James Glynn	Hybrid energy system models: assessing technological mitigation pathways from INDCS towards 1.5°C with TIAM and IMACLIM-KLEM	11.20
Sophie Billington	Insights from the application of the Cambridge Econometric model (E3ME)	11.40
Antonio Valero	How exergy-cost analysis can improve on some macroeconomic aspects of the UN's System of Environmental-Economic Accounts (SEEA)	12.00

### Session 2C: Provocations - Value in Thermodynamics and Economics

- Chair – Tania Sousa

Speaker	Title	Start time
Geoff Hammond	More Heat Than Light': The Use and Abuse of Thermodynamic Ideas	11.00
Mark Lindley	The Useful Concept of "Thermodynamic Rarity"	11.20
Gregor Semieniuk	What do we mean when we speak of economic growth? The significance of value theory for the exergy research programme	11.40
Reiner Kummel	Why exergy economics is right and the neoclassical duality of quantities and prices is wrong	12.00

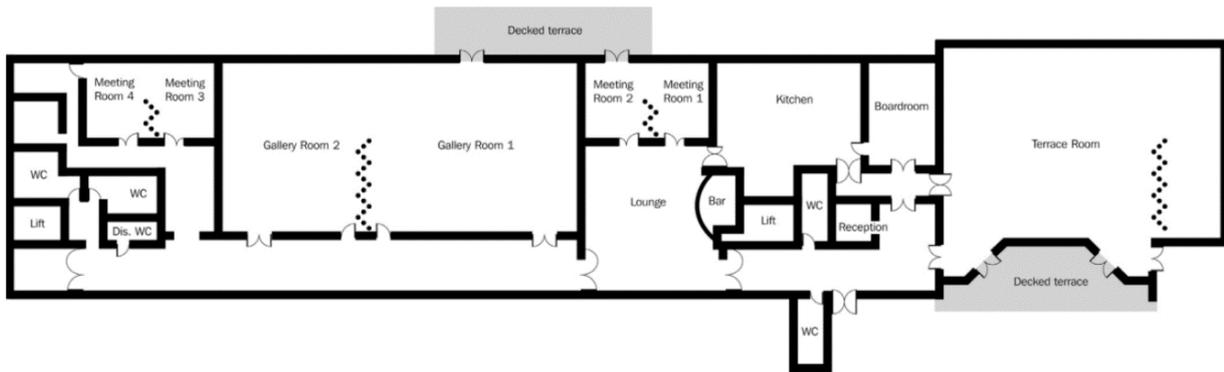
## Workshop attendees

Bob	Ayres	Emeritus Professor, INSEAD, France
John	Barrett	Professor of Energy and Climate Policy, University of Leeds, UK
Sophie	Billington	Project manager, Cambridge Econometrics, Cambridge, UK
Lina	Brand Correa	PhD research student, University of Leeds, UK
Paul	Brockway	UKERC Research Fellow, University of Leeds, UK
Lukas	Bunce	UKERC PhD research student, University of Leeds, UK
Gabriel	Carmona	PhD research student, Instituto Superior Técnico, Lisbon, Portugal
Claire	Carter	PhD research student, University of Sussex, UK
Jonathan	Cullen	University Lecturer, University of Cambridge, UK
Tiago	Domingos	Assistant Professor, Instituto Superior Técnico, Lisbon, Portugal
Nina	Eisenmenger	Assistant Professor, The Institute of Social Ecology, Vienna
Laura	Felício	PhD research student, Instituto Superior Técnico, Lisbon, Portugal
Roger	Fouquet	Associate Professorial Research Fellow, London School of Economics, UK
Tim	Foxon	Professor of Sustainability Transitions, University of Sussex, UK
Julius	Frieling	PhD research student, RWTH Aachen University, Germany
Luis	Gabriel Aparicio	PhD researcher, Instituto Superior Técnico, Lisbon, Portugal
James	Glynn	PhD research student, University College Cork, Ireland
Ana	Gonzalez Hernandez	PhD research student, University of Cambridge, UK
Zeus	Guevara	Postdoctoral researcher, Instituto Superior Técnico, Lisbon, Portugal
Geoff	Hammond	Professor of Mechanical Engineering, University of Bath, UK
Sofia	Henriques	Researcher at Lund University, Sweden
Matt	Heun	Professor Mechanical Engineering, Calvin College, US
Michael	Kumhoff	Directory of Economists, Bank of England, UK
Reiner	Kummel	Professor, University of Würzburg, Germany
Mark	Lindley	Visiting Professor, University of Zaragoza, Spain
Sarah	Livermore	Central Modelling Team, DECC, London
Reinhard	Madlener	Professor of Energy Economics and Management, Aachen University, Germany
Jack	Miller	CIED PhD research student, University of Sussex, UK
Leo	Paoli	PhD researcher, University of Cambridge, UK
Peter	Pearson	Professor, Centre for Environmental Policy, Imperial College, UK
João	Santos	PhD researcher, Instituto Superior Técnico, Lisbon, Portugal
Gregor	Semieniuk	Research Fellow, University of Sussex, UK
André	Serrenho	Research Fellow, University of Cambridge, UK
Steve	Sorrell	Professor of Energy Policy, University of Sussex, UK
Tania	Sousa	Assistant Professor, Instituto Superior Técnico, Lisbon, Portugal
Peter	Taylor	Professor of Sustainable Energy Systems, University of Leeds, UK
Antonio	Valero	Director General of CIRCE, University of Zaragoza, Spain
Vlasios	Voudouris	Affiliate Professor at ESCP Europe Business School
Jim	Watson	Professor of Energy Policy, University of Sussex, UK
Kai	Whiting	PhD researcher, Instituto Superior Técnico, Lisbon, Portugal
Matthew	Winning	Research Associate, UCL Energy Institute, London, UK

## The Venue

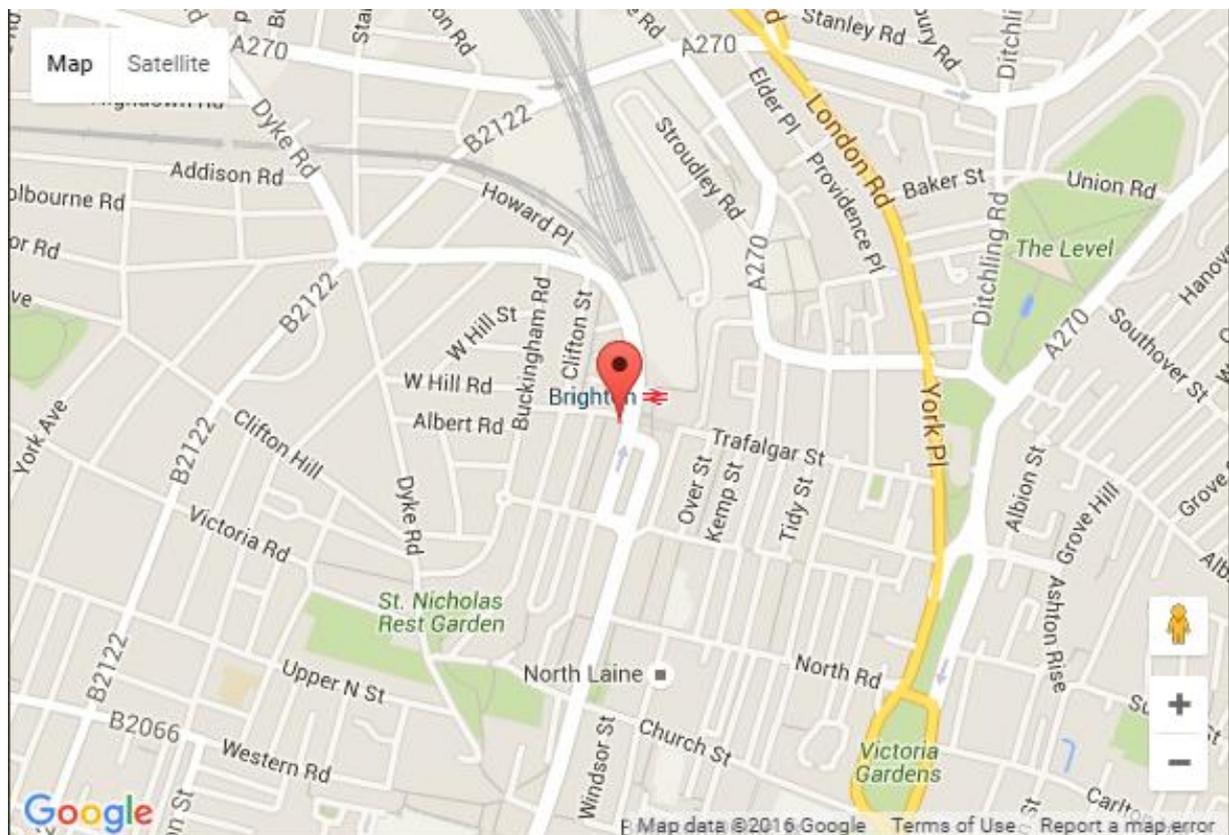
The workshop will take place in the Conference Centre, which is based on the third floor of Bramber House (see campus map). All workshop activities will take place here, including the opening workshop dinner on 13 July.

### Conference Centre Floor Plan



### Main Workshop Dinner

On Thursday 14 July we have organised dinner with “quite likely to be but can’t 100% guarantee” tasteful evening entertainment at the [Nightingale Room](#) in Brighton. It is on the first floor of the Grand Central Pub literally across the road from Brighton station.



## How to get here

### **Train**

Falmer train station is directly opposite the University campus. Pedestrian access is through a subway under the A27 - follow signs for the University of Sussex (the University of Brighton has a campus at Falmer too). Falmer is on the line between Brighton and Lewes, about eight minutes' travel time in each direction. Four trains an hour go there during the day time. Visitors travelling via London and the west should take a train to Brighton and change there for Falmer. The journey time from London to Brighton is just under an hour. You can also change at Lewes for Falmer, if you are coming from the east.

### **Taxi**

Taxis are available at both Brighton and Lewes train stations and at many places in the centre of Brighton. It is about four miles (six kilometres) from central Brighton to the University. (There is no taxi service at Falmer station itself.) It is often quicker to catch the train direct to Falmer from Brighton or Lewes.

### **Car**

The University is at Falmer on the A27 between Brighton and Lewes, about four miles (six kilometres) from the centre of Brighton. (Please follow signs for University of Sussex on the north side of the A27; the University of Brighton also has a campus at Falmer on the south side of the A27.) Visitors from London and the north should take the M23/A23 road towards Brighton. Before entering the centre of Brighton, join the A27 eastbound signposted Lewes. Drivers from the east or west take the A27 direct to the University.

### **Local buses**

The 25, 25A, 25B and 25C buses run between the centre of Brighton and the University, bringing you directly onto campus. You can catch a bus from the Old Steine in Brighton; the 25 and 25A also run from Churchill Square. In addition, the 28 and 29 go from the Old Steine and stop right outside the University campus on their way to Lewes and beyond. Travel time is about 20-30 minutes. Bus timetables and information is available from Brighton buses.

### **Parking**

There will be parking permits available at the venue. There are several car parks near Bramber House, please consult the campus map to find them.

## Accommodation

We have booked en-suite single rooms in Swanborough (see Campus map – building #14).

Check in is from 14:00 on your day of arrival, with check out by 09:00 on the day of departure. Please return your keys to reception when you check out, as there is a £70 fine for lost keys

**To check in to your accommodation, please make your way to York House, which is number 10 on the campus map shown overleaf**

All rooms include breakfast and are equipped with Wifi.



# Campus Map

