

# AIRBORNE WIND ENERGY 2019 CONFERENCE

15-16 OCTOBER  
UNIVERSITY OF  
STRATHCLYDE  
UNITED KINGDOM  
awec2019.com

## PROGRAM





## About the conference

The 8th international Airborne Wind Energy Conference (AWEC 2019) is jointly organized by the University of Strathclyde, Delft University of Technology and Airborne Wind Europe. The event will take place on 14, 15 and 16 October 2019 in Glasgow, hosted by the Wind Energy and Control Centre of the University of Strathclyde.

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The scientific program will take place at the University of Strathclyde at the Technology and Innovation Center (TIC) and include

- five plenary talks by selected experts from international agencies, industry and academia, and
- eleven contributed talk sessions in two parallel tracks, comprising a total of 42 presentations, and
- five panel discussions covering all aspects of airborne wind energy, including a further 10 presentations, and
- two poster sessions, each preceded by plenary spotlight presentations, with altogether 21 poster presentations.

## Organizing committee

- David Ainsworth, KPS, UK
- Navi Rajan, TU Delft, Netherlands
- Roland Schmehl, TU Delft, Netherlands
- Stefanie Thoms (chair), Airborne Wind Europe, Belgium
- Oliver Tulloch, University of Strathclyde, UK
- Hong Yue, University of Strathclyde, UK

- Ahmad Hably, Grenoble INP, France
- Christoph M. Hackl, MUAS, Germany
- Colin Jones, EPFL, Switzerland
- Michiel Kruijff, Ampyx Power, Netherlands
- Rolf Luchsinger, TwingTec, Switzerland
- Stephanie Mann, ORE Catapult, UK
- Johan Meyers, KU Leuven, Belgium
- Espen Oland, Kitemill & UiT, Norway
- Johannes Peschel, Kitepower, Netherlands
- Kristian Petrick, Airborne Wind Europe, Belgium
- Gonzalo Sanchez-Arriaga, UC3 Madrid, Spain
- Roland Schmehl (chair), TU Delft, Netherlands
- Roy Smith, ETHZ, Switzerland
- Alexandre Trofino Neto, UF Santa Catarina, Brazil
- Axelle Viré, TU Delft, Netherlands
- Chris Vermillion, NC State University, USA
- Hong Yue, University of Strathclyde, UK
- Udo Zillmann, Airborne Wind Europe, Belgium

## Program committee

- David Ainsworth, KPS, UK
- Philip Bechtel, University of Bonn, Germany
- Alexander Bormann, EnerKite, Germany
- Moritz Diehl, University of Freiburg, Germany
- Lorenzo Fagiano, Politecnico di Milano, Italy
- Fort Felker, Makani, USA
- Sebastien Gros, NTNU, Norway

The book of abstracts is edited by Roland Schmehl and Oliver Tulloch and distributed to registered conference attendees.

The book of abstracts and this program are available in open access from  
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## Conference sponsors



## Program - Monday, 14 October 2019

<b>Time</b>		
16:00	REGISTRATION	[FOYER]
18:00	<b>WELCOME RECEPTION</b>	[GLASGOW CITY CHAMBERS]

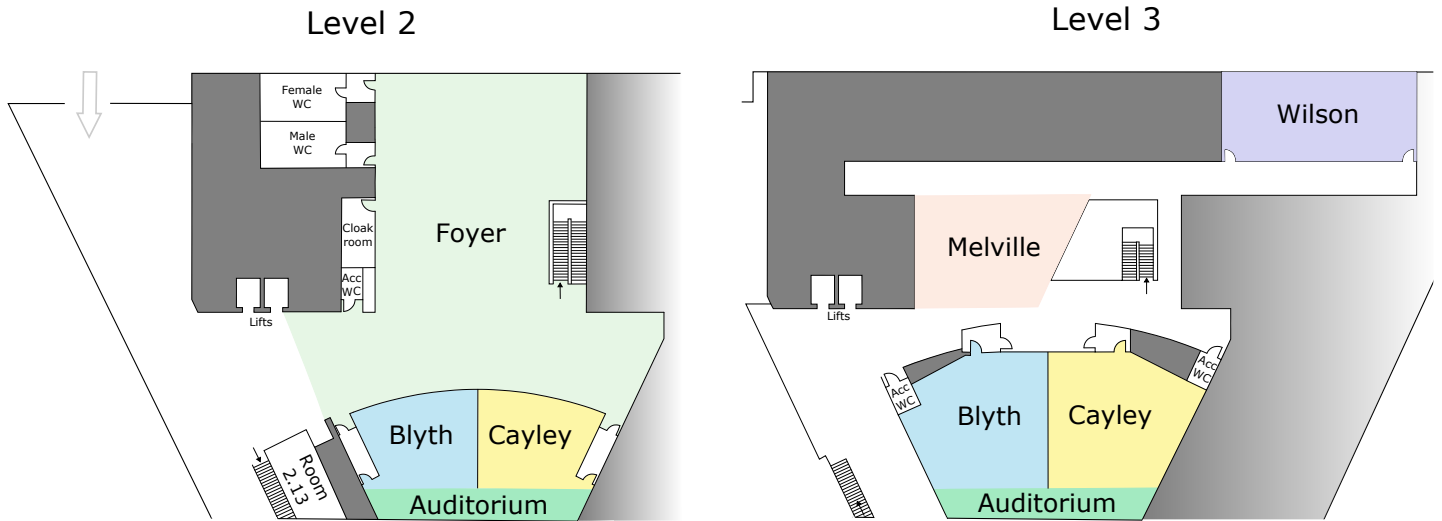
## Program - Tuesday, 15 October 2019

<b>Time</b>			
8:30	REGISTRATION	[FOYER]	
9:00	<b>CONFERENCE OPENING</b>	[AUDITORIUM]	
	Roland Schmehl, <i>TU Delft</i> Stefanie Thoms, <i>Airborne Wind Europe</i> Bill Leithead, <i>University of Strathclyde</i> Giles Dickson, <i>WindEurope</i> Challenges and Learnings to Progress Wind Energy as an Industry		
9:20	<b>INTRODUCTION</b>		
9:40	<b>PLENARY 1 TALK</b>		
	Sören Sieberling, <i>Ampyx Power</i> Status Update and Review of the AP-3 Development		
10:10	<b>PLENARY 2 TALK</b>		
	Doug McLeod, <i>Makani</i> Lessons Learned from Testing Makani's Energy Kite Offshore		
10:40	COFFEE	[FOYER]	
11:10	<b>AWES DEVELOPMENT</b> [BLYTH]	[CAYLEY]	
	Joep Breuer, <i>Kitepower</i> REACH: a H2020 FTI Project to Develop a 100 kW AWE System		
	<b>CONTROL CROSSWIND</b> [WILSON]		
	Eva Ahbe, <i>ETH Zurich</i> Experimental Validation of Path-Tracking Model Predictive Control for Fixed-Wing Power Kites		
	<b>R&amp;D PANEL</b>		
	Jochem Weber, <i>NREL</i> AirborneMax - Scaling as the Key Issue for Airborne Wind Energy Roderick Read, <i>Windswept</i> Practical Tests of Rotary Network AWES Kristian Petrick, <i>Airborne Wind Europe</i> Developing a European Roadmap for AWE		
11:30	Lode Carnel, <i>Kitemill</i> From Minutes to Hours of Autonomous Operation		
11:50	Michiel Kruijff, <i>Ampyx Power</i> Challenges and Opportunities of AWES Market Entry at Utility Scale		
12:10	Andy Stough, <i>Windlift</i> What is the Right Size for an AWE System?		
	Hironori A. Fujii, <i>TMIT</i> Three-Dimensional Flight Trajectories of Tethered UAV for Optimal Energy Generation Ignacio Oficialdegui, <i>Acciona Energy</i> WINDSLED: Alternative Model to Conventional Logistics in Polar Regions Based on AWE Manfred Quack, <i>SkySails Power</i> Extended Periods of Automated Tethered Flight at SkySails		
	<b>PANEL DISCUSSION</b> Roland Schmehl, <i>TU Delft</i> (moderator) Stephanie Mann, <i>ORE Catapult</i> Dominik von Terzi, <i>TU Delft</i> David McMillan, <i>Uni Strathclyde</i> Philip Bechtle, <i>Uni Bonn</i>		
12:30	LUNCH	[FOYER]	
13:40	<b>PLENARY 3 TALK</b>	[AUDITORIUM]	
	Cédric Philibert, <i>International Energy Agency</i> Wind Power in the Energy Transition		
13:50	<b>OEM 1 PANEL</b>		
	Johannes Peschel, <i>Kitepower</i> Kitepower and the Journey Towards 24/7 Operation Thomas Hårklau, <i>Kitemill</i> Kitemill: Past, Present and Future		
14:00			
14:10	<b>PANEL DISCUSSION</b>		
	Udo Zillmann, <i>Airborne Wind Europe</i> (moderator) Richard Ruiterkamp, <i>Ampyx Power</i> Cédric Philibert, <i>IEA</i> Poster 1 Presenters	Stephan Brabeck, <i>Skysails</i> Doug McLeod, <i>Makani</i> Giles Dickson, <i>WindEurope</i>	
15:10	<b>POSTER 1 SPOTLIGHTS</b>		
15:30	COFFEE	[FOYER]	
16:00	<b>POSTER 1 SESSION</b>	[MELVILLE]	
	Eiji Itakura, <i>Toyota Motor Corporation</i> Save from Future Japan Social Crises! "Mother-ship" Project Uwe Fechner, <i>Aenarete</i> Open Data Project: Flight Data Analysis of Kitepower Systems Alex Rementeria, <i>Cranfield University</i> Wind Tunnel Parametric Study of Kite Performance for Power Generation Solenn Le Pense, <i>KPS</i> Effect of Wind Variations on Tether Load Transfer from Kite to Winch Antoine Morvan, <i>ENSTA-Bretagne</i> A Fast Simulation Tool for Ships Towed by Kites: Assessment of Propulsion Efficiency	Peter Listov, <i>EPFL</i> PolyMPC: An Efficient Tool for Embedded Model Predictive Control for Fast Mechatronic Systems Mahdi Ebrahimi Salari, <i>Uni Limerick</i> A Study on Power Transmission Techniques for Marine Airborne Wind Energy Farms Jonathan Dumon, <i>Gipsa-lab</i> Power Curve Analysis Of Airborne Wind Energy Tallak Tveide, <i>Kitemill</i> The Second, Most Important, Law of Tether Scaling Hiroshi Okubo, <i>Kanagawa IT</i> Airborne Wind Power Generation Employing Straight-Bladed Wind Turbines	Rachel Leuthold, <i>Uni Freiburg</i> Comparison of Engineering Induction Models in a Multi-Kite Optimal Control Problem Alan Mortimer, <i>Wood Clean Energy</i> Complex Wind Profiles Measured Offshore and Their Relevance to Airborne Systems Manuel C.R.M. Fernandes, <i>Uni Porto</i> Heading Angle Control for Path-following Guidance in a Pumping Kite Generator Rigo Bosman, <i>DSM</i> Engineering With a Bending-Optimized HMPE AWE Tether Jochem De Schutter, <i>Uni Freiburg</i> OpenOCL - Optimal Control Library for Airborne Wind Energy
16:30	<b>WIND RESOURCE &amp; ENERGY PROD.</b> [BLYTH]	[WILSON]	
	Mark Schelbergen, <i>TU Delft</i> Airborne Wind Energy Production Estimation using Wind Profile Shape Statistics	Thomas Haas, <i>KU Leuven</i> Investigation of Airborne Wind Energy Farm Performance for Different Operation Modes Using Large Eddy Simulation	<b>AIRSPACE &amp; REGULATION PANEL</b> [CAYLEY] Kristian Petrick, <i>Airborne Wind Europe</i> Developing Airborne Wind Energy Safety and Technical Guidelines <b>PANEL DISCUSSION</b> Corey Houle, <i>Twingtec</i> (moderator) Dieter Moormann, <i>RWTH Aachen</i> Nathanel Apter, <i>FOCA</i> Amanda Boekholt, <i>FOCA</i> Martin Lohss, <i>Skysails</i> Neal Rickner, <i>Makani</i> Michiel Kruijff, <i>Ampyx Power</i>
16:50	Philip Bechtle, <i>Uni Bonn</i> Airborne Wind Energy Resource Analysis: From Wind Potential to Power Output	Tim Brodrick, <i>KPS</i> Effect of Mass on Airborne Wind Energy Performance	
17:10	Markus Sommerfeld, <i>Uni Victoria</i> Wind Inflow Profile Impacts on Optimal AWE System Sizing	Vincent Bonnin, <i>Ampyx Power</i> An Analytical Performance Model for AP-4 Conceptual Design Phase	
17:30	END-OF-DAY		
18:30	<b>BUSSES DEPART FOR DINNER</b>	[FOYER]	
19:00	<b>CONFERENCE DINNER</b>	[TALL SHIP]	

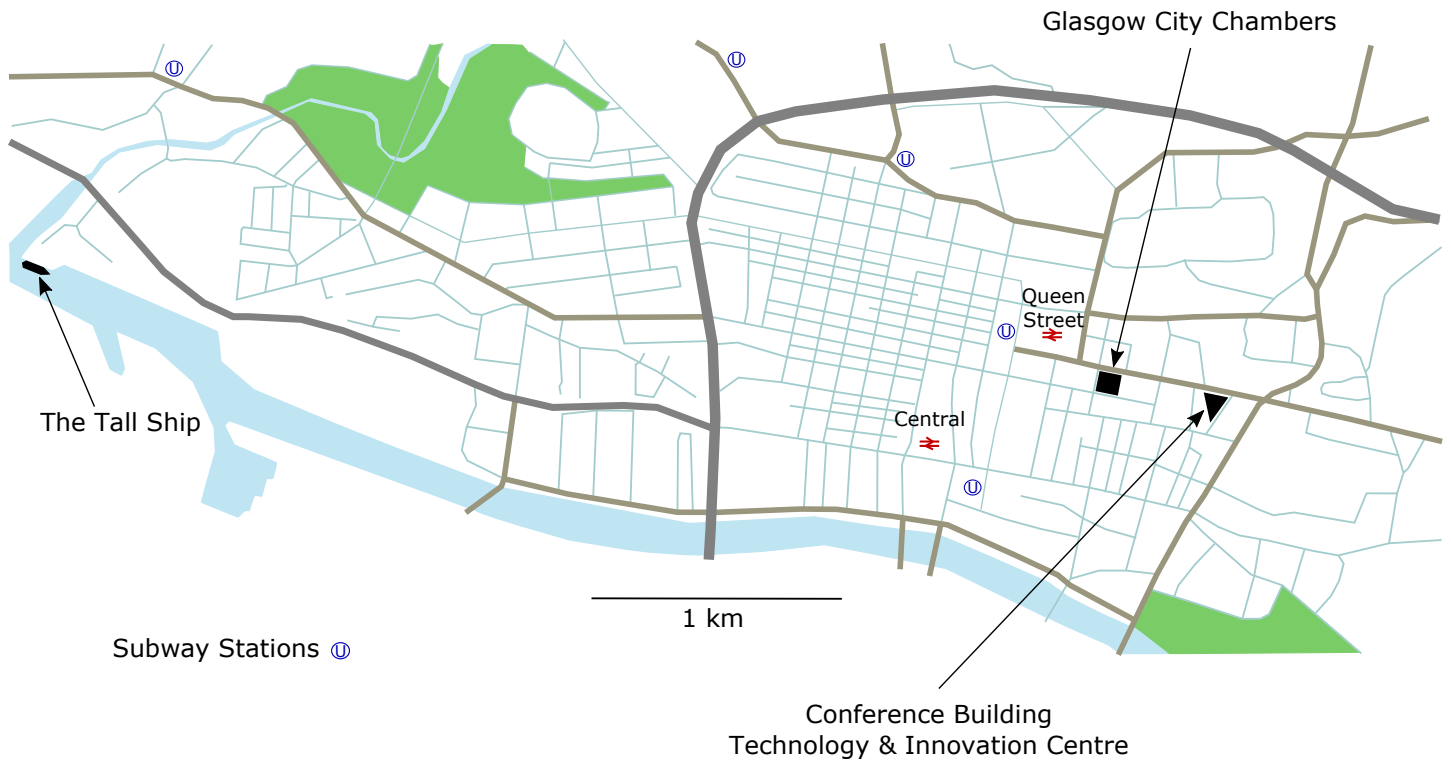
## Program - Wednesday, 16 October 2019

Time				[FOYER]
8:30	REGISTRATION			[FOYER]
9:00	<b>KEYNOTE</b> Lorenzo Fagiano, <i>Politecnico di Milano</i> Automation Challenges in AWE Systems and the Role of Academic Research			[AUDITORIUM]
9:40	<b>OEM 2 PANEL</b> Alexander Bormann, <i>Enerkite</i> Latest Achievements Towards Next Generation Renewables			
9:50	Rolf H. Luchsinger, <i>Twingtec</i> TwingTec's Roadmap to Wind Energy 2.0: From Full Proof of Concept to the First Commercial Product			
10:00	<b>PANEL DISCUSSION</b> Udo Zillmann, <i>Airborne Wind Europe</i> (moderator)     David Ainsworth, <i>KPS</i> Max Ter Horst, <i>e-kite</i> Reinhart Paelinck, <i>Kiteswarms</i> Robert Creighton, <i>Windlift</i> Fort Felker, <i>Makani</i> Poster 2 Presenters			
10:45	<b>POSTER 2 SPOTLIGHTS</b>			
10:55	COFFEE			[FOYER]
11:15	<b>POSTER 2 SESSION</b>			[MELVILLE]
	Michael Perlberger, <i>Brainwhere</i> Brainwhere's AWE System for Harvesting High Altitude Wind Energy Daniel Zywiets, <i>Enerwhere</i> What Will it Take for AWE to be Successful in Remote & Mini-Grid Applications?	Hiroki T. Endo, <i>Niihama-Kosen</i> R&D of Airborne Wind Power Generation at Niihama National College of Technology Espen Oland, <i>Kitemill</i> A Solution to the Pose Estimation Problem for Airborne Wind Energy Systems using Multiple Bluetooth 5.1 Devices	Taewoo Nam, <i>Toyota Research Institute</i> Design Space Exploration of High Altitude Aerial Platform "Mothership" Masafumi Narikawa, <i>University of Fukui</i> Stability of Figure of Eight Maneuver Flight of a Kite based on Hysteresis Control	
11:30	<b>SYSTEM OPT. &amp; COST MODELING</b> [BLYTH] Mitchell Cobb, <i>NC State University</i> Development of Iterative Learning Strategies for Optimal Crosswind Flight of AWE Systems	<b>AWES RESEARCH</b> [WILSON] Max Rüger, <i>Uni Bonn</i> AWESome: An AWE Learning Platform using Open Science and Open Hardware	<b>UTILITY &amp; PROJECT DEV. PANEL</b> [CAYLEY] Kester Gunn, <i>RWE Renewables</i> Investigating Offshore Markets for AWE Technologies Ciaran Frost, <i>BVG Associates</i> Global Prospects for Airborne Wind Onshore	
11:50	Elena Malz, <i>Chalmers</i> The Value of Airborne Wind Energy in a Zero-Emission Electricity System	Gonzalo Sánchez-Arriaga, <i>UC3 Madrid</i> Flight Testing, Aerodynamic Parameter Identification and Dynamic Simulation of Rigid and Flexible Kites Applied to AWE Systems	<b>PANEL DISCUSSION</b> Udo Zillmann, <i>Airborne Wind Europe</i> (mod) Giles Hundleby, <i>BVG Associates</i> Henk Hutting, <i>NuCapital</i> Fabian Wendt, <i>Ramboll</i> Carlos Llopis, <i>Siemens Gamesa</i>	
12:10	Filippo Trevisi, <i>DTU</i> Configuration Optimisation of a Generic Crosswind Wind Energy System	Tarek N. Dief, <i>Kyushu University</i> Hardware-in-the-Loop (HIL) and System Identification of a Pumping Kite Power System		
12:30	Mark Aull, <i>Windlift</i> Airborne Wind Energy System Optimizer (AWESOpt) for Fly-Gen Analysis and Optimization	Rik Bättig, <i>ftero, ETH Zurich</i> Fast Prototyping of Morphing Wings for Airborne Wind Energy		
12:50	LUNCH			[FOYER]
13:50	<b>REGULATION &amp; SAFETY</b> [BLYTH] Corey Houle, <i>Twingtec</i> Safe Testing of AWE Systems	<b>CONTROL LAUNCH &amp; LANDING</b> [WILSON] Lorenzo Fagiano, <i>Politecnico Milano</i> Control of Vertical Take Off, Pumping Operation and Vertical Landing of Hybrid Drones for AWE	<b>MODELING &amp; SIMULATION</b> [CAYLEY] Frédéric Bourgault, <i>New Leaf Mgmt</i> Coupled Kite-Ground Station Simulink Model for Optimal Flight Path Following Assessment	
14:10	Sebastian Rapp, <i>TU Delft</i> Rare Event Prediction for Enhanced Control System Reliability of AWE Systems	Audrey Schanen, <i>Gipsa-lab</i> On Using Drones for the Take-Off and Landing Phases of an AWE System	Mikko Folkersma, <i>TU Delft</i> Fluid-Structure Interaction of Inflatable Wing Sections	
14:30	Gillian Vallejo, <i>Natural Power</i> Avian Collision Risk Modelling: A Comparison of Methods for AWE Devices	Espen Oland, <i>Kitemill</i> Kitemill's Vertical Take-off and Landing System for the KM1 Model	Oliver Tulloch, <i>Uni Strathclyde</i> Modelling Studies on Tensile Rotary Power Transmission for AWE Systems	
14:50	Neal Rickner, <i>Makani</i> AWE Systems as an Obstruction: Makani's Journey with the FAA	Paul Williams, <i>Ampyx Power</i> Autonomous Automatic Takeoff and Landing of Rigid Wind Airborne Wind Energy Systems	Mac Gaunaa, <i>DTU</i> Investigation of the Effect of Modelling Different Degrees of Detail in the Key Elements in a Crosswind Kite Wind Energy System	
15:10	COFFEE			[FOYER]
15:40	<b>AERODYN./STRUCT. MODELING</b> [BLYTH] Mojtaba Kheiri, <i>Concordia University</i> Advances in Aerodynamic Modelling of Crosswind Kite Power Systems	<b>CONCEPT DESIGN</b> [WILSON] Christof Beaupoil, <i>someAWE Labs</i> Practical Experiences With a Torsion Based Rigid Blade Rotary AWE System With Ground Based Power Generation	<b>AIRBORNE WIND EUROPE</b> [ROOM 213] Members (only) meeting, with: Ampyx Power, e-kite, Enerkite, FEcreate, Kitepower, Kiteswarms, Kitemill, KPS, Makani, Politecnico di Milano, Skypull, Skysails, TU Delft, Twingtec	
16:00	Urban Fasel, <i>ETH Zurich</i> Aeroservoelastic Analysis and Optimization Framework for Morphing AWE Wings	Florian Bauer, <i>TU Munich</i> Power Electronic Topologies of Drag Power Kites		
16:20	Ashwin. A. Candade, <i>Enerkite / TU Delft</i> Development of a Toolchain for Aero-structural Design of Composite AWE Kites	Jochem De Schutter, <i>Uni Freiburg</i> Towards a Modular Upscaling Strategy for Utility-Scale Airborne Wind Energy		
16:40	Paul Thedens, <i>SkySails Power</i> Steady-State Solver for a Ram-Air Kite Aeroelastic Model Based on Dynamic Relaxation	Paul Williams, <i>Ampyx Power</i> Model-Based Development and Verification of Ampyx Power's Airborne Wind Energy System		
17:00	<b>CONFERENCE CLOSING PANEL TALK</b> Roland Schmehl, <i>TU Delft</i> Udo Zillmann, <i>Airborne Wind Europe</i> and invited guests			[AUDITORIUM]
	<ul style="list-style-type: none"> <li>• What are the key take-aways from the conference?</li> <li>• What are the key opportunities for AWE in the next years?</li> <li>• What should the industry focus on and how can academia help most effectively?</li> <li>• What are the key messages to the non-AWE world?</li> </ul>			
17:40	END-OF-DAY			

## Map of conference building



## Map of Glasgow and conference locations



## Public transportation

SPT Travel Centres provide information about all types of travel in Glasgow and Strathclyde area. The Glasgow subway system is the easiest way to get around the City Centre and West End. A single journey costs £1.75, a return £3.30 and a day ticket £4.20. Services run every 5 minutes at peak times. Alternatively Nextbike Glasgow has 700 bikes for hire in 70 locations available 24/7. You can rent a bike via nextbike's Android/iPhone App, by the on-bike computer, or by phoning +44 (0)20 816 69851. Rental starts at £1 for the first 30 minutes.

## Internet

Wifi in the conference building is available through the network eduroam, which can be accessed with a host university account. Alternatively you can use the network TIC conferences, which can be accessed with the password DearGreenPlace.