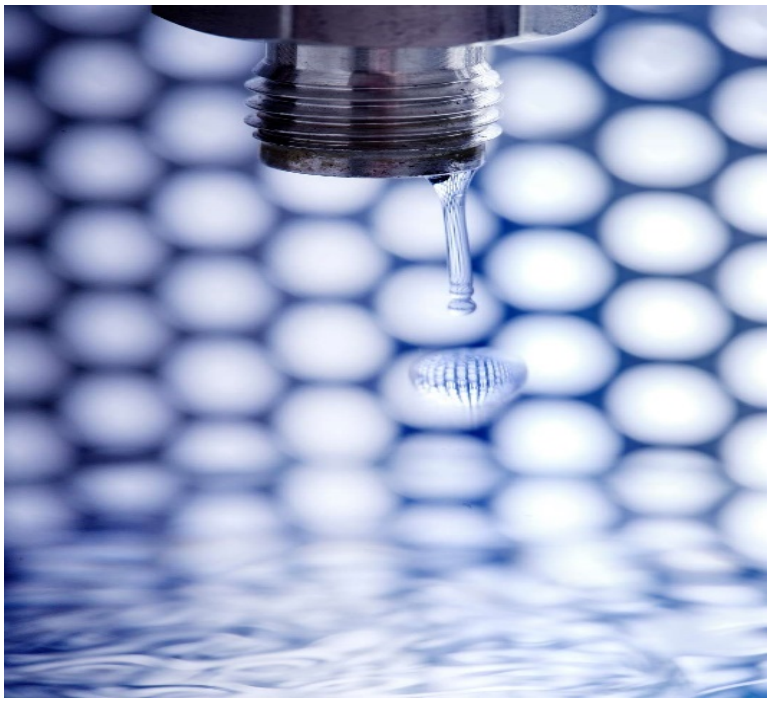
GREEN FUELS



An event organised under the auspices of the

IEA Experts' Group on R&D Priority Setting and Evaluation (EGRD)

October 21st – 22nd 2019

Venue:

IEA

9 Rue de la Fédération

75015 Paris France

International Energy Agency (IEA)

The IEA is an autonomous agency established in November 1974. Its mandate is two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply and to advise member countries on sound energy policy. The IEA carries out a comprehensive programme of energy co-operation among 30 advanced economies[1]. The Agency aims to:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations, and other stakeholders.

Since the 1980s, the IEA has continued to build good working relationships with countries beyond its membership, in particular major energy consuming, producing and transit countries. Countries with which the IEA seeks enhanced engagement including Accession country Chile, Association countries China, India, Indonesia, Morocco, and Singapore. Co-operation with these and other partner countries cover a wide range of activities, from joint workshops to in-depth surveys of specific energy sectors or data exchange. Combined, the IEA co-operates with more than 69 countries worldwide.

Committee on Energy Research and Technology

Comprised of senior experts from IEA member governments, the Committee on Energy Research and Technology (CERT) considers effective energy technology and policies to improve energy security, encourage environmental protection and maintain economic growth. Under the guidance of the IEA Governing Board, the CERT oversees the technology forecasting, analyses and the research, development, demonstration and deployment (RDD&D) strategies of the IEA Secretariat, notably through its flagship publication, *Energy Technology Perspectives*, and the series of energy technology roadmaps. The CERT also provides guidance to its working parties and experts' groups to examine topics that address current energy technology, or technology policy, issues. The CERT is being supported by four topical working parties, including the EGRD.

Experts' Group on R&D Priority-Setting and Evaluation (EGRD)

The EGRD examines analytical approaches to energy technologies, policies, and R&D on targeted, timely topics. The results and recommendations support the Committee on Energy Research and Technology (CERT), feed into IEA analysis, and enable a broad perspective of energy technology issues. Recent topics analysed include System Resiliency and Flexibility (2019), Future Energy Marked Design and Water-Energy Nexus (2018), Towards a Consumer-Driven Energy System - Understanding Human Behaviour and Blue Sky Research for Energy Technology (2017).

[1] Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea (Republic of), Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States; The European Commission also participates in the work of the IEA.

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Rationale

Uncertainty and concern about the future of fossil fuels continues with the agreed climate targets of the Paris Agreement driving a need for deep carbonization of the economy. The impact on the oil and gas sector is intensifying, leading industry and investors to avoid overinvestment in potentially unnecessary projects. Dependency on oil in the transport sector is high due to its high energy density, easy handling and existing infrastructure and cost-competiveness compared to alternatives. Natural gas is often considered the least bad fossil fuel and its growth is linked in part to its environmental benefits relative to other fossil fuels, particularly for air quality as well as greenhouse gas emissions. However the use of oil as well as natural gas must be reduced substantially to reach the targets of the Paris Agreement.

Nevertheless liquid and gaseous energy carrier will play a role in a future energy system. Alternative fuels and technologies are promising complements to oil and gas [unabated fossil fuels] in the near term and likely substitutes in the long term. Alternative fuels, also known as non-conventional or advanced fuels, are any materials or substances that can be used as fuels.

In the longer term, new technologies in generation, storage and smart demand, together with electric cars and the shift towards digitalization, will increase demand for electricity, and not [fossil] fuels. While the full decarbonization of the power system may be manageable, for some usages, the direct shift to electricity may be difficult or very costly for example in waterborne and air transport or high heat industrial processes. However, electricity may be used to generate different energy carriers, including synthetic gas and liquid fuels. Therefore, power-to-gas and power-to-liquids solutions appear to be promising solutions to decarbonize the energy sector, in line with the development of low-carbon electricity generation capacities.

Other promising low-carbon fuels are advanced bio-fuels, provided that production does not lead to increased emissions from direct or indirect land-use changes. Biomass may be a preferable replacement for fossil fuels in transport as it can be converted to high density fuels and can be used in current infrastructure and with all types of ICEs installed in light duty vehicles, heavy duty vehicles, waterborne craft and aircraft.

Aims

The workshop aims at addressing the following questions:

- What is the global outlook for alternative fuels in a low-carbon energy system?
- What is the trade-off between electrification of the energy system and the request for alternative fuels in sectors difficult to electrify?
- Do power-to-x technologies out-rule biogas and –fuels?
- How does the use of Power-to-x technologies influence the efficiency of the energy system?
- What are the technological challenges, risks and co-benefits of alternative fuels?
- What are specific advantages and disadvantages of different energy carriers and which carrier is most adequate for which end use sector?
- How can RD&D policies accelerate affordable, effective and environmentally friendly alternative fuels?

Target audience and expected outcomes

In addition to EGRD members and national experts, we are seeking input from social scientists, behavioural economists, RD&D decision-makers, strategic planners and programme managers from industry, academia, think tanks, national laboratories, NGOs and government. Participation is by invitation only.

The workshop will result in a summary report that identifies challenges and opportunities of alternative fuels and present perspectives and best practice for R&D planners and strategists.

DAY 1 – Monday, October 21st 2019

08:30 Registration

Welcome and introduction Moderator: Birte Holst Jørgensen		
1	09:00	Opening remarks *Birte Holst Jorgensen, EGRD Chair*
2	09:15	Opening speech - alternative fuels *Cédric Philibert, Senior Analyst, Renewable Energy Division, IEA*

Session 1: Setting the scene Moderator: Atsushi Kurosawa		
3	9:45	EU R&I priorities for renewable fuels *Maria Georgiadou, EU Commission*
4	10:15	BEniVer - Accompanying Research on the Energy Turnaround in Transport *Juliane Prause, The German Aerospace Center*
	10:45	*Coffee break*
5	11.15	PtX & Sectorcoupled Infrastructure *Martin Hartvig, Danish TSO Energinet*
6	11.45	Future gas *Thea Larsen, Director, Danish Gas Centre (DGC)*
	12:15	**Discussion**
	12:30	*Business lunch*

Session 2: Power-to-X (gas and liquids) Moderator: Johannes Tambornino		
7	13:30	Synthetic fuels - Sunfire-Synlink project based on SOC *Nils Aldag, Sunfire*
8	14:00	The Future of Hydrogen *Uwe Remme, Energy Technology Policy Division, IEA*
9	14:30	From electrons to molecules *Dr. Todd Deutsch, NREL*
	15:00	*Coffee break*
10	15:30	Renewable methanol – trends and developments *Eelco Dekker, Methanol Institute*
11	16:00	Liquid Inorganic Hydrogen Carrier (LIHC) Technology *Baruch Halpert, Electriq Global*
12	16:30	WIVA P&G – Hydrogen initiative flagship region *Professor DI Dr. Horst Steinmüller, Austria Power & Gas*
	17:00	**Discussion**
	17.30	Wrap-up
	19:30	**Self-paid group dinner (details to follow)**

DAY 2 – Tuesday, October 22nd

Session 3: Advanced biogas and biofuels Moderator: Estathios Peteves, EU Commission		
13	09:00	Green gas and green fuels from dual fluidized bed biomass gasification *Walter Haslinger, CEO & CSO at BEST – Bioenergy and Sustainable Technologies (former BIOENERGY 2020+)*
14	09:30	Biorefineries *Dr. Kati Görsch, DBFZ (Deutsches BiomasseforschungsZentrum GmbH)*
15	10:00	Urban Circular Biorefineries *Javier Gil, CENER*
	10:30	*Coffee break*
16	11:00	Flexjet *Dr. Lais Galileu Speranza, University of Birmingham*
17	11:30	Maritime sector *Svend Soyland, Nordic Energy Research*
	12:00	**Discussion**
	12.30	***Business lunch***

Final session: World café – R&D needs and recommendations Moderator: Herbert Greisberger		
	14:00	Discussion: Workshop summary and R&D recommendations
	15:30	Comments by the devil's advocate
	16:00	End of workshop

Presentations will be available on the IEA website following the event at
https://www.iea.org/workshops/egrd-workshop-green-fuels.html

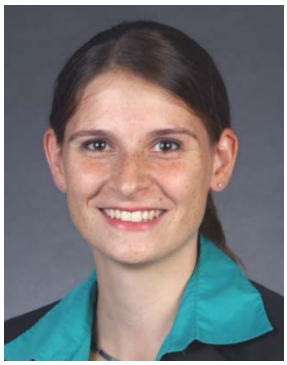
For further information on EGRD activities, see *http://www.iea.org/about/structure/cert/egrd/*

DAY 3 – Wednesday, October 23rd Members' meeting 9:00-12:00 (by invitation only)

IEA Experts' Group on R&D Priority-Setting and Evaluation (EGRD)
Green Fuels workshop 21-22 October 2019

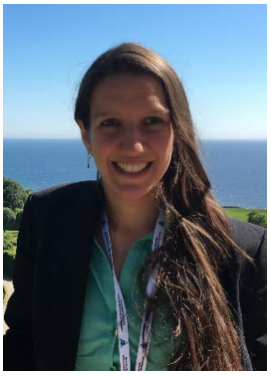
Speakers and Moderators

	**Dr. Birte Holst Jørgensen**, Technical University of Denmark, is Chair of the IEA EGRD. She is an experienced researcher and practitioner in the field of new energy technologies and systems, where she has specialized in energy R&D strategies and technology policies at the national, European and international levels. She is Principal Coordinator in sustainable energy at the Sino-Danish Centre for Research and Education, a strategic co-operation between Danish universities, the Danish Ministry of Science, Technology and Innovation, and the University of the Chinese Academy of Sciences and the Chinese Academy of Sciences. Birte holds a PhD in Political Science (University of Copenhagen) and an MSc in Business Economics (Copenhagen Business School).
	**Cedric Philibert** leads the policy analysis on technologies of the Renewable Energy Division at the International Energy Agency and works on renewable energy for hydrogen, industry and fuels. He authored several IEA Technology Roadmaps on solar and wind (2010 to 2014), the IEA reports Solar Energy Perspectives (2011), Renewable Energy for Industry (2017), and Solar Energy: Mapping the Road ahead (2019). Earlier, Mr. Philibert advised the French Environment Minister and the CEO of the French Agency ADEME, published two books on climate change and on renewable energy in 1990, then the IEA publications Beyond Kyoto (2002), and Act Locally Trade Globally (2005).
	**Dr. Atsushi Kurosawa** is Director, Global Environmental Program, Research and Development Division, Institute of Applied Energy (IAE), where he has led many energy-and environment related projects. Currently his research focuses on integrated assessments of global climate change and energy R&D strategy through the integrated assessment model GRAPE and TIMES Japan model. He has held visiting and fellowship positions at many universities and institutes including Stanford University, the Research Institute of Innovative Technology for the Earth, Kyushu University, Tokyo University of Agriculture and Technology, Japan Science and Technology Agency, New Energy and Industrial Technology Development Organization, and University of Tokyo. He holds a PhD in Electrical Engineering (University of Tokyo), a MSc in Nuclear Engineering (Tokyo Institute of Technology) and a BSc in Nuclear Engineering (Nagoya University).

	**Maria Georgiadou** is in charge of Renewable fuels and Bioenergy in 'Clean Energy Transition' in the Directorate-General for Research and Innovation. She heads the strategic orientation and technology development, as well as the implementation of relevant policies and the support under the European Union's Framework programs for research and innovation. She worked in research and development in the Chemical and Biomolecular Engineering department at the University of Illinois at Urbana Champaign and the National Center of Supercomputing Applications (USA), at Vrije Universiteit Brussels (Belgium), at Ecole Polytechnique Universitaire (France), and Ernst & Young. Maria holds PhD and MSc degrees in Chemical Engineering (University of Illinois at Urbana Champaign, USA), a Master in Business Administration and a B.S in Chemical Engineering (Aristotle University of Thessaloniki, Greece).
	**Juliane Prause** is researcher and project manager at the German Aerospace Center (DLR), Institute of Combustion Technologies since 2012. She currently coordinates the Accompanying Research (BEniVer) within the German research initiative “Energy Transition in Transport”. Juliane Prause graduated in Mechanical Engineering (focus on Energy and Environmental Technology) from Karlsruhe Institute of Technology, worked on hypersonic propulsion at the European Space Agency and completed her PhD in the field of Aerospace Engineering at the University of Stuttgart. Her research interests include the application of alternative fuels and numerical flow simulation in energy and propulsion systems.
	**Dr. Martin Hartvig** is Senior Engineer at Energinet (Denmark) in the Gas System Development department. He works on renewable energy system development focusing on sector coupling of gas, electricity and heat systems through e.g. PtX technologies. He has a Ph.D. from Lund University (Sweden) in mathematical modelling of complex systems and M.Sc. in Technical Physics from the Technical University of Denmark (DTU).
	**Thea Larsen** is CEO of the Danish Gas Technology Centre, a specialized supplier of R&D, consultancy, measurements, assessments and other knowledge intensive services in the field of gas and energy. Key areas of expertise include gas utilization, green gas production/cleaning, sector coupling/hybrid applications and environmental performance. Thea Larsen has an engineering background with more than 20 years of experience in top management in global corporations as well as in a venture capital backed technology company. She has also chaired the Danish EUDP (Energy Technology Development and Demonstration) Programme, which supports private companies and universities to develop and demonstrate new energy technologies. She holds an M.Sc. EE (Electrical Engineering) from the Technical University of Denmark.

	**Dr. Johannes Tambornino** is the head of the Energy Strategies and Systems Analysis Unit at Project Management Jülich, where he is responsible for the R&D program on energy systems analysis funded by the German Ministry of Economic Affairs and Energy. He is leading a group that covers a broad range of topics along the energy innovation chain and currently serves as the German representative in the IEA Experts' Group on R&D Priority Setting and Innovation. He holds a PhD in Mathematical Physics and has actively pursued research in quantum gravity and cosmology at different laboratories in Canada, France and Germany before changing fields and devoting his time to energy-related issues.
	**Nils Aldag** is managing director and co-founder of Sunfire GmbH. At Sunfire he is responsible for business development, sales & marketing, advocacy and investor relations. During his time at Sunfire he was responsible for the acquisition of the venture capital investors Bilfinger Venture Capital, Electranova Capital, KfW Bank, Total Energy Ventures and PaulWurth. He studied Business Administration and Law at the EBS University of Business and Law and at the Universidade Nova de Lisboa.
	**Dr. Uwe Remme** leads the energy supply-side analysis within the Energy Technology Perspectives project of the International Energy Agency (IEA). He has more than fifteen years' experience in the analysis of energy systems and technology policies. Prior to joining the IEA, he worked as researcher at the University Stuttgart on several national and European projects in the fields of energy systems modelling and technology assessment. Uwe studied chemical engineering at RWTH Aachen University, Germany, and Carnegie Mellon University, Pittsburgh, and completed a PhD degree in mechanical engineering at the University Stuttgart.
	**Dr. Todd G. Deutsch** is a Senior Scientist in the Chemistry & Nanoscience Center at the National Renewable Energy Laboratory, in Colorado, USA. His research focuses on electrochemical routes of generating fuels from renewable energy, primarily in the areas of photoelectrochemical water splitting, bipolar membranes, and electrocatalytic CO_2 conversion. Dr. Deutsch is also the co-lead for NREL's Electrons to Molecules (E2M) strategic initiative that more broadly seeks to harness carbon-free electrons for chemical, material, and fuel synthesis. He holds a PhD in Analytical Chemistry from the University of Colorado in Boulder.

	**Mr Eelco Dekker** is the Chief Representative Europe for the Methanol Institute since October 2014, and has over 12 years of experience with regard to alternative fuel applications, renewable methanol production pathways and regulatory affairs. Mr Dekker primarily supports MI in the fields of gasoline blending and marine fuels, as well as exploring opportunities to broaden the use of methanol as diesel substitute, and supports MI and its members in growing the production of renewable methanol from both biogenic feedstocks as well as from renewable electricity and CO2 (CCU). Prior to joining MI Mr Dekker has held several marketing and commercial roles at international chemical companies like DSM and Ciba Specialty Chemicals (now BASF) for more than 10 years.Mr Dekker holds a Master's Degree in Science of Business Administration from the Erasmus University in Rotterdam, The Netherlands.
	**Baruch Halpert** is Executive Chairman of Electriq Global Limited. He is an acknowledged Start up Entrepreneur, Senior Executive and Investor. He has founded companies and served as Chairman and CEO of companies and has a successful turnaround record. He has cross industries hands on experience – Clean Tech, Life Sciences, Nanotechnology, Chemicals, Internet, Finance, Oil and Gas – and extensive experience dealing with business partners and investors. He has a strong international background with work experience in the US, Europe, Asia Pacific, Africa and Israel. He has a LL.B.from Reading University and selected courses in business administration from Boston University.
	**Professor DI Dr. Horst Steinmüller,** Energy Institute, Johannes Kepler University Linz. Since its formation in 2001, Horst Steinmüller has been CEO of the Energy Institute at the Johannes Kepler University Linz. In 2018 he also took over the management of the WIVA P&G – Hydrogen initiative flagship region, Austria Power & Gas. His foremost mission is to develop and implement strategies that correspond to the principle of sustainable development. As to that, the focus is on the cautious use of resources and the promotion of renewable resources and renewable energy carriers.
	**Stathis Peteves** is Head of the Knowledge for the Energy Union Unit in the Directorate C – Energy, Transport & Climate of the European Commission's Joint Research Centre. He has been working for the Commission since 1987 addressing issues such as advanced materials technologies, power generation, alternative fuels, energy technologies assessment and modelling. His Unit supports the Energy Union strategy & its policies by mapping, collating, analysing, quality checking and communicating in a systematic and digestible way all relevant scientific data, methods, tools and knowledge available within the institution and worldwide of relevance to the Energy Union 5 thematic dimensions. He leads the Commission's SET-Plan Information System (SETIS), the scientific and technical support tool to the decision making of the SET-Plan governance and the monitor and assessor of EU's energy technology innovation progress. Stathis holds degrees from the National Technical University of Athens, the George Washington University (MSc) and the University of Florida (PhD). He has authored more than 100 publications and 4 books.

	**Walter Haslinger** is CEO & CSO of BEST – Bioenergy and Sustainable Technologies GmbH (former BIOENERGY 2020+) being in charge of about 90 scientists working in the fields of bioenergy and renewable energy in general. He has been coordinating a number of national and international RTD projects in the field of thermochemical conversion of biomass. Currently, his main activity is the coordination of BEST's research activities conducted in the frame of the Austrian COMET program. He also serves as member of the Board of the European Technology and Innovation Platform Renewable Heating and Cooling. He is Associate Editor of Biomass and Bioenergy and serves as reviewer for a number of scientific journals and as evaluator in European research funding programs. Walter Haslinger holds a PhD in Chemical Engineering from Vienna University of Technology and is Adjunct Professor for Energy Technology at Luleå University of Technology.
	**Dr.-Ing. Kati Görsch** works at the Deutsches Biomasseforschungszentrum gemeinnützige GmbH in the Biorefinery Department since four years. There she is the leader of the working group „Motor Fuels and Engines" and before receiving this position she was engaged among other things in the analysis of fuels. She studied environmental chemistry at the Leipzig University and received her PhD from the Technische Universität Dresden in the field of bioprocess engineering.
	**Dr. Javier Gil** is the Director of the Biomass Department of CENER (National Renewable Energy Centre of Spain) since September 2015 coordinating the activities in several bioeconomy fields: bioresources evaluation, sustainability studies, liquid biofuels, bioproducts and solid biofuels. He is Doctor in Science (Chemical Engineering program) by the University of Zaragoza. From 2002 to 2015 he also worked at CENER, first as senior researcher and later, from 2007, as Head of Service. He has previously held various positions at the Fraunhofer UMSICHT Institute and the University of Zaragoza working in R&D since 1994.
	**Dr. Lais Galileu Speranza** is currently working as project manager at the H2020 flexJET project that aims to produce jet fuel from organic waste and used cooking oil by SABR-TCR technology at pre-commercial scale (15M EUR project with thirteen partners from five countries). She is a Research Fellow at the School of Chemical Engineering at University of Birmingham (UoB), UK since 2017. She obtained her Ph.D. in Chemical Engineering at UoB and graduated in Environmental and Urban Engineering at Federal University of ABC (Universidade Federal do ABC – UFABC), Brazil. She has experience with renewable energy, production of biofuels (thermal and chemical conversions), biofuels policies and environmental analysis.

	**Svend Soeyland** is a senior adviser at Nordic Energy Research (NER). Within NER, he is Project Leader for the Nordic Energy and Transport and Nordic Energy Solutions within the Nordic Prime Ministers Initiative as well as coordinating pre-COP efforts. He has for more than a decade attended international climate negotiations (COP) and meetings at the International Maritime Organisation. Svend served as a Convenor for the ISO working-group that developed the Hull and Propeller Performance Standard (ISO 19030). He has previously worked for the Ministry of Environment, The University of Hong Kong, United Nations in Rome and the Bellona Foundation. Svend is from Bergen, Norway and holds a Master of Philosophy in Criminology as well an undergraduate degree in Administration and Organisational Sciences.
	**Dr. Herbert Greisberger** is the Managing Director of the Lower Austrian Energy and Environment Agency (OGUT), where his projects focus on energy and innovation with a special focus on sustainable buildings and renewables. Dr. Greisberger is also Scientific Manager of the Austrian Futurelab focusing on long-term developments and their consequences for society. He was formerly the Senior Scientist on R&D, innovation and energy technologies for the Austrian Energy Agency and the Austrian Society for Environment and Technology. He is also a Lecturer at the Institute for Research and Education focusing on energy economy and energy management. Dr Greisberger holds a PhD (University of Stuttgart) and studied economics (Universities of Graz and Vienna).