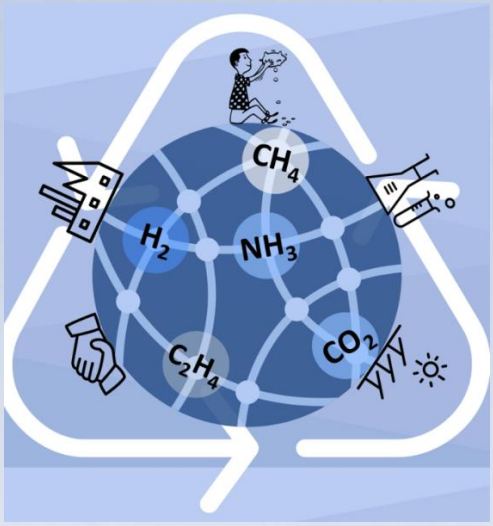
Catalysis at the Energy – Chemistry Nexus:

A Roadmap for Catalysis to Support a Society Powered by Renewable Energies

School Program



Center Paul Langevin - CNRS – Aussois (F) March 14th – 18th, 2022

« Consider this: two billion years ago, cyanobacteria oxygenated the atmosphere and powerfully disrupted life on earth.... But they didn't know it. We're the first species that's become a planet-scale influence and is aware of that reality. »

Andrew Revkin

quoted by
Jospeh Stromberg in
"*What Is theAnthropocene and Are We in It?*"
Smithsonian Magazine 2013;
https://www.smithsonianmag.com/science-nature/what-is-the-anthropocene-and-are-we-in-it-164801414/

quoted in

Peter G. Mahaffy
« *Telling Time: Chemistry Education in the Anthropocene Epoch* »
J. Chem. Educ. 2014, *91*, 463−465
dx.doi.org/10.1021/ed5001922

The School Motivation

We are delighted to welcome you to the second edition of the school "***CatEnerChem**. Scientific and Socio-Economic Aspects of the Energy-Chemistry Nexus : A roadmap for catalysis to support a society powered by renewable energies*"

In the current strive for a more renewable-energy (REN)-driven society, the roadmap on catalyst development, a key technology in the field, depends strongly on if and how the chemical industry can evolve to a REN-driven rather than fossil-fuel driven production. The upcoming generation of researchers and practitioners in catalysis will have to be trained and to operate the connection between the shifting techno-economic panorama of energy-related production systems and catalysis development challenges. The school aims at discussing how to find new ways to teach such panorama with its transdisciplinary connections and how to teach the chemistry-rooted knowledge connected to the challenges that catalysis faces.

As during the first edition in Bardonecchia in 2019, this 5-day event proposes to set the basis for such analysis, through the prism of 5 pivotal molecules that are at the roots of many current production processes and which have significant environmental and social consequences:

- **Methane:** direct conversion to methanol;
- **Hydrogen**: REN-production and use
- **Carbon dioxide**: Is "from waste to resource" building a circular economy?
- **Ammonia**: from fossil-based to fossil-free routes;
- **Ethylene,** as proxy for **Polymers and biopolymers**: as carbon feedstock;

The program strongly relies on **lectures delivered by specialists of their field**. **In harmony with the transdisciplinary goal of the school**, we have invited experts in chemistry and catalysis along with experts in economy, psychology, history and philosophy. For each session we aim at providing three levels of analysis: -> overarching elements of techno-economic analysis and societal impact -> current state-of-the art in the catalytic production route -> new REN-compatible catalysis production routes from such emerging knowledge-driven innovation.

We also wanted to **restitute pedagogically the shifting and systemic nature of the overarching context**. In addition to "ex cathedra" teachings (which are the norm in the teaching of « hard science »), we will **explore other methods of teachings that convey differently the need to acquire, build, share and question inter-dependent scientific knowledge in collectively constructive ways**.

The practicals, focused on becoming rigorous practitioners of catalysis, experiment some alternative methods of teaching: systems' thinking to reflect the systemic nature of the topic at hand, problem-based learning to develop self-reliant problem-solving abilities, and interactive teachings to explore group learning.

A simlar quest for decentralized knowledge generation is at the root of the theatrical workshop on ethics, serious games on economy and psychology as well as « take home message of the day » debrief sessions, where consensus-building by non-violent communication tools will be explored. The poster session and the video booth complete the programme, with activities where you, the partcipant, are the source of knowledge.

In this unsettled and unsettling period for many aspects, risky period some might say, we are taking some risks -within the slender perimeter of our action as chemists and educators– **will this original format reach its aim of turning us in more effective researchers and teachers at the chemistry- energy nexus? We hope so**.

In any case, we believe this is the moment to explore deeper and with more convictions how as scientists we can contribute to a better world, now that larger awareness of the systemic connections underpinning our field of action and faster paces are straining some of our old ways of interpreting our role in the society.

The first day of the school coincides with the first day France is lifting the masks mandate since the beginning of the Covid-sanitary crisis in 2020. Over 3 weeks ago the Russian army invaded Ukraine. While we firmly oppose this war and condemn the governmental attack, we stand in solidarity with the Ukrainian people and with all the peoples that are suffering from this war, with a special thought to our Ukrainian and Russian colleagues who suffer from this situation, believing that working for collective science, hoping to bringing together (what we think we understand about) Aristotele's *Episteme* (Science) and *Téchné* (technology) with *Phronesis* (*Ethics of action*) is also a step toward peace.

We wish all of you, all of us, a great week together,

Alessandra and Silvia
CatEnerChem Chairwomen

More info on the School Chairwomen

Alessandra Quadrelli is director of research of the French National Centre for Scientific Research, CNRS, at the IRCELYON laboratories and chairs the CPE Lyon Engineering School Sustainable Development Chair. She serves as associate editor of the RSC journal "Green Chemistry". Her research focuses on organometallic mechanisms on surfaces (like silica, MOFs and 2D wafers) for heterogeneous catalytic reduction of N_2 and CO_2 en route to renewable energy storage. Alessandra considers her Top-3 professional achievements : A new mechanism for N_2 cleavage (SCIENCE, 2007),the fondation of the "CO_2 forum" confereces on CO_2 chemical tansformation (held biyeraly 2010-2016)- and the synthesis of a MoS_2 monolayer by Atomic Layer Deposition, ALD (NANOSCALE, 2017). She recently co-released a report on "Gender and non-discriminatory evaluation within CNRS" https://hal.archives-ouvertes.fr/hal-03311372

Silvia and Alessandra have co-funded the NANOCAT summer school on catalysis in 2003 and co-chaired the fololwing editions (2nd Ed. 2005 ,3rd in 2009) have co-supervised 2 PhD students, 3 master 2 and 2 master 1 students and published 6 papers together.

Silvia Bordiga is Full Professor in Physical Chemistry at the Department of Chemistry of the University of Turin. From 2012 to 2020 she was Prof. II at the Department of Chemistry of the University of Oslo. She received many awards: 2017- Prize from the French Chemical Society (bilateral prize France – Italy); 2019- Francois Gault Lectureship Award from EFCAT; 2018-2019- Chemistry European Fellow; 2019- Wilhelm Manchot Research Professorship of the Dep. of Chemistry at the TUM University, Germany; 2021- Premio Antonio Feltrinelli dall' Accademia dei Lincei. Her scientific activity is mainly devoted to the characterization of the physical–chemical properties of high surface area nanostructured materials used as heterogeneous catalysts, materials for adsorption, separation and storage, through in situ spectroscopic studies.

Committees

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Program at a Glance

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
	CH_4	**CO_2**	**NH_3**	**(Bio-)Polymers**
	Geo-politics	Economy (Game Theory)	Industrial Catalysis	Industrial catalysis
	Heterogeneous Catalysis	Industrial Engineering	Plasma	Recycling
				Biorefinery
	Poster	Poster	Poster	Poster
	Industrial Catalysis	Homogeneous Catalysis	Electrocatalysis	Biomass
		Life Cycle Analysis		Biofuels
	Q&A	Q&A	Q&A	Q&A
	Take-home Message	Take-home Message	Take-home Message	Take-home Message
Opening	**H_2**			**Conclusion**
Anthropocene	Photochemistry			Transition Scenarios
Renewable Energies	Biotechnology			Discussion
				Epistemology
History	Industrial Production			
	Q&A			Prize & Closing
Ethics		Systemic Approach to Teaching	Problem-Based Learning	
	Psychology (Cognitive Biases)			
Economy (Behavioural)	Take-home Message	Problem-Based Learning	Interactive Teaching	
Economy (Behavioural)	Economy (Behavioural)	Psychology (Cognitive Biases)		

Color Code:

- General lectures
- Social Sciences & Humanities Lectures
- Catalysis Lectures
- Q&A, Debrief & Poster Sessions
- Practicals & Serious Games

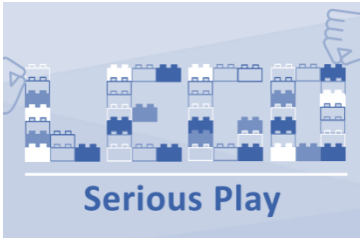
Active Participation

Poster and Q&A sessions

Take the opportunity to **share and discuss your research** with the speakers, and most important **among yourself**. Enjoy a fruitful exchange of ideas and **make new connections!** Beside the official Poster Session, you have the opportunity to **keep your poster exposed for the entire duration of the school**, to increase the time available for discussion.

Theatre -based learning on ethics & science : to reflect in two directions: towards the positionings and choices of scientists in their professional practices, and a second one to share around the ethical implications of the scientific practice

Join our "**video booth"** to share with the world (and with your distant colleagues) your point of view. Use our set-up to record a short video message about what really needs to be highlighted.



Serious games on cognitive biases : explore behavioural economy and cognitive biases in psychology and how much they influence (probably hamper in fact….) our decision making toward energy transition, the emergence of circular production processes, etc.

Choose your session (on CH_4, H_2, CO_2, NH_3 or (bio)polymers) and create the "**take home message**" in collective workshops starting from individual analyses (what is important in what I heard today? Why? How to share it?) leading to "tangible" outputs (video, writings, …)

Choose two of the five possible practicals : introduction to catalysis by problem-based learning, advances catalysis on zeolites with systems' thinking, spectroscopy with interactive voting , electro and photo (electro) with problem-based learning

Program Overview

Opening session: The context

Monday *Room: Paraché Lecture Theatre*
2 PM-4:45 PM *Remote connection:*
https://cnrs.zoom.us/j/94077423010?pwd=V3NFYlRxRXc4dTdoSUZ2MGZsY0g3Zz09
Meeting ID: **940 7742 3010**
Passcode: **CEC_INT1**

Session coordinated by A. Quadrelli (CNRS CPE Lyon) and S. Bordiga (U. Torino, NIS)
Speakers :

- *W. Steffen (SRI)* ***"The Anthropocene: Global Chemistry and Planetary Boundaries"***
- *W. Tumas (NREL)* ***"The Renewable Energy/Chemistry Nexus: Challenges and Opportunities for a Clean Energy Transformation"***
- *Missemer (CIRED)* ***"Economics, history, and the energy transition: some lessons for the 21st century"***

TOPIC 1 - Methane: Current usages and future direct conversion

Tuesday *Room: Paraché Lecture Theatre*
8:15 AM-12:15 PM *Remote connection:*
https://cnrs.zoom.us/j/97621367906?pwd=T2F5ZFdGMmtkRzd4QjliR28rMTdHdz09
Meeting ID: **976 2136 7906**
Passcode: **CEC_CH4**

Discussion leader: F. di Renzo (CNRS)
Speakers::

- *M. Nicolazzi (U. Torino)* ***"Geo political routes of methane CH_4"***
- *J. van Bokoven (ETH-Z & PSI)* ***"The many challenges to convert methane into methanol"***
- *J.-P. Dath (TotalEnergies)* ***"Converting Methane to Monomers: Is There any Sustainable Shortcut?"***

TOPIC 2: Hydrogen: REN-production and use

Tuesday *Room: Paraché Lecture Theatre*
2 PM-5 PM *Remote connection:*
https://cnrs.zoom.us/j/93016240800?pwd=KzNoTEpYYzZ5cjYyMVlmZG9DMmJyZz09
Meeting ID: **930 1624 0800**
Passcode: **CEC_H2**

Discussion leader: V. Artero, (CEA)
Speakers :

- *N. Dupassieux (INES)* ***"Hydrogen from the sun light: from fossil to photons pathways"***
- *K. Vincent (Oxford U.)* ***"Scope for biotechnology in a future hydrogen-based energy economy"***
- *T. Leperq (Solairestream)* ***"Entrepreneurship in the hydrogen economy"***

Tuesday *Room: Paraché Lecture Theatre*
5:30 PM-6:15 PM *Remote connection:*
https://cnrs.zoom.us/j/98046161099?pwd=TVFwVWZkTVoxdThxUzA1SGFDWUFtdz09
Meeting ID: ***980 4616 1099***
Passcode: *CEC_PSY1*

Discussion leader: A. Quadrelli, (CNRS)
Speaker

- *H. Kunreuther (U Penn)* ***"Cognitive biases hampering the energy transition"***

TOPIC 3: CO_2: Is "from waste to resource" building a circular economy?

Wednesday *Room: Paraché Lecture Theatre*
8:15 AM-12:30 PM *Remote connection:*
https://cnrs.zoom.us/j/96352435735?pwd=ZFBZdjNqVW1xSDR3K3JLYlgxVjJQZz09
Meeting ID: **963 5243 5735**
Passcode: **CEC_CO2**

Discussion leader: T. Cantat (CEA)
Speakers:

- *J.C. Pereau (Bordeaux school of economics)* ***"A game-theoretic interpretation of the climate change negotiations"***
- *M. Sorensen (Haldor Topsoe)* ***"CO_2 emission management via production of fuels"***
- *W. Leitner (MPG Mulheim)* ***"Chemical Synthesis using CO_2: From Molecules to Processes (and back)"***
- *A. Bardow (ETHZ)* ***"What to do with CO_2? A life cycle perspective"***

TOPIC 4: Ammonia: from fossil-based to fossil-free routes

Thursday *Room: Room: Paraché Lecture Theatre*
8:15 AM-12:15 PM *Remote connection:*
https://cnrs.zoom.us/j/98067351361?pwd=eDdseXlscU5VQ0Q1Rk9MVElKai9FZz09
Meeting ID: **980 6735 1361**
Passcode: **CEC_NH3**

Discussion leader: A. Quadrelli
Speakers:

- *T. M. Nguyen (Haldor Topsoe)* ***"Current industrial NH_3 production and path to the future"***
- *R. Ingels (N2 Applied)* ***"Do we need the Haber Bosch? Insight from Plasma chemistry"***
- *Chorkendorff (DTU)* ***"Electrochemical Reduction of N_2 to NH_3"***

TOPIC 5: Polyolefin and biopolymers: as carbon feedstock

Friday (hbg) *Room: Paraché Lecture Theatre*
8:15 AM-12:30 PM *Remote connection:*
https://cnrs.zoom.us/j/99559259999?pwd=TVJHa0ZQMHpwcHdoOFRCdnFPZVZYQT09
Meeting ID: **995 5925 9999**
Passcode: **CEC_POLY1**

Discussion leaders: E. Groppo, (U. Torino) and Francesco Di Renzo (CNRS)
Speakers:

- *N. Friederichs (Sabic)* ***"Catalysis as a key enabler towards circularity polyolefins"***
- *V. Monteil (CNRS)* ***"Chemical Recycling of Polymers: Focus on Polyolefins"***
- *K. Barta (Uni Graz)* ***"Biorefinery strategies for the production of polymers from lignocellulose"***
- *F. Picchioni (U Delft)* ***"Biomass & biopolymers. Going "green" is not enough?"***
- *C. Perego (former ENI)* ***"Biofuels: Waste to Fuel in the Age of Circular Economy"***

Closing session

Friday (hbg) *Room: Paraché Lecture Theatre*
2 PM-4:30 PM *Remote connection:*
https://cnrs.zoom.us/j/93743615469?pwd=ZndDcXBiczEvSTJ0dkFXN09QRGNBZz09
Meeting ID: **937 4361 5469**
Passcode: **CEC_CONC1**

Scenarios for the Energy Transition
Discussion leader: F. Chandezon (CEA SUNERGY)

- *Speaker:*
- *B. Weckhuysen (EFCATS)* ***"Role of catalysis in the energy transition & the Sunergy project"***

Final considerations
Session coordinated by A. Quadrelli (CNRS)
Speaker:

- *P. Anastas (Yale University)* ***"Reflections on the scientific method"***

Theatrical Workshops, Serious games, Collective communication and posters

Monday **Economy**
5:15 PM- 6 PM or Room: Paraché Lecture Theatre
6:15 PM-7PM Pedagogy: Serious games (in half groups)

- *B. Ruffieux (U. Grenoble) and L. Aufenberg (Aufbenberg consulting)* ***"What can I learn from behavioral economics?"***

Monday ***9 PM-10:30 PM*** **Economy**
or Tuesday Room: Oerine Lounge (in satellite building)
Pedagogy: serious games (in half groups)

- *B. Ruffieux (U. Grenoble) & L. Aufenberg (Aufbenberg consulting)* ***"Debrief of Serious games on economics"***

Monday **Ethics**
5:15 PM- 6 PM or Room: Norma Room
6:15 PM-7PM Pedagogy: theatrical workshop (in half groups)

- *Maria Grace Salamanca Gonzalez (EUL-U. Lyon)* ***"Theatre to explore individual vs. Collective choices in science"***

Wednesday **Psychology**
9 PM-9:45 PM or Room: Oerine Lounge (in satellite building)
9:45PM-10:30 PM Pedagogy: Serious game (in half groups)

- *B. Ruffieux (U. Grenoble) & L. Aufenberg (Aufbenberg consulting)* ***"Cognitive biases"***

Tuesday **Critical Analysis**
1:15 **PM-2 PM on CH_4** Room: Club 1 room
or 6:15 PM-7 PM on H_2 Pedagogy: collective reflection (by group of 20)
or Wednesday
1:15 PM-2 PM on CO_2
or Thursday
1:15 PM-2 PM on NH_3
or Friday
1:15 PM-2 PM on (bio-) polymers

- *J. Michel (EUL – U. Lyon)* ***"Take home message of the day"***

Monday to Friday **Video**
Free Schedule Room: Club 1 room
Individual

- *J. Kratochvil (EUL – U. Lyon)* ***"Video capsule"***

Tueasday to Friday **Poster Sessions**
10 AM-A0 :30 AM Room: Mezzanine

Practicals

Wednesday and Thursday 5 PM-7 PM

Spectroscopy
Room: Paraché Lecture Theatre
Pedagogy : interactive teaching (up to 40 participants)

- *Silvia Bordiga (U. Torino) Matteo Signorile (U. Torino) E. Groppo (U. Torino)*

Wednesday 5 PM-7 PM

Heterogeneous Catalysis & adsorption: Introduction
Room: Echelle room
Pedagogy: Problem based learning (up to 20 participants)

- *Alessandra Quadrelli (CNRS)*

Wednesday And Thursday 5 PM-7 PM

Heterogeneous Catalysis: Advanced
Room: Rateau room
Pedagogy : Systemic approach (up to 20 participants)

- *Manoj Ravi (U. Birmingham) and Francesco di Renzo (CNRS)*

Wednesday's *Remote connection s1:*
https://cnrs.zoom.us/j/95531763013?pwd=aXhaR1V3ZjB4SmM4OUtuaERhZTlBdz09
Meeting ID: **955 3176 3013**
Passcode: **CEC_PRAC1**

Thursday*'s* *Remote connection s2:*
https://cnrs.zoom.us/j/91067976244?pwd=QVNZS1doSkRJUm1JbHh5UDVuYSt3dz09
Meeting ID: **910 6797 6244**
Passcode: **CEC_PRAC2**

Wednesday 5 PM-7 PM

ElectroCatalysis
Room: Norma
Pedagogy: Problem based learning (up to 40 participants)

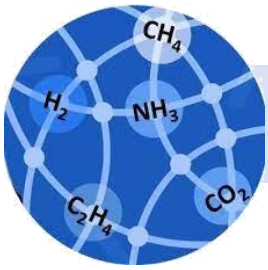
- *Mathieu Prevot (CNRS) and Bertrand Reuillard (CNRS)*

Thursday 5 PM-7 PM

(Photo) Electro Catalysis
Room: Norma
Pedagogy: Problem based learning (up to 40 participants)

- *Mathieu Prevot (CNRS) and Bertrand Reuillard (CNRS)*

Lectures *- abstract & speakers bios*



OPENING SESSION: The context.

Monday
2 PM-4:45 PM

Room: Paraché Lecture Theatre
Remote connection:
https://cnrs.zoom.us/j/94077423010?pwd=V3NFYlRxRXc4dTdoSUZ2MGZsY0g3Zz09
Meeting ID: **940 7742 3010**
Passcode: **CEC_INT1**

Session coordinated by A. Quadrelli (CNRS CPE Lyon) and S. Bordiga (U. Torino, NIS)

- *W. Steffen (SRI)* ***"The Anthropocene: Global Chemistry and Planetary Boundaries"***
- *W. Tumas (NREL)* ***"The Renewable Energy/Chemistry Nexus: Challenges and Opportunities for a Clean Energy Transformation"***
- *Missemer (CIRED)* ***"Economics, history, and the energy transition: some lessons for the 21st century"***

Introduction to the opening session

Paul J. Crutzen, 1995 Nobel Prize in Chemistry for his work on air pollution and ozone who introduced the term Anthropocene, said about this term : "Human beings have become a force of nature". [1] The term Anthropocene makes the link between the planetary biophysical systems (climate, biodiversity, nitrogen and phosphorus cycles,..) , human societies, and the particular historical moment we are living in, where several planetary boundaries appear disregarded.[2] Just one striking number: around year 2020 the weight man-made mass just surpassed or will soon surpass for the first time ever the weight of all global living biomass.[3]

The power of the Anthropocene term, connecting planet boundaries, societies and time, partly explains why this term is shattering its original semantic restriction beyond geology. Geosciences are at the base of the Anthropocene concept and they are also at the root of our capacity to mine resources and change their distribution over the planet (metals, rocks, energy carriers, water, …). Chemistry, the science which studies the properties and behavior of matter, Is not far off because with understanding of matter comes the capacity to transform it and model into forms closer to our use (building materials, fuels, fertilizers, …). In this school we have chosen to focus on a key interface of chemistry : energy;[4] and therefore tackle the energy transition, a central open question within Anthropocene. This introductory session will set the a large framework for this week's work.

Selected readings

1. P. J. Crutzen "Geology of mankind: the anthropocene" **Nature**, 2002 415 23
2. W. Steffen et al. « Planetary boundaries: Guiding human development on a changing planet » **Science** 2015 , 347 , DOI: 10.1126/science.1259855
3. E. Elhacham, L. Ben-Uri, J. Grozovski, Y. M. Bar-On R. Milo « Global human-made mass exceeds all living biomass » **Nature** 2020 , 588 , 442.
4. E. A. Quadrelli "25 years of energy and green chemistry: saving, storing, distributing and using energy responsibly " **Green Chem** ., 18, 328-330 (2016)

More info on the Session Organizer

Alessandra Quadrelli 's info can be found in "School motivation" section.

The Anthropocene:
Global Chemistry and Planetary Boundaries

Will Steffen
Stockholm Resilience Institute (SW) &ANU, Canberra (AU)
will.steffen@anu.edu.au

This presentation explores the role of chemistry at the global level. The talk is organised around the Anthropocene, a new state of the Earth System – and a proposed new geologic epoch – driven by human activities. Chemistry plays a central role in the emergence of the Anthropocene, from the formation of the stratospheric ozone hole to the role of greenhouse gases in driving climate change and the enormous impact of chemical pollution on the biosphere. One approach to restoring a stable and well-functioning Earth System is based on recognition of planetary boundaries – limits to how much humans can change the planet. Again, chemistry plays a central role, with science-based limits on how much, and what types of chemical we can release to the global environment.

Will Steffen, Paul J. Crutzen and John R. McNeill "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?" **Ambio** , 2007, Vol. 36, pp. 614-621

More info on the speaker:

Will Steffen is an Earth System scientist. He is a Councillor on the publicly-funded Climate Council of Australia that delivers independent expert information about climate change. He is also an Emeritus Professor at the Australian National University (ANU); Canberra, a Senior Fellow at the Stockholm Resilience Centre, Sweden; and a member of the Anthropocene Working Group. From 1998 to mid-2004, Steffen was Executive Director of the International Geosphere-Biosphere Programme, based in Stockholm. His research interests span a broad range within Earth System science, with an emphasis on sustainability and climate change.

The Renewable Energy/Chemistry Nexus: Challenges and Opportunities for a Clean Energy Transformation.

William Tumas
the National Renewable Energy Laboratory
bill.tumas@nrel.gov

This lecture will discuss the opportunities and challenges for chemistry, catalysis and materials science to provide the needed innovation and technologies for energy conversion, delivery, storage, and use. An overview of the National Renewable Energy Laboratory's (NREL's) strategy for a clean energy future through our three critical objectives: Integrated Energy Pathways, Electrons to Molecules, and Circular Economy for Energy Materials (https://www.nrel.gov/about/vision.html) will be provided. The focus will be on the interconversion of solar, electrical and chemical energy spanning fundamental and applied research. Advances in materials discovery, photovoltaics, solar fuels, hydrogen generation and utilization, electrochemical conversions, and carbon dioxide utilization will be presented to illustrate how chemistry and materials science can and must play a critical role in our energy transformation.

More info on the speaker:

Bill Tumas is the Associate Laboratory Director for Materials, Chemical, and Computational Science at the National Renewable Energy Laboratory (NREL) overseeing NREL's solar, hydrogen and fuel cells, basic energy sciences, advanced computing, and ARPA-E programs. With over 30 years in industry and at national laboratories, Bill Tumas has led a number of multi-institution and international collaborations. He has also led two Energy Frontier Research Centers on materials discovery: the Center for Next Generation of Materials Design and the Center for Inverse Design.

Prior to joining NREL in December 2009, Bill Tumas was at Los Alamos National Laboratory for 17 years, where his last position was as program director for Applied Energy Programs. He has over 65 peer-reviewed publications, 12 patents and has given over 125 invited presentations. He is a fellow of the American Association for the Advancement of Science and serves on several advisory boards for energy-related research. He has contributed to several Basic Energy Sciences reports, including chair for the Roundtable on Liquid Solar Fuels. Tumas received a Bachelor of Arts in chemistry from Ithaca College and a PhD in Organic Chemistry from Stanford University as an NSF and Hertz Fellow, and was a Chaim Weizmann and NIH postdoctoral fellow at Caltech before starting his career at DuPont Central Research.

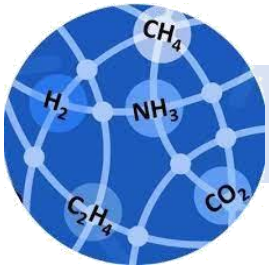
Economics, history, and the energy transition: some lessons for the 21st century

Antoine Missemer
CNRS-CIRED (F)
missemer@centre-cired.fr

This presentation will introduce some key lessons from the history of energy and the history of economic ideas to grasp the challenges of the energy transition in the 21st century. Three main sets of issues will be addressed: (1) the articulation between energy *sources* and energy *systems*, requiring special attention to the socio-economic organisation surrounding the use of energy; (2) the meaning of the word 'energy transition' in view of the simultaneous past co-existence of several energy systems; (3) the old origins of environmental consciousness, within the discipline of economics and beyond, questioning the true obstacles to achieving full energy transitions. Discussing these issues will help to see how the social sciences, informed by history, can participate to a better understanding of the challenges associated to the energy transition.

More info on the speaker:

Antoine Missemer is a CNRS researcher currently working at CIRED – Centre international de recherche sur l'environnement et le développement (Paris, France). He holds a PhD in economics from the University of Lausanne and the University of Lyon. His interdisciplinary work focuses primarily on the history of environmental, ecological, energy, and natural resource economics, i.e. on how the economic discipline and economists have approached energy and ecological issues in the past. Through the steering (PI) of the ERC StG project #ETRANHET (2022-27), his research will soon cover the place of energy transitions in the history of economic thought on a global scale (5 linguistic and cultural areas in Europe, America and Asia).



Topic 1: Methane
Current usages and future direct conversion

Tuesday
8:15 AM-12:15 PM

Room: Paraché Lecture Theatre
Remote connection:
https://cnrs.zoom.us/j/97621367906?pwd=T2F5ZFdGMmtkRzd4QjliR28rMTdHdz09
Meeting ID: **976 2136 7906**
Passcode: **CEC_CH4**

tumas

Introduction to Session 1 :

Methane

At the heart of profound geo-political stakes, methane is at the crossroad of vital sector: as energy provider or as hydrogen source for refining and chemical industry, or even directly flared into the atmosphere, its central carbon is ultimately tossed away as CO_2. Catalytic ways to add value to this hard to chemically functionalize molecule are emerging.

For some of the connection between methane, and more largely hydrocarbons and sustianibility, Euchems Webinar " The Carbon Element – Key towards a sustainable society " https://www.euchems.eu/carbon-element-webinar/ https://www.youtube.com/watch?v=Ug4f2VDynxM

More info on the Discussion Leader

With a formation in chemical engineering and a PhD in industrial chemistry, Francesco di Renzo spent his research career in the research units of CNRS and ENSCM (Ecole Nationale de Chimie de Montpellier), notably by leading the MACS (Matériaux Avancés pour la Catalyse et la Santé) team of the Institut Charles Gerhardt and coordinating the Montpellier participation to the Erasmus Mundus doctorate Sinchem (Sustainable Industrial Chemistry). His activity was always directed to the elaboration of heterogeneous catalysts for oil refinery and for the valorisation of natural resources. The control of the texture and the characterisation of porous materials (zeolites, micelle-templated silicates, nano-oxides, polysaccharide aerogels) have been at the centre of his research. Current position as emeritus research director of CNRS in the ICGM.

Geo political routes of methane CH_4: Gas as usual?

Massimo Nicolazzi
Università degli studi di Torino
massimo.nicolazzi@unito.it

Decarbonisation is not a beauty contest. We need to identify sector by sector the most efficient decarbonisation path and be realistic in assessing the steps and timing of the substitution. February 24 events, as fa as Russian methane is concerned, turned a decarbonation issue into a wider political issue.

More info on the speaker:

With almost 35 years of experience in the hydrocarbon sector, Massimo Nicolazzi worked for Eni and Lukoil before being appointed Ceo of Centrex Europe. Today he is Energ advisor and Senior Advisor of ISPI's Energy Security Program. He has written several publications and he is member of the Italian Geopolitical Magazine "Limes". From https://www.ispionline.it/en/bio/massimo-nicolazzi-0. Massimo Nicolazzi has been teaching International Trade Law at LUISS University (Rome) and is currently Professor of Economics of Energy Resources at the University of Turin. He has authored essays and articles focusing on energy and on international policy, including the books "Il prezzo del petrolio" ("The price of Oil" – Milano, Boroli, 2009) and "Elogio del petrolio" ("In Praise of Oil", Milano, Feltrinelli, 2019)

The many challenges to convert methane into methanol

Jeroen van Bokhoven
ETHzurich and PSI (CH)
jeroen.vanbokhoven@chem.ethz.ch

Methane flaring is a major contributor to greenhouse gas emission and presents an enormous loss of resource. The major challenge is to directly convert methane into methanol. The difficulty of reaching high yields is the higher reactivity of methanol than of methane. I will present the progress that has been made, compare the different methods that are being employed, and address the major shortcomings. There is some reason for optimism, even though economic analyses indicate that even the best-performing systems are coming up short. Finding a solution requires focusing research efforts on those systems that are most promising. There are many scientific and engineering questions that need to be resolved. A more concerted effort by the whole community would help our progress to large extend.

More info on the speaker:

Jeroen A. van Bokhoven completed a degree in chemistry at Utrecht University (Netherlands) in 1995 and went on to obtain a PhD in inorganic chemistry and catalysis from the same university in 2000 (with honours). From 1999 until 2002 he was head of the XAS (X-ray absorption spectroscopy) users – support group at Utrecht University. In 2002, he moved to the ETH, where he worked as researcher in the group of professor Prins. In 2006 he obtained an SNF assistant professorship in the Department of Chemistry and Applied Biology.

He was the 2008 recipient of the Swiss Chemical Society Werner Prize. Since 2010, Jeroen A. van Bokhoven has a Chair in Heterogeneous Catalysis at the Institute for Chemical and Bioengineering at ETH Zurich and is Head of Laboratory for Catalysis and Sustainable Chemistry at Paul Scherrer Institute. Van Bokhoven works in the field of heterogeneous catalysis aiming at producing better catalysts and processes that allow sustainable development. Goal is the determination of structure-performance relationships, which aid the design and construction of better catalysts for cleaner and more efficient processes. His main interests are heterogeneous catalysts and developing advanced tools in X-ray spectroscopy and scattering to study the catalyst structure under catalytic relevant conditions.

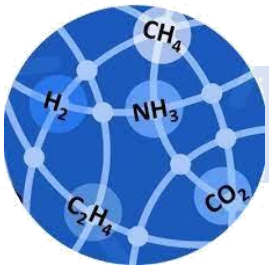
Converting Methane to Monomers: Is There any Sustainable Shortcut?

Jean-Pierre Dath
TotalEnergies (F)
jean-pierre.dath@totalenergies.com

Along with its use in the energy sector (as a lesser CO_2 emitter per amount of delivered energy compared to other fossil sources), methane has also been considered as a raw material for petrochemicals and more particularly in the production of olefins, like its counterparts with a greater number of carbon atoms. The indirect route through synthesis gas, methanol, and conversion into olefins using MTO or MTP processes, implies a sequence of processes which is costly and also a source of significant greenhouse gas (GHG) emissions. Direct conversion of methane can provide important gains in energy and atom economy. Since the 1980's, catalytic methane-to-chemicals conversion technologies have been proposed by Oxidative Coupling (OCM) and Non-Oxidative Coupling (NOCM) of methane (so called methane dehydroaromatization). Eventually, the OCM technology was commercialized by Siluria in collaboration with Linde in 2016 but the ethylene selectivity remained low, and associated with a large amount of CO_2. In the meantime, Dalian Institute of Chemical Physics (DICP) in collaboration with Sabic announced the development of catalytic non-oxidative technology based on "single site" concept, with strong potential avoiding the formation of oxygenate by-products (including CO_2). The concept of single site is here further explored, first with a metallo-zeolite, an improved Mo-ZSM-5 where Mo has been successfully integrated as single atoms within the zeolite framework; second, with a new type of metal-free catalyst made of carbon with a specific morphology. Moreover, techniques capable of directly supplying the required energy to the catalyst can significantly improve the stability of products and catalyst. These techniques also have the advantage of using electricity as energy source, which at the same time makes it possible to minimize the carbon footprint of the process, as long as this electricity is renewable.

Biography

Jean-Pierre Dath earned his master degree in chemistry at the University of Mons, Belgium in 1981. After earning a Ph.D. in science from the same university and doing postdoctoral research as a member of Professor Gerhard Ertl's team at the Fritz Haber Institut in Berlin, he joined Belgium's Fund for Scientific Research (FNRS) as a research scientist. He finally resigned to join Fina Research, the forerunner of Total Research & Technology Feluy, to work in oleochemistry, focusing closely on a series of catalytic reactions, mainly to reduce fatty acids to alcohols, hydrogenate sugar and synthesize biodegradable detergents. He transferred afterwards to the Polyolefins Catalysis Division and worked on ethylene and propylene polymerization catalysis, before being appointed Manager of the Catalyst Division in the Refining Catalysis & Processes Department, handling catalysts used in refineries and base chemicals. Accredited as R&C's catalysis expert in 2013, Jean-Pierre is today R&D Program Manager in the R&D Division to coordinate cross-functional gas-related programs. He is the author / co-author of more than 25 scientific publications and 90 patents. Jean-Pierre is also chairman of the board of CERTECH (« Centre de Ressources Technologiques en Chimie », Seneffe, Belgium), chairman of the board of Meurice R&D (Anderlecht, Belgium) and a former chairman of Société Royale de Chimie (SRC, Belgium).



TOPIC 2: Hydrogen. REN-production and use

Tuesday
2 PM-5 PM

Room: Paraché Lecture Theatre
Remote connection:
https://cnrs.zoom.us/j/93016240800?pwd=KzNoTEpYYzZ5cjYyMVlmZG9DMmJyZz09
Meeting ID: **930 1624 0800**
Passcode: **CEC_H2**

Speakers:

- *N. Dupassieux (INES)* ***"Hydrogen from the sun light: from fossil to photons pathways"***
- *K. Vincent (Oxford U.)* ***"Scope for biotechnology in a future hydrogen-based energy economy"***
- *T. Leperq (Solairestream)* ***"Entrepreneurship in the hydrogen economy"***

Discussion leader: V. Artero, (CEA)

Tuesday
5:30 PM- 6:15PM

Room: Paraché Lecture Theatre
Remote connection:
https://cnrs.zoom.us/j/98046161099?pwd=TVFwVWZkTVoxdThxUzA1SGFDWUFtdz09
*Meeting ID : **980 4616 1099***
Passcode : CEC_PSY1

Speaker :

- *Howard KUNREUTHER (*U. Pennsylvania*)* ***"Cognitive biases hampering the energy transition"***

Introduction to Session 2: Hydrogen

A sustainable production of hydrogen with low carbon emissions is central to the ecological transition, since hydrogen is an important vector for the energy and transport sector, and a large-volume resource for chemical industry. Hydrogen indeed represents an enabling molecule in the production of ammonia and carbon-based fuels and chemicals. Besides mature water electrolysis, less mature green hydrogen production methods such as direct conversion of sunlight into hydrogen will have a prominent place in the future scenario.

Selected readings

- Sunrise Technological Roadmap : https://sunriseaction.com/sunrise-releases-its-technological-roadmap-to-a-clean-energy-eu/
- "Pathways to Solar Hydrogen Technologies" Shane Ardo,* David Fernandez Rivas,* Miguel Modestino,* Verena Schulze Greiving,* Fatwa Abdi, Peter Achterberg, Esther Alarcon llado, Vincent Artero, et al. , *Energy Environ. Sci*., **2018,** 11, 2768-2783

More info on the Discussion Leader

Vincent Artero was born in 1973. He is a graduate of the Ecole Normale Supérieure (Ulm; D/S 93) and of the University Pierre et Marie Curie (Paris 6). He received the Ph.D. degree in 2000 under the supervision of Prof. A. Proust. His doctoral work dealt with organometallic derivatives of polyoxometalates. After a postdoctoral stay at the University of Aachen (Aix la Chapelle) with Prof. U. Kölle, he joined in 2001 the group of Prof. M. Fontecave in Grenoble with a junior scientist position in the Life Science Division of CEA. In 2016, he became Research Director at CEA. In addition to the SolHyCat group, he now leads the Laboratory of Chemistry and Biology of Metals and chairs the board of management of the ARCANE Excellence Laboratory Network (LABEX) for bio-driven chemistry in Grenoble. His research interests are in bio-inspired chemistry including catalysis related to hydrogen energy and artificial photosynthesis. Vincent Artero is associate editor of the Royal Society of Chemistry flagship journal "Chemical Science".

Hydrogen from the sun light : from fossil to photons pathways

Nathalie Dupassieux

CEA (F)

Nathalie.DUPASSIEUX@cea.fr

A few hundred million years ago, biomass grew thank to CO_2 and sunlight, matured under specific geologic conditions, and was transformed into fossil oil. For the last hundred years, this stored solar energy has been destocked; among many uses, hydrogen is produced from these hydrocarbons (C_xH_y). This H_2 production is done through several proven catalytic processes and is associated to huge CO_2 emission contributing to global warming. For few decades, H_2 has been seen as a potential game-changer, whether as a fuel, as an energy carrier, as a means of energy storage. The conversion of low-carbon electricity (renewable and nuclear) through electrochemical processes (electrolysis) is the main near-term strategy (2030) strategy to turn the energetic system to a new hydrogen based one. Deeper decarbonisation of the energy system (Net Zero by 2050, IEA) will depend on the deployment of additional technologies i.e Solar Hydrogen. Thermochemicals, photoelectrochemical, photo-chemicals approaches, currently explored, will require key catalytic strategies to be implemented over the next generations of photosynthetic systems for the hydrogen sustainable production.

More info on the speaker:

Nathalie Dupassieux is since 2016 head of the CEA's Solar Systems and Thermodynamics laboratory. She starts her research career at the French Petroleum Institute (IFPEN) after a master degree from UTC (Technical Univ. Compiègne), France (2003) in chemical engineering. Her work has focused on the catalytic pathways and processes to convert biomass into transportation fuels. She has co-supervised several thesis works on bio-refinery (lignocellulose liquefaction and hydro-deoxygenation routes) and taught at IFP-School. The environmental analysis and the scarcity of biomass materials as a substitute for hydrocarbons led her to redirect her work in hybritation with the harvesting of solar energy.

She joined CEA-LITEN in 2012 at the Institut National de l'Energie Solaire where she initiated the "solar fuels" theme, focusing on the reactors's design and scale-up for syngas, hydrogen and solar fuels production. She has authored more than 20 publications in international journals and patents in the field of alternative and solar fuels production and solar processes management.

Scope for biotechnology in a future hydrogen-based energy economy.

Kylie Vincent
Oxford Uiversity (UK)
kylie.vincent@chem.ox.ac.uk

Microbes have run on hydrogen-based energy for billions of years. Hydrogenase enzymes allow bacteria to extract energy from H_2, or to produce H_2 as a disposal mechanism for excess reducing equivalents. These enzymes are inspirational to chemists because they utilise earth-abundant metals - iron, or nickel and iron – in place of the precious metals which are the best chemo catalysts for hydrogen technologies. Nature has tuned the iron/nickel-iron catalytic sites of hydrogenases for high turnover frequency and impressive selectivity for H_2 over other small molecules which would poison precious metals, including carbon monoxide and sulfides. Insight into the mechanisms of hydrogenases is starting to translate into new design principles for hydrogen energy catalysis. The enzymes themselves may also have roles to play in future hydrogen energy systems. They have been trialled in biocatalytic fuel cells, in biohydrogen production systems, and in biotechnology for cleaner application of biocatalysis in chemical manufacturing.

More info on the speaker:

Kylie Vincent is Professor of Inorganic Chemistry, and Fellow of Jesus College at the University of Oxford. She graduated from the University of Melbourne, Australia (BA/ BSc(Hons), Ph.D. (2004)), before carrying out postdoctoral research at the University of Oxford with Fraser Armstrong from 2002-2007. She then took up a Royal Society University Research Fellowship and RCUK Academic Fellowship in Oxford in 2007/8. She was appointed Associate Professor in 2013 and Professor in 2017. She was denoted the UK's Science and Technology Woman of the Future in 2011, won the Clara Immerwahr Award for outstanding catalysis research in 2012, and was the overall winner of the Royal Society of Chemistry's Emerging Technologies Competition in 2013.

In 2021 she co-founded the spin-out company HydRegen Ltd where she serves on the Board, and was appointed to a newly-created University role as Academic Champion for Women in Entrepreneurship. She has supervised 17 DPhil students and 42 Masters students to completion. Her research interests include mechanistic studies of small molecule activation in biology, and applications of enzymes in chemical manufacturing.

Entrepreuneusrhip in hydrogen production

Thierry Lepercq
Solairedirect
thierry.lepercq@soladvent.com

Since its creation in 2006, Solairedirect has been a French pioneer in the competitive solar energy sector, developing, building, operating, maintaining and financing large-scale solar power plants on four continents. Its innovative business model is based on an industrial approach to solar power production, combined with a cost reduction approach.

Solairedirect has developed 57 solar power plants in the past, representing a total of 486 MW, and currently operates a gross capacity of 224 MW in France, with the ambition of developing 125 MW per year.

Translated from: https://www.engie.com/journalistes/communiques-de-presse/engie-leader-du-solaire-en-france-solairedirect (accessed March 10th, 2022)

More info on the speaker:

Thierry Lepercq is an entrepreneur in disruptive technologies and energy. He has created several companies including Solairedirect, a global player in solar energy. Deputy CEO of Engie, in charge of research, technology and innovation, until 2018, he recently created Soladvent, a pioneer in competitive green hydrogen. A lecturer, he speaks around the world on energy, climate and foresight issues. He is the author of Hydrogen, the new oil (2019).

Taken from : https://www.dunod.com/

Cognitive biases hampering the energy transition

Howard Kunreuther
Wharton School, University of Pennsylvania,
kunreuth@wharton.upenn.edu

Solar power is now economically competitive with fossil fuels in many countries, yet relatively few homeowners have elected to install solar panels. A principal reason for this behavior stems from cognitive biases—such as myopia, inertia, and herding—that cause consumers to avoid investing in long-term measures, even those that are financially attractive to them and produce social benefits, such as reducing the long-term consequences of climate change. A behavioral risk audit demonstrates ways to address these cognitive biases, in concert with short-term economic incentives, social influences and regulation to spark climate action now. We focus on the installation of solar panels and the additional use of solar energy, an issue that has global relevance. The behavioral risk audit offers a way to guide decisions on how to incentivize and accelerate diffusion of solar in the United States and offers lessons for other countries. [from Kunreuther, Polise & Spellmeyer Working Paper 28678 DOI 10.3386/w28678

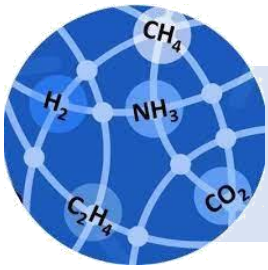
Further reading : Issue Brief: The Ostrich Paradox: Why We Underprepare for Disasters, https://riskcenter.wharton.upenn.edu/wp-content/uploads/2019/03/Ostrich-Paradox-issue-brief.pdf

"Research in cognitive psychology and behavioral economics suggest that most disaster preparedness errors can be traced to the effects of the following six decision-making biases:

- Myopia – a tendency to focus on overly short future time horizons when appraising immediate costs and the potential benefits of protective investments.
- Amnesia – a tendency to forget too quickly the lessons of past disasters.
- Optimism – a tendency to underestimate the likelihood that losses will occur from future hazards.
- Inertia – a tendency to maintain the status quo or adopt a default option when there is uncertainty about the potential benefits of investing in alternative protective measures.
- Simplification – a tendency to selectively attend to only a subset of the relevant facts to consider when making choices involving risk.
- Herding – a tendency to base choices on the observed actions of others"

More info on the speaker:

Howard Kunreuther is the James G. Dinan Professor Emeritus of Decision Sciences and Public Policy, and Co-Director Emeritus of the Wharton Risk Management and Decision Processes Center at the University of Pennsylvania. Howard has a long-standing interest in ways that society can better manage low-probability, high-consequence events related to technological and natural hazards. He is a fellow of the American Association for the Advancement of Science and a distinguished fellow of the Society for Risk Analysis, and recipient of the Shin Research Excellence Award from the Geneva Association and International Insurance Society in recognition of his outstanding work on the role of public-private partnerships in mitigating and managing risks. Recent books include *The Ostrich Paradox: Why We Underprepare for Disasters* (with R. Meyer, Wharton School Press; https://wsp.wharton.upenn.edu/book/ostrich-paradox/).



TOPIC 3: Carbon Dioxide Is "from waste to resource" building a circular economy?

Wednesday
8:15 AM-12:30 PM

Room: Paraché Lecture Theatre
Remote connection:
https://cnrs.zoom.us/j/96352435735?pwd=ZFBZdjNqVW1xSDR3K3JLYlgxVjJQZz09
Meeting ID: ***963 5243 5735***
Passcode: ***CEC_CO2***

Discussion leader: T. Cantat (CEA)
Speakers:

- *J.C. Pereau (Bordeaux school of economics)* ***"A game-theoretic interpretation of the climate change negotiations"***
- *M. Sorensen (Haldor Topsoe)* ***"CO_2 emission management via production of fuels"***
- *W. Leitner (MPG Mulheim)* ***"Chemical Synthesis using CO_2: From Molecules to Processes (and back)"***
- *A. Bardow (ETHZ)* ***"What to do with CO_2? A life cycle perspective"***

Introduction to Session 3: CO_2

Current economies emit enormous amounts of CO_2 mostly because of the use of fossil resources, such as coal, gas and oil. Yet, a complete decarbonisation of energy mixes is highly unlikely in the future, as some uses for carbon must be maintained and cannot be electrified. This is the case for instance for the production of chemicals but also liquid fuels for long-range transportation. How can we reach carbon neutrality while continuing to utilize carbon based products? What is the place for CO_2 capture, storage and/or utilization?

Selected readings

- *Novel Carbon Capture and Utilization Technologies, Research and Climate Aspects*, SAPEA Report 2017, https://www.sapea.info/wp-content/uploads/CCU-report-May2018-3.pdf

- *Green Carbon Science: Efficient Carbon Resource Processing, Utilization, and Recycling towards Carbon Neutrality***,** M. He, Y. Sun, B. Han, *Angew. Chem. Int. Ed.* **2022**, DOI: 10.1002/anie.202112835.

More info on the Discussion Leader

Thibault Cantat is a Research Director and the Head of the Carbon Circular Economy program at CEA, where he works on the activation of CO_2 and its catalytic conversion using molecular systems, including organometallic complexes and main group elements compounds. The general topic of his research is the development of novel catalytic reactions for the efficient reduction of CO_2 and biomass. His research interests therefore span organometallic chemistry of the transition metals and the f–elements to homogenous catalysis and computational chemistry.

Thibault studied chemistry at the École Normale Superieure in Paris and obtained his Ph.D. in Chemistry in 2007, under the supervision of Dr. Nicolas Mézailles and Prof. Pascal Le Floch, at the Ecole Polytechnique. He then became interested in the unique chemical behaviors of the early actinides and he held a joint Director's Postdoctoral position at Los Alamos National Laboratory (USA) in the groups of Dr. Jaqueline Kiplinger, Dr. Enrique Batista and Dr. P. Jeffrey Hay. He joined CEA in 2009 where he is leading the Laboratory of Molecular Chemistry and Catalysis for Energy since 2016.

A game-theoretic interpretation of the climate change negotiations

Jean-Christophe Pereau
Bordeaux school of economics
jean-christophe.pereau@u-bordeaux.fr

We describe in this paper an evolutionary game theoretic model aiming at representing the climate change negotiation. We show on that framework that a third significant alternative to the binary coordination-defection strategies needs to be considered: a unilateral commitment as precautionary strategy. As a means to widen cooperation, we examine the influence of linking environmental and trade policies via the implementation of a trade penalty on non cooperative behaviours.

[from abstract of "**An Evolutionary Approach to the Climate Change Negotiation Game"**
Pereau, Courtois & Tadzaït, /SSRN-Electronic-Journal-1556-5068
10.2139/ssrn.291939

More info on the speaker:

Jean-Christophe PEREAU, is Professor of Economics at the University of Bordeaux. His major research interests include environmental economics, game theory and bargaining, dynamic systems. Precisely, his work uses bio-economic and hydro-economic models, quantitative methods and game theory tools to address economic issues such as the international negotiations over global public goods, the management of renewable resources and biodiversity, the implementation of market-based instrument like fisheries and water resources, the design of payment for ecosystem services for ecosystems like wetlands. For more information https://www.bse.u-bordeaux.fr/membres/jean-christophe-pereau/.

CO_2 emission management via production of fuels

Martin Dan Palis SØRENSEN

Haldor Topsoe (DK)

mps@topsoe.com

Synthetic fuels derived from CO_2 and H_2 represents an important part of the Power-to-Fuel concept needed to achieve sustainability in the transport sector. This presentation introduces the Power-to-Fuel concept with focus on sustainable gasoline from e-methanol. The main process steps involved are; electrolysis, CO_2 recovery, methanol synthesis, and gasoline synthesis via the methanol-to-gasoline route over a zeolite-based catalyst. The methanol technology is well-proven in the industry; however, a new catalyst has been developed that favours higher methanol formation rate in a CO_2 rich synthesis gas. The e-methanol is converted into high octane gasoline ready as a direct "drop-in fuel" using the TIGAS (Topsoe **I**mproved Gasoline) technology. The TIGAS process was commercialized in a 15,500bpd (barrel per day) gasoline plant in Turkmenistan in 2014. The development of the TIGAS process from pilot plant data will be used as an example to show how scientists in Topsoe combine fundamental understanding, testing, and rigorous modelling to provide the basis for commercializing new technology.

More info on the speaker:

Martin Dan Palis Sørensen is a Principal Scientist with a background in chemical reaction engineering and has been working in R&D for 18 years at Haldor Topsoe within a wide range of areas such as catalyst development and testing in small-scale equipment, scale-up, process development and optimization, kinetic and reactor modelling, demonstration of new technology in larger scale pilot/demo plants, start-up supervision and operational optimization of commercial plants. Main research area is production of synthetic fuels for both road transport and aviation.

Chemical Synthesis using Carbon Dioxide: From Molecules to Processes (and back)

Walter Leitner
MPG Mulheim
walter.leitner@cec.mpg.de

The catalytic conversion of carbon dioxide to energy carriers and chemicals is a major pillar of future technologies coupling the energy and chemical industrial sectors. In favourable cases, CO_2 can replace petrochemical feedstocks contributing to more sustainable production processes of large volume chemicals and polymers already today. In context of storing, using, and harvesting carbon-free electricity, CO_2 is also envisaged as feedstock for so-called "power-to-x"-technologies. The talk will focus on fundamental scientific challenges and present successful examples for application, while critically discussing the challenges and opportunities of these concepts.

More info on the speaker:

Walter Leitner is Director at the Max Planck Institute for Chemical Energy Conversion (MPI CEC) in Mülheim an der Ruhr and holds the Chair of Chemical Technology and Petrochemistry at RWTH Aachen University. His research focusses on a molecular approach to catalysis motivated by the principles of Green Chemistry. Main research topics are the selective conversion of CO_2 and biomass as well as the use of advanced reaction media such as supercritical fluids, ionic liquids, and multiphasic systems. From 2004 - 2016, Walter Leitner served as Scientific Editor and Chairman of the Editorial Board of the Journal "Green Chemistry" and since 2018 he is a Scientific Advisory Editor of "Angewandte Chemie".

What to do with CO_2 ? A life cycle perspective

André Bardow

ETH ZÜRICH, (CH)

ABARDOW@ETHZ.CH

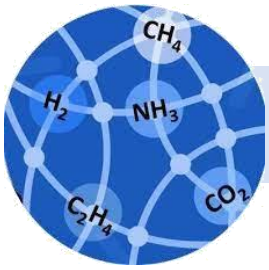
Carbon dioxide emissions from fossil resource use are the primary driver of climate change. Fossil resources, therefore, have to be replaced both as energy providers and chemical feedstock. While wind and power provide renewable electricity, carbon could be obtained from the – unfortunately – abundantly available greenhouse gas CO_2.

In this presentation, we will discuss different pathways to use CO2 as carbon feedstock. While using a GHG as feedstock intuitively suggests climate benefits, CO2 use is usually energy-intensive. Thus, climate benefits are not guaranteed. Therefore, we employ life-cycle assessment (LCA) to identify potential bottlenecks, promising products and quantify the potential contribution of CO2 use towards carbon-neutral societies.

More info on the speaker:

André Bardow has been full professor for Energy and Process Systems Engineering at ETH Zurich since 2020. Previously, he was a professor and head of the Institute of Technical Thermodynamics at RWTH Aachen University (2010-2020); and associate professor at TU Delft (2007-2010). From 2017 to 2022, he was also the director of the Institute for Energy and Climate Research (IEK-10) at Forschungszentrum Jülich, Germany. He was a visiting professor at the University of California, Santa Barbara (2015/16). He earned his Ph.D. degree at RWTH Aachen University.

Prof. Bardow is a fellow of the Royal Chemical Society and chairs the Technical Committee for Thermodynamics of VDI – The Association of German Engineers. He received the Recent Innovative Contribution Award of the CAPE-Working Party of the European Federation of Chemical Engineering (EFCE) in 2019, and the PSE Model-Based Innovation (MBI) Prize by Process Systems Enterprise in 2018. He was the first recipient of the Covestro Science Award. In 2009, he received the Arnold-Eucken-Award of the VDI-Society for Chemical Engineering (GVC). He is the recipient of RWTH's "FAMOS für Familie" award for family-friendly leadership, and of teaching awards at RWTH and TU Delft.



TOPIC 4: Ammonia
From fossil-based to fossil-free routes.

Thursday *Room: Paraché Lecture Theatre*
8:15 AM-12:15 PM *Remote connection:*
https://cnrs.zoom.us/j/98067351361?pwd=eDdseXlscU5VQ0Q1Rk9MVElKai9FZz09
Meeting ID: **980 6735 1361**
Passcode: **CEC_NH3**

Discussion leader: A. Quadrelli
Speakers

- *T. M. Nguyen (Haldor Topsoe)* ***"Current industrial NH_3 production and path to the future"***
- *R. Ingels (N2 Applied)* ***"Do we need the Haber Bosch? Insight from Plasma chemistry"***
- *Chorkendorff (DTU)* ***"Electrochemical Reduction of N_2 to NH_3"***

Introduction to session: Amonia

"A strategic choice at the dawn of the twentieth century, the Haber-Bosch process for chemical ammonia production from airborne nitrogen quickly turned into a vital resource. The chemical fertilizers derived from ammonia became instrumental in feeding an exponentially growing population. Almost one century later, dramatically poor nitrogen usage is complicating this life-enabling technology with life-threatening water and air pollution. How does ammonia production fit within the planetary nitrogen cycle at the basis of nutrition? To what extent can the impact of ammonia production be reduced without compromising food production? Are there alternatives to the Haber-Bosch process and at what costs? Can we promote the sustainable use of this essential element? "

From https://www.euchems.eu/nitrogen-workshop/

You are invited to attend such European Chemical Society, EuChemS, science policy workshop '*The Nitrogen Element – Sustainable food production*?'. The free online event will be held on 26 April 2022, from 10:00 to 16:30 CEST. Program and registration on the webpage adress above

Selected readings

Sutton M.A., et al (2013) "Our Nutrient World: The challenge to produce more food and energy with less pollution." Global Overview of Nutrient Management. Centre for Ecology and Hydrology, Edinburgh on behalf of the Global Partnership on Nutrient Management and the International Nitrogen Initiative. ISBN: 978-1-906698-40-9

Fowler D et al. 2013 The global nitrogen cycle in the twenty-first century. Phil Trans R Soc B 368: 20130164. http://dx.doi.org/10.1098/rstb.2013.0164

RSC Policy Briefing « Ammonia: zero-carbon fertiliser, fuel and energy store » Issued: February 2020 DES5711 ISBN: 978-1-78252-448-9 © The Royal Society
https://royalsociety.org/topics-policy/projects/low-carbon-energy-programme/green-ammonia/

More info on the Discussion Leader

Alessandra Quadrelli 's info can be found in "School motivation" section …

Current industrial NH_3 production and path to the future

Thoa Minh Nguyen
Haldor Topsoe
TTMN@topsoe.com

Ammonia is vital in the modern society for fertilizer production in agriculture to boost food production. Its commodity nature means that it is of desire to produce ammonia at the lowest possible cost. The main feedstock utilized is natural gas and great efforts have been put into improving the process efficiency. However, ammonia production still accounts for 2% of the world total energy consumption and 1% of the world CO_2 emission. This presentation will give an overview of how ammonia has been produced industrially in the last decades and how renewable energy and the wish to combat climate change are beginning to shape a new future for ammonia production, where there is room for new technologies. Different production routes with (substantially) reduced CO_2 emission will be presented together with their advantages and main challenges.

More info on the speaker:

Thoa Nguyen is currently R&D Senior Director at Haldor Topsoe, a Danish company supplying catalysts, technology, hardware and engineering for the Chemicals, Clean Fuels and Clean Air industries. She has been with Haldor Topsoe R&D since 2008 and been working in a number of different processes, such as ammonia, reforming, water-gas-shift, etc., both within catalyst and technology development, having roles from research engineer to project manager and people manager. In her current role, she has the overall responsibility for technology development within gasoline, diesel, marine and jet fuel, taking them from ideas to the lab, pilot and subsequently to commercialisation. She completed her Ph.D. at Cambridge University, UK using magnetic resonance imaging (MRI) on trickle-bed reactors after graduating from Adelaide University, Australia in Chemical Engineering.

Do we need the Haber Bosch?

Rune Ingels
N2 Applied(NO)
rune.ingels@n2.no

The Haber Bosch process making ammonia. The process depends on energy to make hydrogen for the catalytic synthesis of ammonia, NH3. The process is energy efficient when methane is used both as energy and hydrogen source. The process is far less efficient when coal or electricity is used as energy source.
Science and the fertiliser industry has concluded that 40-50% of the world population is kept alive due to the Haber Bosch. This is also why the Haber Bosch still is seen as a strategic technology for global and local food security.
The paradigm shift away from fossil fuels to renewable energy and recycling of nutrients, is therefor going to be a critical shift. The fertiliser technologies with low to zero CO2-footprint are available. The timing and mechanism for phasing fossil out and renewable in will be critical, and we have already got a taste of the unpredictable forces being released.

More info on the speaker:

M.Sc. Chemical Engineering, Institute of Technology, University of Trondheim, Norway.
Yara Int. 1982-2010. Process Engineer production of Green Ammonia, Licensing Fertilizer Technologies to China, R&D Director Yara Technology, VP Technology Strategy.
Seconded to Qafco 1987-1993 and seconded to Lifeco 2009-2015. CEO Tinfos ASA 2015-2017. Operating, financing, and constructing Small scale Hydro Electric Power Plants. CTO N2 Applied 2010- .
Co-founder of a plasma-based nitrogen fertilizer technology company. The technology is processing livestock slurry making Nitrate Enriched Organic fertilizer, NEO. Stopping ammonia and methane emissions.

Electrochemical Reduction of N_2 to NH_3

Ib Chorkendorff

SurfCat, Physics Department, Technical University of Denmark

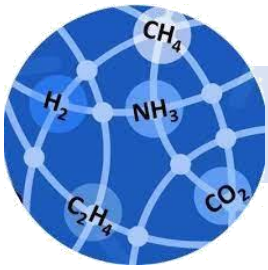
ibchork@fysik.dtu.dk

We have for more than 15 years tried to activate molecular nitrogen electrochemically at ambient conditions and have made ammonia many times, however, when we performed the appropriate control experiments, we found that it was only impurities that were converting into ammonia. This also applies for many of the studies also published in the literature we tried to reproduce. Recently we found that a method published by Tsuneto et al. 25 years ago worked and proved that by simultaneous depositing Li in an N_2 atmosphere it was indeed possible to synthesize ammonia. We shall discuss these results and the methods making us confident that we actually did activate N_2. A very simple model for the synthesis has been proposed and based on this insight devised experiments that significantly improved the Faradaic and energy efficiency by oscillating the potential. Further improvements have been gained by controlling the oxygen content and by synthesizing of high area electrodes leading to Faradaic efficiency of ~80% and current densities above 100 mA/cm^2. Despite this excellent recent progress there are still substantial outstanding questions concerning the energy efficiency which will also be discussed.

More info on the speaker:

Ib Chorkendorff is Professor in Heterogeneous Catalysis at DTU- Physics. He earned his PhD in 1985 Odense University Denmark, and after a post-doc at University of Pittsburgh, USA, he was employed in 1987 at DTU where he became full professor in 1999. From 2005-2016 ne was director of Danish National Research Foundation Center for Individual Nanoparticle Functionality (CINF) and from 2016 he has been director of The Villum Center for the Science of Sustainable Fuels and Chemicals (V-SUSTAIN). He has author or coauthored more than 390 scientific papers, 22 patents and one textbook "Concepts of Modern Catalysis and Kinetics". Professor Chorkendorff's work is a surface science approach to heterogeneous catalysis including thermal,Professor electro-, and photo-catalysis.

He has since 2017 been listed as Highly Cited Researcher (ISI) (top 1%). Ib Chorkendorff's research activities focus on finding new catalysts for improving sustainable energy production/conversion and for environmental protection. He is co-founder of three start-up companies RENCAT APS, HPNOW APS and Spectroinlets APS



TOPIC 5: (Bio-) Polymers Carbon-based feedstocks.

Friday *Room: Paraché Lecture Theatre*
8:15 AM-12:30 PM *Remote connection:*
https://cnrs.zoom.us/j/99559259999?pwd=TVJHa0ZQMHpwcHdoOFRCdnFPZVZYQT09
Meeting ID: **995 5925 9999**
Passcode: **CEC_POLY1**

Discussion leaders: E. Groppo, (U. Torino)

- *N. Friederichs (Sabic)* ***"Catalysis as a key enabler towards circularity polyolefins"***
- *V. Monteil (CNRS)* ***"Chemical Recycling of Polymers: Focus on Polyolefins"***

K. Barta (Uni Graz) ***"Biorefinery strategies for the production of polymers from lignocellulose"***

F. Picchioni (U Delft) ***"Biomass & biopolymers. Going "green" is not enough?"***

C. Perego (Former ENI) ***"Biofuels: Waste to Fuel in the Age of Circular Economy"***

Introduction to Session 5: Polyolefin and biopolymers

Plastics are the most extraordinary, but controversial, legacies of the twentieth century: they have brought enormous benefits to different sectors, but their production and end-of-life management strategies impact negatively on the environment and represent an ever-growing challenissemer
mge for our society. This holds true especially for polyolefins, which account for about 50% of the global plastics demand. According to the "European Strategy for Plastics in a Circular Economy", launched at the beginning of 2018, the whole plastics value-chain has to be rethought and improved in order to create a new plastic economy. Relevant actions would involve: 1) the use of renewable resources instead of fossil fuels for plastics production; 2) an elongation of the plastics lifetime through plastic design (e.g. specialty polyolefins), and 3) the development of efficient strategies for upcycling plastic waste, as a feedstock for the production of value-added monomers. The extraordinarily success in plastics story in the last century was driven by the innovations in catalysis, engineering and processing. In the same way it is expected that catalysis will play a major role also in the modern economy, providing many exciting opportunities for scientists in polymer science and plastics upcycling, which at the same time will have a huge impact on the society and is expected to increase the profitability of the sector.

Selected readings

- *A European Strategy for Plastics in a Circular Economy, http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:28:FIN*
- *Coates, G.W., Getzler, Y.D.Y.L. Chemical recycling to monomer for an ideal, circular polymer economy. Nat Rev Mater 5, 501–516 (2020). DOI:10.1038/s41578-020-0190-4*
- *Hillmyer, M. A. The promise of plastics from plants. Science 358, 868-870 (2017). DOI: 10.1126/science.aao6711*
- *Albertsson, A. C., Hakkarainen, M. Designed to degrade. Science 358, 872-873 (2017) DOI: 10.1126/science.aap8115*

More info on the Discussion Leader

Elena Groppo was born in 1978. She graduated in Materials Science at the University of Torino in 2002, and in 2006 she received the PhD degree under the supervision of Prof. A. Zecchina. Currently, she is associate Professor in Physical Chemistry at the Department of Chemistry of the University of Torino. In 2014 she was awarded the Ivano Bertini Gold Medal from the Italian Chemical Society (SCI). Her research interests are mainly focused on the understanding the physical-chemical working principles of heterogeneous catalysts by applying a multi-technique approach, comprising in situ and operando spectroscopic techniques. Most investigated systems are heterogeneous catalysts for olefin polymerization and supported metal nanoparticles for selective hydrogenation reactions. Elena Groppo is author of 150 papers, which have received more than 5900 citations (H-index: 41), and she is editor of "Catalysis Today" journal.

Catalysis as a key enabler towards circularity polyolefins

Nic. Friederichs

SABIC Technology Centre Europe

Nicolaas.Friederichs@SABIC.com

Polyolefins, notably polyethylene and polypropylene, constitute more than 50% of the annual polymer demand. Although polyolefins are produced from very simple monomers like ethylene and propylene, they are extremely versatile in their applications ranging from “simple” packaging materials towards long lasting pressure pipes and even artificial joints for in-body usage. These simple building blocks combined with the broad application range makes polyolefins intrinsically suited for circularity in which the polymers are reused after serving their initial purpose. The road towards full circularity of plastics requires many technical challenges in which the catalysts that are used to aim at a specific molecular topology in polyolefins continue to play an important role.

More info on the speaker:

After completing his BSc educations in both Organic Chemistry as well as Process Technology, Nic. Friederichs started his industrial career in 1986 at DSM, the Netherlands, working on organometallic catalysts for the production of polyolefins. After spending five years at a DSM/ExxonMobil joint venture called DEX-Plastomers, working on the implementation of so-called metallocenes in commercial polyolefin production, he spent another 2 years at DSM and since 2002 he has been working for SABIC, after SABIC’s acquisition of DSM’s petrochemicals division. Over the years, he has been involved in R&D for a wide variety of polyolefins, including polyethylene, polypropylene, EPDM and UHMWPE, focusing on the interplay between catalysis, process technology and material properties. Currently he is a Chief Scientists within the Corporate R&D department of SABIC, focusing on polyolefins, still the most versatile class of polymers.

Chemical Recycling of Polymers: Focus on Polyolefins

Vincent Monteil

CP2M: CNRS / University of Lyon / CPE Lyon (F)

vincent.monteil@univ-lyon1.fr

Considering polymers, and particularly the ubiquitous and most produced polyolefins, under the prism of circular economy has led to an increase demand of (chemical) recycling solutions.

Chemical recycling of polyolefins is not an easy task. By pyrolysis at 600-900 °C pyrolysis crude oils are produced mainly used as fuels. Up to 45% of monomer (ethylene) can be recovered under certain process conditions. Introduction of catalysis mainly allows to decrease degradation temperature and to be more selective.

More info on the speaker:

Vincent Monteil obtained his Ph.D. from the University of Lyon in 2002 where he worked on catalytic copolymerization of ethylene and butadiene. He subsequently moved to the group of Stefan Mecking (University of Freiburg then Constance) as a postdoctoral researcher working on catalytic polymerizations in water. In 2005, he returned to Lyon as a CNRS Research Associate. He became CNRS Research Director in 2017. His research interests deal with catalysis at polymer' service: the synthesis of polyolefins by catalytic and/or radical polymerization, the use of catalysis for polymer crosslinking (silicones, polyurethanes) and more recently with chemical recycling of polymers such as polyolefins, silicones… (catalytic depolymerization, upcycling). He is Junior Distinguished Member of French Chemical Society (SCF) since 2017 and received the Young Researcher Prize of Catalysis Division of SCF in 2014 and the bronze medal of CNRS in 2011.

Biorefinery strategies for the production of polymers from lignocellulose

Katalin BARTA
U. Graz (AU)
k.barta@rug.nl

The production of polymers from lignocellulose is an interesting direction challenged by the complexity of the starting material. In this talk I would like to give insight to our strategies that consider the conversion of lignocellulose into bio-based polymers, with focusing on integration of such approaches into appropriate biorefinery schemes. Since lignin depolymerization results in mixtures of compounds that challenge practical applications, we developed simple catalytic funnelling strategies for the conversion of lignin-derived mixtures to aliphatic alcohols. First, I would like to present a biorefinery strategy for converting RCF-based bio-oils into fully bio-based polyesters that may serve as analogues for PET. Second, I would like to show the sequence of steps that allow to obtain a single well-defined diol and diamine and ultimately fully-lignin based polybenzoxazines from technical lignins that are relevant as large-scale side-products in the paper and pulp industry.

More info on the speaker:

Katalin Barta is full professor at the University of Graz, leading the unit sustainable catalysis. Her research focuses on green chemistry, catalysis and renewable resources. She is member of the Young Academy of Europe and secretary of the EuChemSoc Green Chemistry division and Co-Chair of the Gordon conference in lignin valorization. She is recipient of the ERC Starting Grant 2015 and an EIC Transition grant of 2.5 million for bio-based products. The group's research in sustainability and green chemistry was recognized by the 2020 ACS Sustainable Chemistry and Engineering Lectureship award, the first NCCC award in 2019. She obtained her Ph.D. in 2008 at RWTH-Aachen, Germany in the group of Prof. Walter Leitner in homogeneous catalysis. She was a postdoctoral researcher (2008-2010) with Prof. Peter Ford at University of California, Santa Barbara and Associate Research Scientist (2010-2012) at Yale University, Center for Green Chemistry with Prof. Paul T. Anastas. She started her independent career as tenure track assistant professor at the Stratingh Institute of the University of Groningen, in 2013 where she was promoted to Associate professor in 2017.

Going "green" is not enough

Francesco Picchioni
U. Delft (NL)
f.picchioni@rug.nl

The use of biomass-derived monomers for the preparation of (novel) polymeric materials has been attracting the interest of academic and industrial research groups in the last two decades. Besides simple drop-in strategies, this has resulted also in the preparation of entirely new polymeric structures with a wide range of properties and application fields. In this lecture we will tackle some paradigmatic examples of such strategies by show casing our research based on vegetable oils and sugar derivatives. In the second part we will also illustrate some examples of biomass-derived materials displaying also the presence of covalent reversible networks. The conceptual combination of the latter with the biomass origin yields novel materials that are "green" but also recyclable.

More info on the speaker:

Prof. dr. Francesco Picchioni received his MSc (1996) and PhD (2000) degrees at the University of Pisa (Italy) working in the group of prof. F.Ciardelli on polymer functionalization and blending. After a postdoc (2000-2002) at the Technical University of Eindhoven (TUe, The Netherlands), he joined the University of Groningen (RuG, The Netherlands) first as Assistant and later as Associate (2008-2013) and full Professor (since 2014). He currently chairs the research group of Product Technology, which comprises at the moment 1 Associate Professor, 4 Assistant Professors and about 35 PhDs and PostDocs. His research interests include bio-based materials, thermally-reversible networks and material recycling.

Waste to Fuel in the Age of Circular Economy

Carlo PEREGO

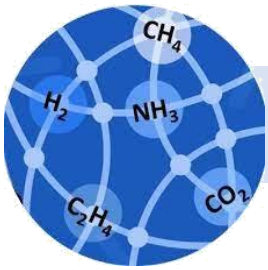
Former Senior Vice President of Eni S.p.A

Caregoperlo54@gmail.com

The indiscriminate use of resources, the accumulation of huge quantities of waste and the greenhouse gas emissions, are among the most urgent problems to be solved to contain the average temperature increase and safeguard the future of the planet. The transport sector alone contributes over 21% of total CO_2 emissions of the world. Hence replacing traditional fuels produced from oil, with biofuels, can help to fight the climate change. The biofuels currently available, bioethanol, biodiesel and Hydrogenated Vegetable Oil (HVO), are almost exclusively produced from raw materials competing with the food sector. For this reason, new legislation has evolved by promoting the introduction of advanced biofuels, produced from waste biomass (e.g. agricultural waste such as wheat straw or corn stalks, agroforestry residues, biomass cultivated for energy use on marginal land such as miscanthus, aquatic biomass, the organic fraction of urban waste, sludge from water purification plants, and livestock sewage), according to a circular economy approach. From a technological point of view, the processes for the production of these fuels can be classified as biochemical, thermochemical and synthetic catalytic processes.
The presentation will illustrate the most salient technological aspects of this industrial sector.

More info on the speaker:

Former Senior Vice President of Eni S.p.A he has more than 40 years' experience in R&D with competencies in the field of chemistry, oil & gas and energy business.
As director of the Renewable Energy and Environmental Research Center of Eni he had the responsibility of projects involving solar energy, biomass valorisation and environmental technologies - for 12 years.
He also served as SVP for R&D Energy Transition and Biomass Program dealing with energy transition from fossil fuels to renewables, biomass to energy vectors and circular economy. The program included R&D projects for the valorisation of natural gas as bridge between fossil and renewable fuels; solar H_2 technology production; CO_2 capture and utilization; waste to energy; residual biomass from agriculture and forestry, algae, energy crops, into renewable fuels.
He served as President of Industrial Chemistry Division of Italian Chemical Society and member of Catalysis Commission of International Zeolite Association.
He is inventor of 58 patents, and author or co-author of 100 scientific publications in international journals or books. He has delivered more than 90 presentations, including 25 invited and key note lectures in international conferences.



Closing Session:
Scenarios for the Energy Transition

Friday
2 PM-4:30 PM

Room: Paraché Lecture Theatre
Remote connection:
https://cnrs.zoom.us/j/93743615469?pwd=ZndDcXBiczEvSTJ0dkFXN09QRGNBZz09
Meeting ID: **937 4361 5469**
Passcode: **CEC_CONC1**

Scenarios for the Energy Transition
Discussion leader: F. Chandezon (CEA SUNERGY)

- *B. Weckhuysen (EFCATS)* ***"Role of catalysis in the energy transition & the Sunergy project"***

Final considerations
Session coordinated by A. Quadrelli (CNRS)

- *P. Anastas (Yale University)* ***"Reflections on the scientific method"***

Closing session - Scenarios for the Energy Transition.

As pointed again in the recently released reports from the International Panel on Climate Change, there is an urgent need of deep cuts in the world CO_2 and other greenhouse gases emissions if we want to limit the increase of global temperature to 1,5°C – 2 °C (as compared to the pre-industrial period). Current emissions are mostly due to a massive utilization of fossil resources combined with an unsustainable linear economy model. There is thus a need from shifting away from the utilization of fossil-resources and replacing them by renewable and low carbon sources whilst undergoing a transition from a linear to a circular society. As a future sustainable energy mix will combine different sources, this means building suitable transition scenarios taking into account the potential contribution of different renewable and low carbon energy sources, including emerging technologies. Renewable and solar fuels (or liquid sun) as addressed by the SUNERGY European initiative can take an important in such future energy mix and thus transition scenarios.

Selected readings

- SUNERGY European initiative: Fossil-free fuels and chemicals for a climate-neutral Europe

More info on the Discussion Leader

Frédéric Chandezon (55), Dr. Ing. Hab. holds an engineer degree in physics (1991) from the Physics and Chemistry school of Paris (ESPCI) and a Ph.D. degree from Grenoble University (1994). After a postdoctoral stay at the Niels Bohr Institute in Copenhagen, he joined CEA in Grenoble as research scientist (1996). His research interests included nanoparticles and nanomaterials for energy applications. He has an extensive experience in management and international cooperation. Until 2020, he headed the SyMMES laboratory, a CEA-CNRS-Grenoble University joint laboratory (total staff approx. 120) developing basic research on themes related to low carbon energy and health. From 2013 to 2020, he coordinated the EERA Joint Programme AMPEA (Advanced Materials and Processes for Energy Applications). Currently, he is in charge of European programmes on energy at the IRIG (Interdisciplinary Research Institute of Grenoble) institute. He is also deputy coordinator of SUNERGY, an European initiative gathering more than 300 organizations from academia (universities & RTOs), industry and society. SUNERGY overarching goal is the conversion and storage of renewable energy into fossil-free fuels and commodity chemicals for the chemical and fertilizers industries

SUNERGY INITIATIVE Unlocking the renewable energy future
Fossil-free fuels and chemicals for a climate-neutral Europe

Bert Weckhuysen
Utrecht Univerity (NL)
B.M.Weckhuysen@uu.nl

THE CHALLENGE we are facing: Running our entire world strongly depends on fossil-based energy sources and raw materials. Their intensive use over the last decades not only depleted the Earth's reservoirs, but also caused a significant increase of the carbon dioxide concentration in the atmosphere and therewith global warming, with tremendous consequences for ecosystems, resources and society in general. In the EU, the energy and transport sector generate the major part of greenhouse gas emissions, with 54% for energy and 24% for transport-related activities in 2016. These sectors remain central for economic growth, industrial competitiveness and quality of life. At the same time, the electrification of society continues to grow, with the need for efficient storage solutions. **THE SOLUTION we aim to provide** By using energy from renewable sources (sunlight, wind) and abundant molecules (CO2, water, nitrogen), we can produce fuels and chemicals that can contribute to stopping global warming: - Storage of renewable energy as liquid fuels- Production of fossil-free base chemicals for industry and agriculture- Technologies with a negative CO2 footprint
From https://www.sunergy-initiative.eu/about

More info on the speaker:

Bert Weckhuysen is since October 1 2000 Full Professor at Utrecht University (The Netherlands). Hi sreserach group he group is internationally known for the development of in-situ and operando spectroscopy and microscopy for studying catalytic solids under realistic conditions. This approach has provided unique insights in the working and deactivation mechanisms of catalytic processes, as well as in the internal architecture of solid catalysts
For his outstinding contributions, Bert Weckhuysen has received sevral prizes among which the the 2017 Xing Da Lectureship of Peking University, the 2018 Robert B. Anderson Award from the Canadian Catalysis Society and the 2019 Karl Ziegler Lectureship Award from the Max-Planck-Institut fur Kohlenforschung. (from https://www.uu.nl/staff/BMWeckhuysen/CV)
Bert is the president of EFCATS, European Federations of Cataysis societies . He also directs the European initiative, SUNERGY (www.sunergy-initiative.eu), to foster thescience and technology to produce fossil-free fuels and chemicals to create a circular society.

Reflexions on the scientific method

Paul Anastas
Yale University (USA)
paul.anastas@yale.edu

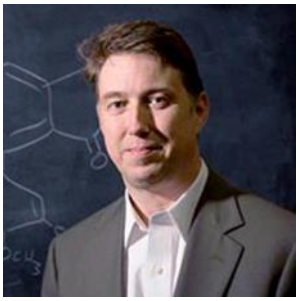
"Great breakthroughs in chemistry over the past two centuries have been accomplished largely through reductionist methods. However, the incredible sustainability challenges that we face as a civilization are systems challenges, requiring careful combination of knowledge gained from reductionist approaches with integrative-systems thinking to inform designs for a sustainable future."

Abstract of P. Anastas " Beyond Reductionist Thinking in Chemistry for Sustainability" Trends in Chemistry , 1, (2019), 145-148
https://doi.org/10.1016/j.trechm.2019.03.007

Suggested further readings:

Anderson, P.W. (1972) More is different. Science, 177, 393–396
L. Pauling, The Nature of the chemical Bond
Paul T. Anastas: Green Chemistry Next: Moving from Evolutionary to Revolutionary . Aldrichimica Acta, 48, (2015)

More info on the speaker:



Prof. Anastas serves as the Director of the Center for Green Chemistry and Green Engineering at Yale. Anastas took public service leave from Yale to serve as the Assistant Administrator for the US Environmental Protection Agency and the Agency Science Advisor from 2009-2012. From 2004 -2006, Paul Anastas served as Director of the ACS Green Chemistry Institute in Washington, D.C. He was previously the Assistant Director for the Environment in the White House Office of Science and Technology Policy where he worked from 1999-2004.

Trained as a synthetic organic chemist, Dr. Anastas received his Ph.D. from Brandeis University and worked as an industrial consultant. He is credited with establishing the field of green chemistry during his time working for the U.S. Environmental Protection Agency as the Chief of the Industrial Chemistry Branch and as the Director of the U.S. Green Chemistry Program. Dr. Anastas has published widely on topics of science through sustainability including eleven books, such as Benign by Design, Designing Safer Polymers, Green Engineering, and his seminal work with co-author John Warner, Green Chemistry: Theory and Practice. *Taken from : https://seas.yale.edu/*

Paul Anasts is the recipient of the 2021 Volvo Environment Prize Foundation.

Serious Games, Theatrical Workshops and posters *- abstracts & teachers' bios*

Monday **Economy**
5:15 PM- 6 PM or Room: Paraché Lecture Theatre
6:15 PM-7PM Pedagogy: Serious games (in half groups)

- *B. Ruffieux (U. Grenoble) and L. Aufenberg (Aufbenberg consulting)* ***"What can I learn from behavioral economics?"***

Monday ***9 PM-10:30 PM*** **Economy**
or Tuesday Room: Oerine Lounge (in satellite building)
Pedagogy: serious games (in half groups)

- *B. Ruffieux (U. Grenoble) & L. Aufenberg (Aufbenberg consulting)* ***"Debrief of Serious games on economics"***

Monday **Ethics**
5:15 PM- 6 PM or Room: Norma Room
6:15 PM-7PM Pedagogy: theatrical workshop (in half groups)

- *Maria Grace Salamanca Gonzalez (EUL-U. Lyon)* ***"Theatre to explore individual vs. Collective choices in science"***

Wednesday **Psychology**
9 PM-9:45 PM or Room: Oerine Lounge (in satellite building)
9:45PM-10:30 PM Pedagogy: Serious game (in half groups)

- *B. Ruffieux (U. Grenoble) & L. Aufenberg (Aufbenberg consulting)* ***"Cognitive biases"***

Tuesday-Friday **Critical Analysis**
1:15 **PM-2 PM** Room: Club 1 room
or 6:15 PM-7 PM Pedagogy: collective reflection (by group of 20)

- *J. Michel (EUL – U. Lyon)* ***"Take home message of the day"***

Monday to Friday **Video**
Free Schedule Room: Club 1 room
Individual

- *J. Kratochvil (EUL – U. Lyon)* ***"Video capsule"***

Tueasday to Friday **Poster Sessions**
10 AM-A0 :30 AM Room: Mezzanine

Theatre to explore individual vs. collective choices

Chemistry, chemists & ethics

Maria Grace Salamanca Gonzalez
Ecole Urbaine de Lyon (F)
mariagrace.salamanca@universite-lyon.fr

We will create collective spaces to question and share the ethical implications of the scientific practice of chemistry. Some of the questions we will study are: Are there any ethical dimensions to chemistry? Are there moral dilemmas in the practice of chemistry? How are they addressed? Who and how are they addressed? How do we decide while in "professional" contexts?
Methodologically, we will work both with the stablished tools of philosophy and through embodied theatrical exercises and experiments.

About the teacher

Post-doctoral researcher at the École Urbaine de Lyon. PHD in Philosophy did on a codirection between the University of Lyon and the research program "Social Actors of the medicinal Flore in Mexico" part of the National Institute of Anthropology and History. Specialist in the Epistemologies of the South. Theatre actress practicing decolonial aesthetics. Member of research and clinical ethics committees. Professor of ethics, bioethics and epistemology.

Bahavioral Economics

Bernard Ruffieux and Laurence Aufenberg
Grenoble INP, and Aufenberg conseils (F)
Bernard.ruffieux@grenoble-inp.fr Laurence@aufenberg.fr

On Monday afternoon, we shall Play Games. During 45 minutes, each participant will join one of the two groups and is going to participate, individually or collectively, to a series of approximatively twelve games. These aims at discovering basis strategic environments, what behavioral economics call "the grammar of behavior". Answers will be written, but will be kept anonymous. This first session will be active, quiet, reflective and organized.

On Monday or Tuesday evening, we shall look at Monday's Games. As at a meal of cannibals (*sic!*), you will be alternately eater and eaten. Tuesday, during a plenary session, Laurence and Bernard will show and comment what participants did in the twelve Monday games (statistical results will be enough, again, no individual name will be revealed). Empirical generalization will be presented, concepts defined, and we shall try to draw some lessons that may be retained for the future. This session will mainly mobilize Laurence and Bernard, who will present and comment on your behavior, while trying to answer all your questions.

About the teachers

Laurence Aufenberg *is a consultant accompanying companies in their transformation through coaching and training for over 14 years, after an experience of 15 years in the Liquified Petroleum Gas industry. Her favorite field of theory is psychological and physiological mechanisms at stake when human beings are confronted to change (biases, emotions, resistance, beliefs…). Her main field of practice consists in helping organizations or individuals to understand the (r)evolution happening in their context (industry or sector), to subsequently redesign their strategy and value proposition to adapt and survive, to measure the evolution of jobs and competencies required, and finally to implement a specific support or process to diminish resistance and engage (oneself or employees) in change.*

Bernard Ruffieux *is a Professor of Economics at the University of Grenoble. His research focuses on behavioral economics, using experimental methods. His favorite theoretical field is consumer's willingness to pay for special product characteristics such as novel, hidden, threatening in the individual long run or affecting the common good. He recently investigates consumer food purchasing behavior toward nutritional and environmental characteristics, contributing to the design of front-of-pack logos for the French government. His present works also are in industrial forecasting, metacognition, and pricing.*

Cognitive Biases in Psychology

Laurence Aufenberg and Bernard Ruffieux
Aufenberg conseils (F) and Grenoble INP,
Laurence@aufenberg.fr Bernard.ruffieux@grenoble-inp.fr

We Shall Explore our Emotions and Cognitive Biases Facing the Issue: "Personal change and climate change". This last session will be dedicated to the theme of the CNRS School, under psychological views. After a formulating the professional consequences (as a researcher) of the question addressed during the CNRS School, Laurent and Bernard will help each individual and the group to explore and share resulting emotions and cognitive biases. The aim here is to reveal both the drivers and the stoppers of a researcher facing change and challenge. This session will be of a new kind for Laurence and Bernard. They will use tools never used before neither in teaching, research or coaching. This will be exploratory for all of us.

About the teachers

See Laurence's and Bernard's bios in the previous page

Take Home message

Juliette Michel
Ecole Urbaine de Lyon (F)
Juliette.michel@universite-lyon.fr

With this workshop we aim to structure a synthesis of the exchanges on each topic by collecting and discussing personal and collective feedback on the day's events. By repeating the workshop for each session, we will try to map the connection between each subject, but also with the broader shifting techno-economic panorama.

The objectives of this participatory workshop are to build a take home messages for each session but also the week as a all by providing an overview of interrogations and perspectives that may emerge from the Winter School, for its participant but also a broader audience.

Biography

Juliette Michel has a PhD in social geography. After a thesis on aging, health and social participation, in a framework of interdisciplinary and participatory research, she joined the Urban School of Lyon as a post-doctoral fellow in charge of the development, follow-up and valorization of the projects of the Fabrique des Questions Simples, an interdisciplinary group that aim to reflect and experiment new ways to conduct research in the Anthropocene era.

Video capsule

What is the key message of the day?

Jindra Kratochvil
Ecole Urbaine de Lyon (F)
jindra.kratochvil@universite-lyon.fr

Join our "video booth" to share with the world (and with your distant colleagues) your point of view. Use our set-up to record a short video message about what really needs to be highlighted. You can pick-up one of the slides seen previously during the day and tell us why it grabbed your attention so much. You can become a spokesperson for a group and emphasize the outcome of your passionate discussions!

Biography

Head of audio and video activities of the Lyon urban school. Helping teams of researchers, students, partners to share – often online – the state of their art: conferences, public lessons, conversations, debates, interviews, presentations, live streaming, podcasts etc. Convinced that knowledge needs and deserves to get in shape to be shared, spread, understood, discussed, improved. Which means (more than ever) that creativity, experimentation, and communication skills are mandatory.
He would never have believed that science would need so much to be defended in the public space. But as 9% of French citizens believe that the Earth is flat, he tells himself that even the most basic scientific thinking is not obvious.
Deeply involved, within the team of Lyon urban school, in the transdisciplinary studies of the urban Anthropocene. How could we take the measure of the impact of human activities on the local and global scale? How could we possibly avoid putting in danger the balance that allows Earth to be a livable place?

Posters

# 1	Barbara	CENTRELLA
	U. of Turin	Synthesis of complexes and MOFs
# 2	Alessia	AMODIO
	U. of Turin	Heterogeneous and homogeneous…
# 3	Anthony	ROPP
	Sorbonne U.	Nanocatalysis, Synthesis of nano..
# 4	Pascale	CHENEVIER
	U. Grenoble Alpes	chemistry, nanomaterials for energy
# 5	Antonietta	MANCUSO
	U. of Salerno	Industrial Catalysis
# 6	Cyprien	POUCIN
	Sorbonne U.	Nanoparticle synthesis for catalysis
# 7	Dong	CHUAN-DING
	ZheJiang U.	density functional theory (DFT). ..
# 8	Davide	SALUSSO
	U.y of Turin	CO2 chemical recycling
# 9	Huan	DOAN
	U. of Bristol	Porous materials, catalysis, CO2…
# 10	Niklas	VON WOLFF
	CNRS/U. of Paris,	Alcohol oxidation, electrificiation, CO2 …
# 11	Eva	PUGLIESE
	U. Paris Saclay,	Artificial photosynthesis for CO2…
# 12	Clara	LARGHI
	Politecnico di Milano	Catalysis of CO2 reutilization
# 13	Katarzyna	SWIRK
	Norwegian U. of Science and Technology,	heterogeneous catalysis for chemical CO2 utilization
# 14	Jithin	GOPAKUMAR
	Norges teknisk-naturvitenskaplige U.	Chemical Engineering - Catalysis
# 15	Veronica	PIAZZA
	Politecnico di Milano, LCCP	Biomass to fuels: development of thermochemical …
# 16	Julia	WOHLAND
	RWTH Aachen	Heterogeneous catalysis, gas phase catalysis
# 17	RICCARDO	BACCHIOCCHI
	Bologna U.	Heterogenous Catalysis
# 18	Keanu	BIRKELBACH
	RWTH Aachen	Solid molecular catalysts, immobilized catalysts
# 19	Luca	MAGGIULLI
	ETH Zuerich, Paul Scherrer Institut	Heterogeneous catalysis
# 20	Ludivine	KBIDI
	Sorbonne U. IPCM	Molecular Chemistry
# 21	Marie-Hélène	PIETRARU
	U. Paris-Saclay	Molecular chemistry and catalysis
# 22	Maximiliano	RODRIGUEZ
	U. catholique de Louvain	Heterogeneous Catalysis
# 23	Patrick	DA COSTA
	Sorbonne U.	Catalytic CO2 utilization / Plasma-…
# 24	Oleg	USOLTEV
	Southern Federal U.	Physics and chemistry
# 25	Rudy	CALLIGARO
	U. of Udine	Energy and Environmental Engineering
# 26	Gabriele	DEPLANO
	U. degli studi di Torino	Physical chemistry, catalysis
# 27	Savarithai Jenani	LOUIS ANANDARAJ
	RWTH Aachen	CO2 Hydrogenation and metal …
# 28	Sebastian	SEIDEL
	RWTH Aachen U.	Technical application of CO2 …
# 29	Silvia	MAURI
	U. degli studi di Trieste	X-Ray absorption spectroscopy …
# 30	Abdelrahman	MOSTAFA
	Politecnico di Milano	Hydrogen production from renewable sources
# 31	Vittoria	TROISI
	Politecnico di Milano	Energy and Nuclear Science and Technology
# 32	Valeria	FINELLI
	U. degli Studi di Torino	Spectroscopic Characterization
# 33	Filippo	BUTTIGNOL
	Paul Scherrer Institut, - EPFL,	Applied catalysis and spectroscopy
# 34	Shengfei	WANG
	MINES ParisTech, PSL	Non-thermal plasma-catalysis, Dry reforming, CO2 utilization
# 35	Yingrui	ZHAO
	Uclouvain,	carbon dioxide conversion
# 36	Petter	TINGELSTAD
	Norwegian U. of Science and Technology	Catalysis in biomass pyrolysis and conversion
# 37	Margherita	CAVALLO
	U. of Turin	Physical Chemistry
# 38	Sara	D'ANIELLO
	U. degli studi di Salerno	Catalysis
# 39	CHANJUAN	ZHANG
	U.é Paris Saclay, ICMMO	Heterogeneous CO2 electrocatalysis with metal porphyrins
# 40	Francesco	BATTISTELLA
	Politecnico di Milano, Department of Energy	Household-scale hydrogen systems
# 41	Prince	AMANIAMPONG
	U. of Poitiers	Sonochemistry and Catalysis
# 42	Maria Carmenza	DIAZ LACHARME
	Politecnico di Milano	Laboratory of catalysis and catalytic …

Practicals *- Abstracts and teacher's bios*

____Each participant selects one for Wednseday and one for Thursday_____

Wednesday and Thursday 5 PM-7 PM — **Spectroscopy**
Room: Paraché Lecture Theatre
Pedagogy : interactive teaching (up to 40 participants)

- *Silvia Bordiga (U. Torino) Matteo Signorile (U. Torino) E. Groppo (U. Torino)*

Wednesday 5 PM-7 PM — **Heterogeneous Catalysis & adsorption: Introduction**
Room: Echelle room
Pedagogy: Problem based learning (up to 20 participants)

- *Alessandra Quadrelli (CNRS)*

Wednesday And Thursday 5 PM-7 PM — **Heterogeneous Catalysis: Advanced**
Room: Rateau room
Pedagogy : Systemic approach (up to 20 participants)

- *Manoj Ravi (U. Birmingham) and Francesco di Renzo (CNRS)*

Wednesday 5 PM-7 PM — **ElectroCatalysis**
Room: Norma
Pedagogy: Problem based learning (up to 40 participants)

- *Mathieu Prevot (CNRS) and Bertrand Reuillard (CNRS)*

Thursday 5 PM-7 PM — **(Photo) Electro Catalysis**
Room: Norma
Pedagogy: Problem based learning (up to 40 participants)

- *Mathieu Prevot (CNRS) and Bertrand Reuillard (CNRS)*

Problem based learning Electrocatalysis

Bertrand Reuillard
CEA Grenoble
Bertrand.REUILLARD@cea.fr

Accurate electrocatalytic performance assessment of materials or molecularly defined surfaces rely on proper catalyst and material characterisation, in order to obtain the real performance metric of a system: surface area, real active site number determination, selectivity, catalyst integrity, parasitic reactions. In this practical session, we will study several common pitfalls that electrochemist face when characterising their active materials.

About the teachers

Bertrand Reuillard received his PhD degree in 2014 from the University of Grenoble Alpes (under the supervision of Dr. Alan Le Goff) for the development of carbon nanotube based glucose-oxygen enzymatic biofuel cells. He then joined the group of Prof. Erwin Reisner for a first post-doctoral stay in Cambridge where his work mainly focused on the immobilization of molecular or enzymatic electrocatalysts on electrode surfaces for energy conversion. In February 2018, he joined the SolHyCat team of Dr. Vincent Artero and aimed at the development noble metal free molecular based anodes for H_2-O_2 fuel cells. In June 2020, Bertrand was hired as full CEA researcher to develop new (macro)molecular systems for supported electrocatalytic CO_2 reduction.

Mathieu Prévot (see Next practical) will also teach this session

Photo (electro) catalysis

Mathieu Prévot
CNRS, IRCELYON
mathieu.prevot@ircelyon.univ-lyon1.fr

The research fields of photocatalysis and photoelectrocatalysis have known a rapid growth in recent years, due to their promises as contributing technologies to the ongoing energy transition away from fossil resources. However, this explosion of reports can make it difficult to compare results and identify the best scientific practices to contribute efficiently to the development of the field. It is crucial that young scientists interested in joining the community are able to identify the most common pitfalls and misconceptions of the domain so they can easily avoid them and deliver a sound scientific analysis of the complex interaction between material design, light absorption, and charge management found is photocatalytic and photoelectrocatalytic systems.

The purpose of this series of practical exercises is to actively increase the awareness of young scientists and new members of the photo (electro) catalysis field towards its most common pitfalls and discuss best practices to avoid them through a problem-based learning approach.

About the teachers

Mathieu Prévot is a CNRS researcher of the "Heterogeneous Catalysis for the Energy Transition" (CATREN) team at the Research Institute on Catalysis and Environment of Lyon. His research focuses on photoelectrochemical solar energy conversion to solar fuels (H_2 from water, C1 and C2 molecules from CO_2) and to value-added biomass-derived compounds. He obtained his PhD in 2017 from the Ecole Polytechnique Federal de Lausanne (EPFL) in Switzerland after defending his thesis on the design and optimization of $CuFeO_2$ photocathodes for solar H_2 production, a work performed under the supervision of Prof. Kevin Sivula.

Then, he joined the laboratory of Prof. Omar Yaghi as a postdoctroral fellow to study the electrocatalytic performances of Metal-Organic Frameworks, before joining IRCELYON in 2019 as a Marie Sklodowska-Curie Action Fellow before joining the CNRS.

Betrand Reuillard, see previous practicals, will also teach this practical.

Fostering holistic thinking in heterogeneous catalysis

Manoj Ravi
University of Birmingham
manorav92@gmail.com

The extension of a holistic or 'systems thinking' approach to chemical education is a recent advancement. Catalysis is undeniably an important tool in developing green and sustainable chemical processes, yet course units on catalysis have conventionally been taught through a reductionist perspective and predominantly in a petrochemical context. In this session, through a case study on alkane isomerization, we will identify the scope to transition from a reductionist to a holistic thinking approach in heterogeneous catalysis.

Selected readings

- M. Ravi et al., Identifying Opportunities to Promote Systems Thinking in Catalysis Education, *J. Chem. Educ.* 2021, 98, 5, 1583–1593
- P. Mahaffy et al., Reorienting chemistry education through systems thinking, *Nat. Rev. Chem.,* 2018, 2, 0126

Wednesday's Remote connection s1:
https://cnrs.zoom.us/j/95531763013?pwd=aXhaR1V3ZjB4SmM4OUtuaERhZTlBdz09
Meeting ID: 955 3176 3013
Passcode: CEC_PRAC1

Thursday's Remote connection s2:
https://cnrs.zoom.us/j/91067976244?pwd=QVNZS1doSkRJUm1JbHh5UDVuYSt3dz09
Meeting ID: 910 6797 6244
Passcode: CEC_PRAC2

More info about the teachers

Manoj Ravi currently works as a postdoctoral research fellow at the University of Birmingham investigating heterogeneous catalysts for green ammonia synthesis. Later in 2022, he will be joining the University of Leeds as a lecturer in Chemical Engineering. Before moving to the UK, Manoj obtained his PhD from ETH Zurich, Switzerland. His doctoral thesis titled 'From the catalytic partial oxidation of methane to Lewis acid sites in zeolites' was distinguished with the prestigious ETH Medal for research excellence. Recognized as a Fellow of the Higher Education Academy (FHEA), Manoj also has a strong enthusiasm for teaching and works on identifying didactic approaches that enhance student learning experience in chemistry and chemical engineering. Francesco Di Renzo (see his bio as discussion leader of the methane lecture session) will also teach this practical

Good practice in spectroscopy

Matteo Signorile, Elena Groppo and Silvia Bordiga
University of Torino
matteo.signorile@unito.it

Spectroscopic techniques represent a “Swiss Army Knife” in modern chemistry, since their capability to shed light on the intimate nature of molecules and materials, as well as over their mutual interactions. Though some spectroscopic tools (e.g. IR or UV-vis) are nowadays broadly available, their fundamentals are often not fully handled by the final user, sometime leading to gross error in their application and reporting of results. This practical section aims at promoting good practices in spectroscopy, dealing with both theoretical and applicative aspects.

More info about the teachers

Matteo Signorile received his MSc in Materials Science in 2013 at University of Torino, under the guidance of prof. Silvia Bordiga. In 2017, he earned the PhD title at the same institution (tutor prof. Francesca Bonino). After some years as postdoctoral fellow, he joined Bordiga’s group as Assistant Professor in 2020. Along his whole carrier, MS mostly focused on the spectroscopic characterization of catalysts under conditions approaching as much as possible reaction ones.

Silvia Bordiga (see “Motivation of the school) and Elena Groppo (discussion leader of the (bio)polymers session will also teach thes this practical.

Acknowledgements

The support of the following institutions is kindly acknowledged