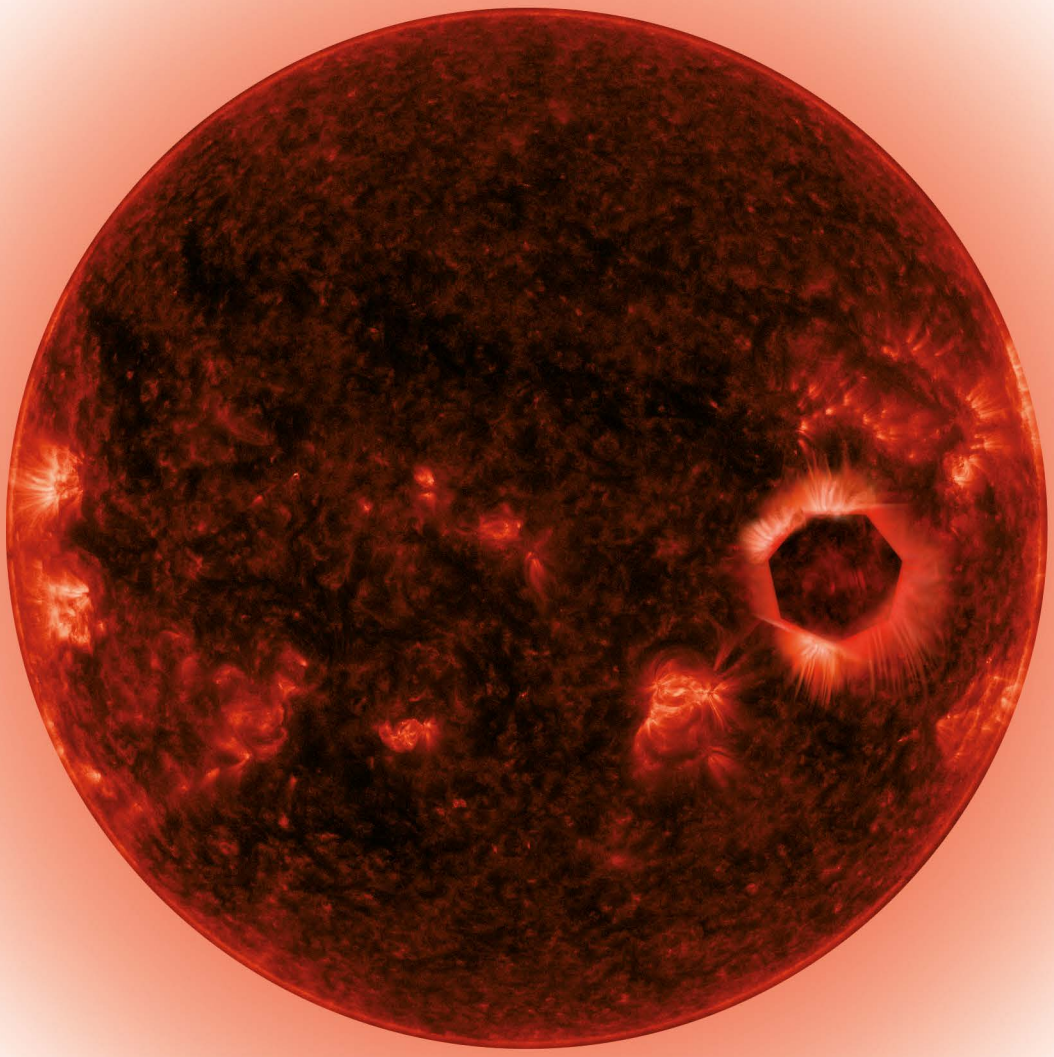
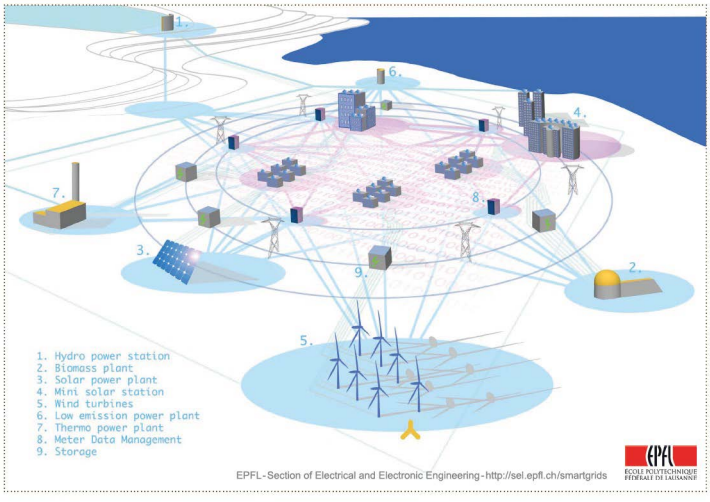
ENERGY

DOCTORAL SCHOOL



EPFL

Energy conversion has and will shape the evolution of mankind. In a number of ways it is absolutely essential for human existence. The EPFL doctoral program in energy provides an educational and research environment that inspires students to develop the ability to contribute to the advancement of science and technology through creative research in various fields of energy.



Smart Grids: a new electrical infrastructure for the massive integration of renewable energy resources

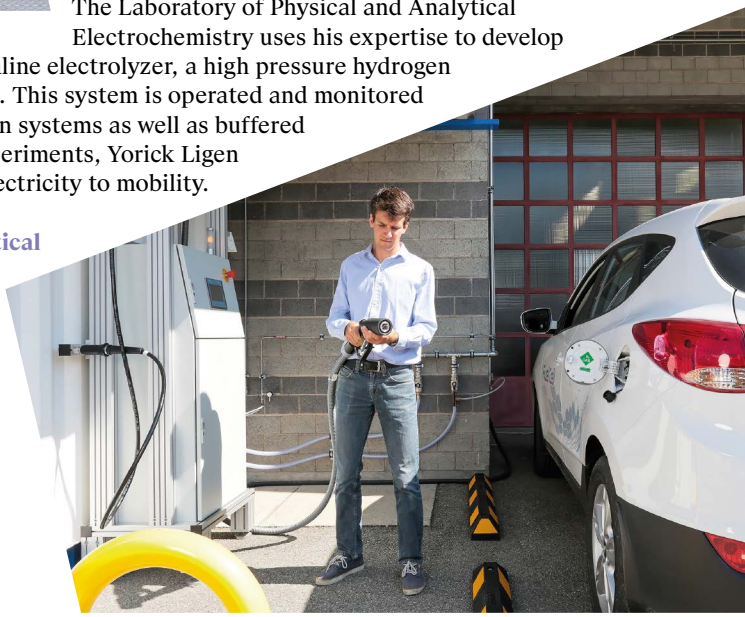
Future generations will rely on energy converted by massive renewable energy resources. The inherent stochastic behavior of these resources is posing new challenges to researchers.

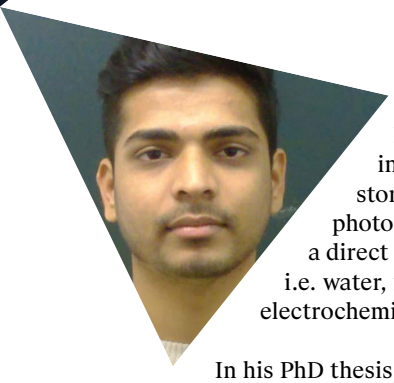
Smart Grids are expected to shape the next generation of the power systems enabling the vast penetration of renewables. This will be realized by integrating new technologies in energy conversion and storage systems together with new approaches in the control of advanced electrical and energy systems.

The electrification of road transport is one of the key solutions to decarbonize our economy and improve air quality. Two technologies, battery electric vehicles and hydrogen fuel cell vehicles, are expected to address the needs of private users as well as freight transportation. Thus, the fossil fuel based infrastructure must be replaced by electric charging stations and hydrogen refueling stations. On the one hand, charging stations are triggering new challenges to manage MW peaks in the power demand and to use local production from renewables. On the other hand, hydrogen is a new fuel which can either be transported from large plants or produced on-site, resulting in various configurations in terms of storage and compression capacity.

The Laboratory of Physical and Analytical Electrochemistry uses his expertise to develop Grid to Mobility systems. A pilot scale demonstrator with a 50 kW alkaline electrolyzer, a high pressure hydrogen cascade and a 200kW/400 kWh vanadium redox flow battery was built. This system is operated and monitored to fully characterize hydrogen production, purification and compression systems as well as buffered charging stations to reduce grid constraints. With both models and experiments, Yorick Ligen proposes and analyzes energetic pathways for the conversion of grid electricity to mobility.

Yorick Ligen PhD student at the Laboratory of Physical and Analytical Electrochemistry

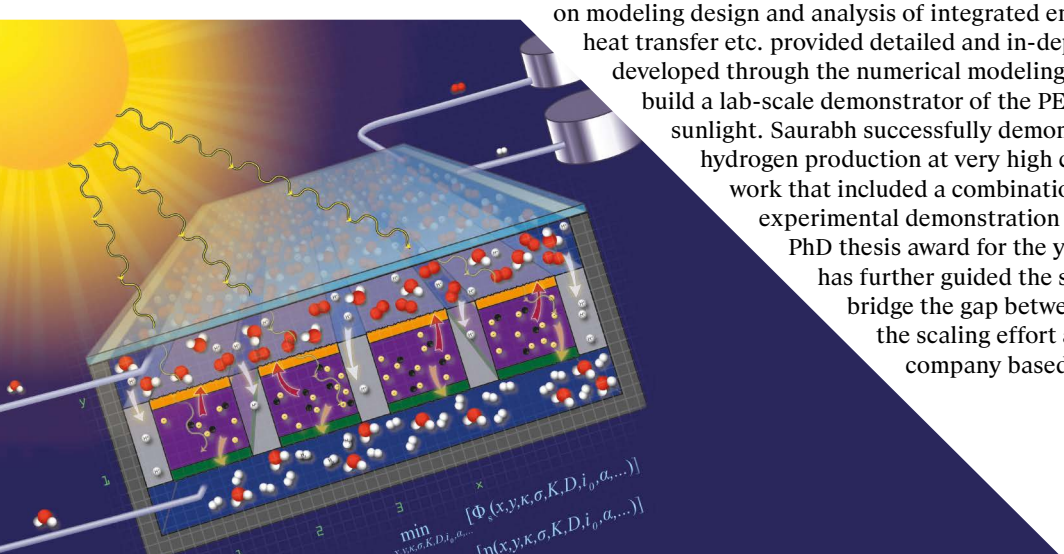




Saurabh Yuvraj Tembhurne

Renewable energy sources are fluctuating, dilute and unequally distributed. Their broad usage in our fuel and power economy relies therefore on cheap, efficient, stable, and sustainable energy storage opportunities. The direct conversion of solar energy into a high energy density fuel via photoelectrochemical (PEC) processes offers one promising storage solution for solar energy. It describes a direct processing route for storable fuels requiring solely solar irradiation and a non-toxic chemical source, i.e. water, for the production of a solar fuel, i.e. hydrogen. The solar radiation drives anodic and cathodic electrochemical reactions to drive water electrolysis into hydrogen and oxygen.

In his PhD thesis, Saurabh Tembhurne investigated the feasibility of using concentrated irradiation for PEC devices. Concentration of incoming sunlight enables minimal use of photoactive and electrochemically active materials (therefore reducing device cost) and allows for thermal management opportunities. Firstly, Saurabh developed a multi-dimensional multi-physics computational model for a photo-electrochemical device operating under concentrated irradiation in order to investigate feasibility of the approach and to provide design guidance for device implementation. EDEY courses on modeling design and analysis of integrated energy systems, two-phase flows and heat transfer etc. provided detailed and in-depth expertise. The design guidelines developed through the numerical modeling where then used to implement and build a lab-scale demonstrator of the PEC device working with concentrated sunlight. Saurabh successfully demonstrated highly efficient and stable hydrogen production at very high current and power densities. His unusual work that included a combination of advanced modeling and novel experimental demonstration was recognized by EDEY's Outstanding PhD thesis award for the year 2018. Saurabh's PhD thesis work has further guided the scale-up of the technology and is helping bridge the gap between academia and industry. He continues the scaling effort and is ready to launch his own startup company based on the work.



Laboratory for Hydraulic Machines	LMH	Prof. François AVELLAN	https://lmh.epfl.ch/
Photovoltaics and Thin Film Electronics Laboratory	PV-LAB	Prof. Christophe BALLIF	https://pvlab.epfl.ch/
Power Systems Group	STI-SCI	Dr. Rachid CHERKAOUI	https://desl-pwrs.epfl.ch/
Power Electronics Laboratory	PEL	Prof. Drazen DUJIC	https://pel.epfl.ch/
Laboratory of Physical and Analytical Electrochemistry	LEPA	Prof. Hubert GIRAULT	https://lepa.epfl.ch/
Laboratory of Photonics and Interfaces	LPI	Prof. Michael GRAETZEL	https://lpi.epfl.ch/
Laboratory of Renewable Energy Science and Engineering	LRESE	Prof. Sophia HAUSSENER	https://lrese.epfl.ch/
Thermal Engineering for the Built Environment Laboratory	TEBEL	Prof. Dolaana KHOVALYG	https://tebel.epfl.ch/
Computer Communications and Applications Laboratory 2	LCA	Prof. Jean-Yves LE BOUDEC	https://icawww.epfl.ch/
Ludwig Group	LG	Prof. Christian LUDWIG	https://cpm.web.psi.ch/
Laboratory of Sustainable and Catalytic Processing	LPDC	Prof. Jeremy LUTERBACHER	https://lpdc.epfl.ch/
Industrial Energy Systems Laboratory, Group Marechal	LENI	Prof. François MARECHAL	https://leni.epfl.ch/
Laboratory for Reactor Physics and Systems Behaviour	LRS	Dr. Konstantin MIKITYUK	https://www.psi.ch/fast/
Unsteady Flow Diagnostics Laboratory	UNFOLD	Prof. Karen MULLENERS	https://unfold.epfl.ch/
Group of Thermal Turbomachinery	LTT	Dr. Peter OTT	https://gtt.epfl.ch/
Distributed Electrical Systems Laboratory - EOS Holding Chair	DESL	Prof. Mario PAOLONE	https://desl-pwrs.epfl.ch/
Laboratory for Reactor Physics and Systems Behaviour	LRS	Prof. Andreas PAUTZ	https://lrs.epfl.ch/
Solar Energy and Building Physics Laboratory	LESO	Prof. Jean-Louis SCARTEZZINI	https://leso.epfl.ch/
Laboratory for Applied Mechanical Design	LAMD	Prof. Jürg SCHIFFMANN	https://lamd.epfl.ch/
Laboratory of Nanoscience for Energy Technologies	LNET	Prof. Giulia TAGLIABUE	https://lnet.epfl.ch/
Industrial Energy Systems Laboratory	LENI	Dr. Jan VAN HERLE	https://leni.epfl.ch/
Laboratory of Photonics and Interfaces	LPI	Prof. Shaik M. ZAKEERUDDIN	https://lpi.epfl.ch/

We look forward to your eagerness to learn and discover!

EPFL's reputation has been earned by forming multi-disciplinary engineers capable of solving complex problems by applying innovative approaches. Following this path, the EPFL-EDEY PhD studies are open to candidates characterized by multidisciplinary attitudes and who are motivated to grow within a unique learning environment in which new methodologies and technologies meet in the challenging area of Energy Sciences for the 21st century.

Need more information? Visit us at

go.epfl.ch/phd-edey

and find out about the current opportunities, application instructions, and more…

Contact: edey@epfl.ch

Cover picture: courtesy of SOHO (ESA & NASA)