Symposium Physics for the Energy Turn (SYPE)

jointly organized by
the Quantum Optics and Photonics Division (Q),
the Working Group on Energy (AKE),
the Working Group 'Young DPG' (AGjDPG), and
the Working Group on School Issues (AGS)

Andreas Buchleitner
Physikalisches Institut
Albert-Ludwigs-Universität Freiburg
Hermann-Herder-Str. 3
79104 Freiburg
a.buchleitner@physik.uni-freiburg.de

Hardo Bruhns
Arbeitskreis Energie
Meliesallee 5
40597 Düsseldorf
ake@bruhns.info

Cora Uhlemann
Arnold Sommerfeld Center
for Theoretical Physics
Theresienstr. 37
80333 München
uhlemann@jdpg.de

Rudolf Lehn
Schülerforschungszentrum
am Störck Gymnasium
Liebfrauenstr. 1
88348 Bad Saulgau
sfz@uni-konstanz.de

Sustainable and affordable energy production is one of the key challenges for the global society in the 21st century, and has been set on the front-page of Germany's political agenda by the so-called "Energy Turn". Arguably more than any other current political headline, the latter attracts and stimulates the curiosity and creativity of scientists from fundamental to applied research, inasmuch as it defines a truly interdisciplinary research field, with tons of fascinating, widely open questions, many of them challenging the physics community. Not only does this subject give us physicists a wonderful, hard problem to solve, but it also makes the relevance of modern physics research, from thermodynamics and turbulence to fundamental quantum science, very tangible for the broader public. In particular does the Physics for the Energy Turn provide a fascinating nucleation point for the next generation's perception of our scientific discipline as an indispensable cultural competence to the solution of high-impact challenges for modern societies. The present Symposium will convey the chances and challenges for scientific innovation as unveiled by the Energy Turn, with high school students, teachers and young researchers as target audience. Short interventions of prominent and active players in the field, followed by questions and discussion, will provide an arena for enlightening debate.

Overview of Invited Talks and Sessions

(Lecture room: Kinosaal)

Invited Talks

SYPE 1.1	Mon	14:00–14:15	Kinosaal	**Meeting the Energy Challenge** — •Steve Chu
SYPE 1.2	Mon	14:15–14:30	Kinosaal	**Energy transformation pathways towards 2°C stabilization** — •Gunnar Luderer
SYPE 1.3	Mon	14:30–14:45	Kinosaal	**How can Physicists contribute to the Energy Transformation?** — •Eicke R. Weber
SYPE 1.4	Mon	14:45–15:00	Kinosaal	**Photosynthesis: lessons from nature** — •Rienk van Grondelle
SYPE 1.5	Mon	15:00–15:20	Kinosaal	**Questions and perspectives for highschool physics and young researchers** — •Gerwald Heckmann

Sessions

SYPE 1.1–1.5	Mon	14:00–16:00	Kinosaal	**Physics for the Energy Turn**

SYPE 1: Physics for the Energy Turn

Time: Monday 14:00–16:00 Location: Kinosaal

Invited Talk SYPE 1.1 Mon 14:00 Kinosaal
Meeting the Energy Challenge — •Steve Chu — Stanford University

Science and technology has profoundly transformed the lives of much of humanity. The industrial and agricultural revolutions are also changing the future destiny of the world. I will discuss the necessity, challenges, and opportunities in innovation and policy that will be needed to transition to a sustainable future.

Invited Talk SYPE 1.2 Mon 14:15 Kinosaal
Energy transformation pathways towards 2°C stabilization — •Gunnar Luderer — Potsdam Institute for Climate Impact Research, 14473 Potsdam, Germany

The international community has agreed on the objective of limiting global warming to no more than 2°C relative to pre-industrial levels. This goal implies a tight limit on the remaining cumulative CO_2 emissions budget, and thus CO_2 emissions have to become close to zero or even negative during the 2nd half of the 21st century. Innovative technologies play a central role in the quest of transforming global energy systems without compromising economic prosperity and growth prospects of the developing world. A variety of technology options are available to decarbonize energy supply, electrify end use and to increase energy efficiency. Nonetheless, many challenges remain. As an example, the integration of variable renewable energy sources such as solar and wind power is difficult, while other options, such as nuclear power, carbon capture and storage or large-scale biomass production face limited societal acceptance. Some energy sectors are particularly difficult to decarbonize, such as transport and industry. And foremost, climate policies and emission reductions pledged by nations are still much too weak to put the world on a pathway consistent with 2°C stabilization, highlighting political and institutional barriers to the low-carbon transition. Interdisciplinary research focusing on the interlinkages between natural sciences, engineering, economics and political science is crucial to deal with the challenges of the low-carbon transformation, and helps to derive robust policy strategies towards a more sustainable future.

Invited Talk SYPE 1.3 Mon 14:30 Kinosaal
How can Physicists contribute to the Energy Transformation? — •Eicke R. Weber — Fraunhofer Institute for Solar Energy Systems and Institute of Physics, Albert-Ludwigs-University, Freiburg, Germany

The transformation of the global energy system towards more efficient use of finally close to 100% renewable energy is one of the big tasks of mankind, on our way to a sustainable use of the earth's resources. In order to facilitate this unavoidable transformation process in a cost-effective way, science is essential in many areas. Just as examples, we need to understand the fundamental processes of light interacting with complex molecules, to pave the way for low-cost organic photovoltaics, we need to better understand electrochemical reactions to allow the development of low-cost long-lasting batteries, and better fuel cells for hydrogen-based transportation. The scientific challenges of the energy transformation will keep physicists and other scientists busy for years to come, and open opportunities for the best and brightest to make substantial progress to the direct benefit of mankind.

Invited Talk SYPE 1.4 Mon 14:45 Kinosaal
Photosynthesis: lessons from nature — •Rienk van Grondelle — VU University, Faculty of Science, Amsterdam, the Netherlands

Photosynthesis is the process that converts solar energy into chemical free energy. The global rate of energy storage by photosynthesis is 150 TW (1 TW = 10^{12} W), while human energy consumption is about 17 TW. To harvest solar photons nature applies a variety of dedicated design principles. A plant harvests photons with almost 100% quantum efficiency, meaning that every photon that is absorbed by the plant is used for photosynthesis. Once absorbed the energy is transported on an ultrafast (femtosecond)timescale from one chlorophyll to the next to reach a special chlorophyll-protein, the reaction center, a true 'biosolar cell' where again with close to 100% quantum efficiency the energy is converted into a trans-membrane electrochemical gradient via charge transfer across the photosynthetic membrane. In this talk I will illustrate some of the physical principles used by nature and show how by studying the natural process we may learn how to build the next generation of solar cells

Invited Talk SYPE 1.5 Mon 15:00 Kinosaal
Questions and perspectives for highschool physics and young researchers — •Gerwald Heckmann — Asam-Gymnasium München

Plenary Discussion