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Speakers' List Summer PhD School Mont-Soleil 2018

Mathieu Boccard received his engineer degree from École Polytechnique, Paris, his Master Degree from ENSTA University of Paris, and his PhD Degree in Novel Micromorph solar cell structures for efficient light trapping and high-quality absorber layers from EPFL, Ecole Polytechnique Fédérale de Lausanne. After post-doctoral stay at Arizona State University – Holman Research group, USA, he joined EPFL PV Lab in Neuchâtel, Switzerland.
Dr Boccard has a strong expertise in solar cells, both theoretical and experimental, in particular for silicon and multijunction devices. Technical skills include the use and maintenance of vacuum deposition tools as well as of optical and electrical characterization equipment. He coauthored over 70 scientific contributions, including ten peer-reviewed papers as a first author

Outline of the presentation

The main objective of this lecture is to give an overview of the physics and manufacturing processes of photovoltaic solar cells. The students will be briefly introduced to the basics of the physics of solar cells. They will learn how to describe the main device properties in terms of key parameters. The most important fabrication process steps will then be described, ranging from silicon fabrication to encapsulation processes, by going through some details of the wafer fabrication, dopant diffusion, dry and wet chemical etching of surfaces, contacting, module assembly. Finally, the most advanced and innovative devices will be presented, focusing on crystalline silicon but also touching more advanced designs for future generations. Discussion on the integration of photovoltaics, both on an architectural point of view and on an electricity generation point of view will also be included, for the students to have a complete overview of the photovoltaics field, from research challenges to the integration in our every-day life through manufacturing and economic aspects.

Martin Bölli is an Electrical and Environmental Engineer working as an expert on renewable energy and environmental technologies since 2004. He started his career at Entec Consulting & Engineering Ltd in St. Gallen / Switzerland. His main activities were planning, design, capacity building, technical, institutional and environmental assessments of renewable energy systems, with a strong focus on small hydropower (SHP). Studies which he elaborated e.g. in Ethiopia included among others assessment of hydropower potential, energy and electrification policies, legal requirements, willingness and ability to pay and productive use of electricity. Martin Bölli contributed to the formulation of energy policies in different countries (Switzerland, Ethiopia, Nepal and Azerbaijan), with the specific focus on linking policy and legal aspects to the respective technical implications (e.g. for feed-in rules, tariff setting and power purchase agreements). He has specific experience not only in pure hydropower but also hybrid power systems. Beside his international assignments, Martin Bölli was until 2011 managing the Swiss SHP Promotion Program of the Federal Office of Energy where he was responsible for the coordination of SHP promotion activities in Switzerland. In 2012, he changed to Skat Consulting Ltd in St. Gallen. In several projects (Jordan, Lebanon, Tunisia) he analysed the hydropower potential in drinking and irrigation water systems. Since 2013, he manages the secretariat of "Swiss Small Hydro", the national association of Small Hydropower in Switzerland.

Outline of the contribution

- Overview SHP in Switzerland: its history, role in electricity supply today and future within the new Swiss energy strategy.
- Basics about SHP: Components of a typical SHP, estimation of the power potential, flow duration curve, energy calculation

- Types of SHP: using hydropower potentials, classification of SHP according to power, head, type of application, …
- Challenges for SHP today: environmental, ecological and social issues.

Saskia Bourgeois studied Earth Sciences and received her Master and PhD Degree at the ETH in Zurich, Switzerland, Institute for Atmosphere and Climate. In 2006 she joined Meteotest as an expert for wind assessments including measurements with met masts, SODARs and LIDARs as well as different modelling approaches. Since 2011 Saskia Bourgeois is heading the Wind Energy Department at Meteotest. Meteotest is a wind energy consultant specialised in complex terrain and cold climate and is involved in numerous commercial and research projects. Saskia Bourgeois has carried out a large number of wind assessments and computed wind maps for sites in complex terrain all over the world. Within Switzerland, she was involved in the planning phase of most operating wind parks including the energy forecasts and environmental studies. Since 2017 Saskia Bourgeois is representing Switzerland in the IEA Wind Task 19, Wind Energy in Cold Climate.

Outline of the contribution

- Wind energy: history, facts and figures
- Energy in the wind
- Wind in complex terrain, turbulences
- Challenges of wind measurements in complex terrain and icing conditions
- Long term wind speed
- Wind modelling, wind maps
- Forecasts of energy production
- Uncertainty of wind energy forecasts

Ndaona Chokani received his B.A. from Oxford University and his Ph.D. from Cambridge University. He was a Professor for 17 years in the USA, and since 2006 he is at ETH Zurich, where he leads the wind energy program and the energy, economics & policy program in the Laboratory for Energy Conversion. In the last five years, Dr Chokani has published more than 30 journal and conference papers. He is a recipient of a 2017 Best Paper Award from the General Meeting of the IEEE Power and Energy Society, a 2015 Best Poster Award from the European Offshore Wind Conference of the European Wind Energy Association, and a 2013 Best Paper Award from the Wind Turbine Committee of the IGTI. Dr Chokani is President of Switzerland's IEC Technical Committee 88, past-Chair of IGTI Wind Energy Committee, and he has served on scientific committees for several European Wind Energy Association conferences and European Energy Market conferences.

Outline of the presentation

- field measurements
- sub-scale model testing
- computational methods
- wake modelling

Michel Hausmann received the HTL-Engineer diploma in Electrotechnics from the Bern University of Applied Sciences in Biel in 1992. In 1993 he joined ABB Power Generation acting worldwide as a Commissioning Engineer of gas turbines and combined cycle power plants. In 1998 he was appointed as General Commissioning Manager. From 2001 till 2004 he worked in southern China as a Business Unit Manager for Microcomponents developing and producing components for the automotive industry. Starting in 2005, Michel Hausmann specialized in hydro power technologies and projects, offering with his own companies Turbinor and EnEn engineering and commissioning services for large and small hydro power stations.

Outline of the contribution

- Presenting the Swiss Energypark, a reference microgrid using different types of renewable energy generators such as solar-PV, hydro and wind turbines
- Monitoring, metering and regulation of the main grid parameters. Live measurements, degree of autonomy and statistics. Smart metering applications.
- Overview of related R&D projects

Manuel Lanz obtained his BSc in electrical engineering from Bern University of Applied Sciences BFH in 2015. His research thesis was on building and investigating the application of a thermal imaging drone at PV installations. Since graduation, he has been working as a research assistant at the PV Laboratory of Professor Muntwyler at the BFH where he is responsible for the long-term measurement and quality control of PV-Installations.

Outline of the contribution

The manual inspection for defects in large PV systems can be very time-consuming. The use of a thermal drone makes the process much more efficient and enables the detection and localisation of smallest energy losses. This new methodology was evaluated on various PV systems such as the installations on Mont-Soleil and Stade de Suisse.

Markus Leuenberger is Professor for Physics at the University of Bern and interested in experimental physics related to climate and environmental change. He studied physics, mathematics and geography followed by a doctorate at the University of Bern. As a Swiss National Science Fellow, he stayed with the Commonwealth Science and Industrial Research Organisation (CSIRO) in Aspendale (near Melbourne), Australia. He authored or co-authored more than 100 publications.

Markus Leuenberger is a specialist in stable isotope research in a multi-disciplinary field of hydrology, paleoclimatology (ice cores, tree rings, speleothems) as well as recent atmospheric composition change. His research is embedded into local (Oeschger Centre), national (MeteoSwiss, Metas, SNF, ETHZ, Uni Basel) as well as international (ICOS, GAW, GCOS, IAEA/WMO) collaborations.

He is Director of the International Foundation High Altitude Research Stations Jungfraujoch and Gornergrat. This Foundation serves a diverse, international community of science institutions by running two well-known research stations in the Swiss Alps.

Outline of the contribution

During the guided visit through the Research Station and the Sphinx Observatory at Jungfraujoch, the participants of the Mont-Soleil Summer School are exposed to completely contrasting impressions. For instance, the contrast between tourism and research or the differences between the Research Station, still in its style from the 1930ies when it was built, and state-of-the-art research at the Top of Europe. A short presentation will bring us from the early research topics across highlights in the past to today's investigations that are mainly in the field of climate and environmental research.

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Rudolf Minder received his diploma in experimental physics in 1970 and a PhD degree in applied physics in 1973, both from the University of Basel. After a post-doc stay at the University of Modena (IT) he joined the consulting and engineering company Electrowatt Engineering Services Ltd. in Zurich where he established and led the renewable energy department. He was responsible for the planning and the construction of the Mont-Soleil solar power project which became operational in 1992. In 1997 he

founded his own company Minder Energy Consulting GmbH (MEC). This company is active in applied research, feasibility studies, optimization and design of energy systems mainly in the fields of solar power and geothermal energy. Clients include private companies, electric utilities, government offices, and international institutions such as the World Bank, the European Commission and others. From 2006 to 2015 the Swiss Federal Office of Energy mandated MEC to manage the Swiss geothermal Energy Research Programme including project evaluation, controlling and strategic research planning. From 1996 to 2012 Rudolf Minder was appointed as a lecturer for a master course on solar cells by the Federal Institute of Technology (ETH) Zurich. Within the Société Mont-Soleil he is responsible for the research activities.

Outline of the contribution

The contribution will include a guided tour of the main technical components and subsystems of the Mont-Soleil power plant. Besides the technical aspects environmental issues and the coexistence of electricity production and livestock farming will be addressed.

In a second part, the use of the Mont-Soleil plant as a research platform will be presented. This includes mainly the following projects:

- Long-term data collection: results and experience with the modules and power electronics.
- Thermography for remote fault detection in large module arrays using drones as well as terrestrial cameras
- Studies on short-term production prediction by means of sky photography, satellite images and high-speed solar radiation data collection.

Mario Paolone received the M.Sc. (with honors) and the Ph.D. degree in electrical engineering from the University of Bologna, Italy, in 1998 and 2002, respectively. In 2005, he was appointed assistant professor in power systems at the University of Bologna where he was with the Power Systems laboratory until 2011. In 2010, he received the Associate Professor eligibility from the Politecnico di Milano, Italy. Since 2011 he joined the Swiss Federal Institute of Technology, Lausanne, Switzerland, where he is now Full Professor, Chair of the Distributed Electrical Systems laboratory and Head of the Swiss Competence Center for Energy Research (SCCER) FURIES (Future Swiss Electrical infrastructure).

Outline of the contribution

- Statistical performance power distribution networks hosting large share of stochastic generation.
- Methods for the optimal planning of distributed energy storage systems.
- Clustering of ancillary services provided by active distribution networks (e.g. dispatch-by-design, primary frequency control).
- Assessment of the technical and economical impact of ancillary services provided by active distribution networks on bulk transmission systems.

Martin Pfisterer studied law at the Universities of Geneva, Berne and Washington DC. He graduated as attorney-at-law and notary (1977), doctor iuris (1979) and master of public relations (1983). Before joining BKW group in 1987 he was Head of Section at the Federal Office for Spatial Planning. At BKW he was member of the board responsible for the development of new renewable energies and efficiency in application of electricity (1987 – 2014).

He was chairman of SOL-E SUISSE AG where he was responsible for the construction and management of over 80 small renewable energy plants in the fields of solar and wind energy, hydro power, biomass and heating. He was president of a number of renewable energy companies. As president of JUVENT SA (1995 – 2017) he was responsible for the installation of 24 windturbines creating the biggest wind power plant of Switzerland. He is a co-founder of the SOCIETE MONT-SOLEIL (1989), a company that he is chairing from the beginning until

today. In this function he contributed to different partner projects such as the large solar powered passenger ship on the lake of Bienne and the well known PV plants on Stade de Suisse Berne and on Jungfraujoch where PV cells were tested in high altitude (3'500 meters above sea-level) for the partner project SolarImpulse of Bertrand Piccard.

Furthermore, he was vice-president of the Swiss Electric Association where he represented Switzerland in different national and international organizations (inter alia Economiesuisse Zurich, Unipede Paris, Eurelectric Brussels).

Since his retirement (2014) he is still in charge of a few mandates for BKW in the French speaking part of Switzerland (especially: SOCIETE MONT-SOLEIL and a windpower project).

Outline of the contribution

-Situation and promotion of renewable energies in Switzerland

-Proximity between industry, education and practical work

-Site of Mont-Soleil/Jura bernois, potential and chances

Alfred Rufer received the M.S. degree from the Swiss Federal Institute of Technology Lausanne (EPFL) in 1976. In 1978 he joined BBC/ABB where he was active in R&D in power electronics, its control, and developed high-power frequency converters for drives and other high power applications. In 1993 Alfred Rufer became an Assistant Professor at EPFL, Lausanne Switzerland. In 1996 he became a Full Professor and Head of the Industrial Electronics Laboratory, EPFL.
Research activities: power converters, solutions and applications of multilevel converters. Other fields initiated by Alfred Rufer are dedicated to energy storage, or storage devices for sustainable energy.
In 2006 Alfred Rufer was elected at the IEEE Fellow grade. From March 2016 Alfred Rufer is an emeritus professor.

Outline of the contribution

- Generalities on energy storage, history and context of use, general definitions.
- Energy storage systems, from electrochemistry to other physical systems, SMES, BESS, KERS CAES and Pumped Storage.
- Comparative ratings and properties, the theory of the Ragone representation.
- Models, thermal models, multiphysics models , exercises simulations.
- System arrangements and applications.

Remus Teodorescu received the Dipl.Ing. degree in electrical engineering from the Polytechnical University of Bucharest, Bucharest, Romania, in 1989, and the Ph.D. degree in power electronics from the University of Galati, Romania, in 1994. In 1998, he joined the Department of Energy Technology, Aalborg University, Aalborg, Denmark, where he is currently a Professor in power electronics. Since 2013, he has been a Visiting Professor with the Division of Electric Power Engineering, Chalmers University of Technology, Goteborg, Sweden. He has coauthored more than 400 papers, three books, and eight patents. His areas of interests include modular multilevel converter, HVDC/FACTS, HV SiC MOSFET, design and control of power converters for wind power systems and photovoltaic, energy storage systems based on Li batteries. Dr. Teodorescu received ISI "Highly Cited Researcher" in 2010–2015 by Thomson Reuters. He was the Coordinator of Vestas Power Program (2008–2013, involving ten Ph.D. projects in the areas of power electronics, power systems and energy storage.

Outline of the contribution

The MMC technology, recently adopted by major manufacturers of HVDC equipment, has demonstrated clear advantages in comparison with two-level VSC in terms of reduced losses and footprint. This lecture aims to

describe the fundamentals aspects of MMC including: basic MMC properties and modelling, converter dynamics and control strategies under steady-state and fault conditions, modulation and submodule energy-balancing methods. Simulation models in Simulink and PLECS will be provided. The reference is the book: Sharifabadi, K.; Harnefors, L.; Nee, H.-P.; Norrga, S.; Teodorescu, R., "Design, Control and Application of Modular Multilevel Converters for HVDC Transmission Systems," Wiley-IEEE Press, 2016 ISBN: 978-1-118-85156-2.

The benefits of MMC technology can be used to improve the efficiency, power density and fault-tolerance of the existing solutions for connecting WT, PV or ES (for grid support or ultra-fast charging of EVs) to MV distribution grid.. Also for EV, integrating the battery cells with a LV MMC has potential to improve battery cell balancing performance, life-time and increase the effective EV range. Cost and complexity are still the major challenges that needs to be addressed. Different topologies and system architectures are analyzed and compared to the conventional ones.

Thomas Schott received his diploma in electrical engineering from the Bern University of Applied Sciences in 1983. After graduation he was working for six years in the machine industry (at Brero & Cie AG, Biel, Switzerland) where he developed electronic machine controls. In 1990 he took part in a one year postgraduate course in environmental technics. From there he went back to Brero & Cie AG for an other four years. In 1994 Thomas Schott Joint Hänni Instruments in Jegenstorf, Switzerland, where he was involved in the development of pressure sensors. From 1998 to 2014 Thomas Schott had been working at the Swiss National Hydrological Survey where he managed the electronic laboratory. In this laboratory he developed electronic compounds for the measurement of hydrometrical parameters like water-level, water-velocity, water-discharge etc. The laboratory of electronics was also responsible for the functionality of the measuring network of the hydrometrical gauging stations. Fore some gauging stations Thomas Schott designed and constructed photovoltaic power supply systems for the hydrometric instruments in the these stations.

In May 2014 Thomas Schott changed from hydrometry to photovoltaics by moving to the Laboratory for Photovoltaics at the Bern University of Applied Sciences where he is responsible for the measuring network for the observation of photovoltaic power plants.

Suzanne Thoma has been CEO of the BKW Group since 2013. Since assuming this role, Dr. Thoma has been leading the BKW through a profound transformation process in a demanding environment of increased volatility and uncertainty. Her strategic aim is to reposition and to develop the BKW from a conventional power supply company into a service company offering integrated services in the fields of energy, building technology, and infrastructure. In 2017, Dr. Thoma was designated «CEO of the year» (category large companies, Switzerland). The award honoured her as second out of three gold-winning CEOs who showed the best overall performance in growth, operating efficiency, and investment results. For her outstanding contributions in favor of the energy sector, Dr. Thoma received the ETH Zürich Chemical Engineering Medal in 2016.

Dr. Thoma holds a master's degree and PhD in chemical engineering from ETH Zurich. She worked for 10 years in various leading positions at Ciba Spezialitätenchemie AG (today BASF AG) both in Switzerland and abroad, before heading high-tech materials and technology licensing firm Rolic Technologies AG. Prior to joining BKW as Head of Networks in 2010, Dr. Thoma managed the WICOR Group's international automotive supply business in Rapperswil.

Furthermore, Dr. Thoma is a board member of two listed companies.

Outline of the contribution

The world we live in is increasingly complex, ever-changing and unpredictable. No one knows for certain what tomorrow will bring. Clarity, transparency and predictability are becoming scarce, and ambiguity is becoming increasingly widespread.

This is also true in the energy industry, which is facing major challenges. In an ever more decentralised energy landscape, grid operations, accounting and management of data are more complex and demanding. On the one hand, the decentralisation and digitalisation of the industry is leading to a process of democratisation, in which the market power of central energy suppliers is declining and the number of players in the market is on the rise. On the other hand, data tends to become more centralised and thus a source of power to more effectively engage our customers and partners.

The energy market is also becoming increasingly volatile: plants using fossil fuels such as coal and nuclear power still cover the base load, but these are gradually being decommissioned and replaced by renewable energies such as hydroelectric, wind and solar power. Production and prices will fluctuate significantly in the future as a result. Predictability and calculability are decreasing when it comes to both production and prices. This means we have to look at ways of continuing to meet increasing energy demands in an environment that is becoming more volatile as we move away from traditional to more renewable energy sources.

These factors create a challenging environment in which to run a successful energy business. It calls for a transformation in order to adapt to these new circumstances. BKW CEO, Dr. Suzanne Thoma, explains how clarity, agility and a coherent vision will enable BKW to face the challenges of a disrupted energy world, and continue to succeed in the market.

Andrea Vezzini received 1996 a PhD in Electrical Engineering from ETH Zürich, Switzerland and successfully completed in 2002 the program for Mastering Technology Enterprises (MTE) at IMD Lausanne.

He is Professor for Industrial Power Electronics at Bern University of Applied Sciences since 1996 and was visiting Professor at GM Advanced Technology Centre in 2003 and Distinguished Visiting Scientist at CSIRO Australia (Commonwealth Science and Industrial Research Organization) in 2007.

Currently Prof. Dr. Andrea Vezzini holds the position of Head of the BFH-CSEM Energy Storage Research Center and Deputy Head of the Swiss Competence Center for Energy Research (SCCER) Mobility. Since Beginning of 2015 he is member of the Federal Energy Research Commission (CORE).

Prof. Vezzini is Chairman of the board and founding member of drivetek ag and member of the board and founding member of Integrated Power Solutions AG.

Prof. Vezzini holds 23 patents / 8 patent families in the field of electric drives and battery power management systems.

www.bfh.ch/energy
www.drivetek.ch

Jakob Vollenweider received the Dipl. Ing. degree in mechanical engineering from the Swiss Federal Institute of Technology Zurich (ETHZ) in 1983. Having completed his PhD in mechanical engineering at the Rensselaer Polytechnic Institute in Troy (New York) in 1987, Jakob Vollenweider joined the Diesel Engine Division of SULZER LTD. in Winterthur where he headed the emissions control group. Between 1995 and 2017 he was with BKW ENERGIE LTD. in Bern working mainly in the fields of renewable energies, business development and innovation. He was managing director of BKW's subsidiaries JUVENT SA and SOCIETE MONT-SOLEIL as well as head of business development and innovation of BKW's subsidiary SOL-E SUISSE AG. Since 2017 he manages his own energy consulting company ENERGIEBOUTIQUE.

Outline of the contribution

Switzerland is a relatively densely populated country whilst it is famous for its wonderful landscape. When developing its wind power plant JUVENT was therefore particularly challenged to find a way to deal with the often quite different demands of the many stakeholders. The way JUVENT did that and especially the model

scheme JUVENT developed in cooperation with the Swiss landscape protection has gained international acclaim.

The above cited framework conditions in Switzerland require that the wind resources in Switzerland are used in the most effective manner, that is above all with the latest wind turbine generation. JUVENT has already carried out two repowering projects in its wind farm thereby gaining profound expertise in this increasingly important question. One repowering project e.g. involved the reinstallation of a JUVENT wind turbine in New Zealand.

Of course, Switzerland is also famous for its mountains. In terms of wind energy this often leads to a so-called complex terrain though, which entails particularly high demands in wind measurements. JUVENT therefore also acquired with the support of the Swiss Federal Institute of Technology (ETH) in Zurich a high expertise in the wind resource mapping in complex terrain. For example, in one of the projects researchers of the ETH Zurich performed the first-ever measurements of the wake of a full-scale wind turbine using an autonomous drone equipped with a fast response aerodynamic probe.