Content

Greetings .............................................................................................................. 4
Program .................................................................................................................. 7
   Tuesday .............................................................................................................. 7
   Wednesday ....................................................................................................... 9
   Thursday ......................................................................................................... 17
Program Overview .............................................................................................. 24
   Friday ............................................................................................................... 28
Poster Sessions .................................................................................................. 33
   Tuesday .......................................................................................................... 33
   Wednesday .................................................................................................... 37
   Thursday ....................................................................................................... 40
General Information ........................................................................................... 45
Technical Tour .................................................................................................... 46

To get the latest version of the scientific program on your cell phone please scan the QR-code or enter the URL.
https://cms2019.solarpaces-conference.org/program
Dear SolarPACES participants,

On behalf of the International Energy Agency, I am pleased to welcome you all to the 25th SolarPACES Conference in Daegu, South Korea. As you probably know, SolarPACES was initiated by the IEA forty-two years ago, as one of its most successful technology collaboration programmes. It has been instrumental since inception in the development and deployment of concentrating solar technologies, notably CSP for electricity generation, but also for industrial process heat, CSH.

Ten years ago, the IEA Secretariat published its Technology Roadmap: Concentrating Solar Power. At the time, in parts of the world with warm climates and clear skies, concentrating solar power was the best possible option for harnessing solar energy. Since then, renewable energy technologies have improved considerably. Photovoltaic energy in particular, has seen its cost diminished by an order of magnitude, and is rapidly expanding.

However, CSP brings specific advantages. Its built-in thermal storage capability allows for generating electricity after sunset, during peak demand, when electricity has the highest value. The next step will be to generate electricity all night, during both highest and lowest value times, as the world strives to bring global net greenhouse gas emissions towards zero. While photovoltaic electricity dominates the landscape of daytime solar energy, CSP has only begun to prove its advantages for night, while CSH can also play a significant role in addressing the challenge of decarbonising heat, which represents about half the world’s total energy consumption.

And CSP itself is on a learning curve, with technologies that have been proven since the 80s, and ongoing innovations. The earliest technology, trough CSP, now benefits more easily from good financing conditions and is still progressing in new and on-going projects. However, innovative designs promise even better performances and lower costs. Global cumulative CSP capacity will double within the next five years.

Policy makers have an important role to play in accelerating the deployment of solar energy in all its forms, in setting objectives, designing policy frameworks and market designs, removing barriers and mitigating investor risk. And they must understand the complementarities of the three families of solar technologies, PV, CSP and solar heating and cooling. Partnering with the International Solar Alliance, the IEA will soon release a guide for policy makers, Solar: Mapping the Road ahead.

In conclusion, allow me to reiterate the IEA’s continued support and appreciation of the outstanding work of the SolarPACES Technology Collaboration Programme. As our Executive Director, Dr Fatih Birol, put it last year: your work to further develop and demonstrate reliable, affordable and climate-friendly energy technologies is of the utmost importance for the success of a smooth energy transition.

I wish you all a very successful SolarPACES 2019 Conference.

Cédric Philibert
Renewable Energy Division, the International Energy Agency
Dear SolarPACES participants,

Looking at the global situation of our CSP sector in 2019, we face a massive shift in causes and effects that bears in itself a new chance for our sector to deploy quicker, building on its main assets.

Causes. The strong decline of RES prices made the policy makers see the costs of the electrical system as the main driver for decarbonization, leaving a bit aside the political commitment to it. In terms of LCOE, RES including CSP, are already competitive against fossil power generation.

Effects. Since variable RES gained weight in the energy mix, the lowest LCOE (as sole decisive criterion for technology choices) lost momentum, as it excludes externalities whose costs can be higher than the LCOE itself! Moreover, the need for storage, for network reinforcements, increased curtailments result today in having no longer LCOE, but flexibility in the focus. This also triggered a multi-sector ‘race for solutions’ across electricity and gas utilities (P2G, P2X) as well as the automotive sector (batteries) leaving aside much of the decarbonization objective.

Opportunity. This is a true opportunity for solar thermal technology with storage. In countries with good DNI, CSP plants with storage will provide the best complement to PV for meeting the demand after sunset and contribute to increasing firmness of the back-up capacity thanks to its manageability.

Apart from thermal storage, our sector may take advantage of the new situation with flexibility as essential piece to guarantee the stability and reasonable costs of the power system.

Strong CSP assets. I would like to highlight thermal storage. By the end of 2018, the current storage capacity of CSP plants exceeded more than 10 times the capacity of all batteries connected to the network – worldwide. This mature technology, of great capacity in terms of volume of energy and power of delivery, has demonstrated its reliability – without major degradations. It offers flexibility services for the electrical systems and can be combined with the steam cycles of both coal and combined cycles that will have to be dismantled, especially in Europe. This will reduce the economic and social impact of the dismantling.

The development of specific applications for each market and its own natural resources could precisely integrate technologies linked to the CSP industry and provide value for the decarbonization process. The SolarPACES conference is a privileged place to share the progress made as well as our future action lines.

I wish you a very fruitful conference and a pleasant stay in Daegu.

José Luís Martínez Dalmau
President of ESTELA
Dear friends and colleagues,

as chairman of our SolarPACES Technical Cooperation Program it is my pleasure to celebrate with you our 25th SolarPACES international Symposium. When we started this effort in 1982 in Claremont, fewer than 100 participants were present and the topic of a world with commercial concentration solar technologies was a dream. 37 years and 24 conferences later, the technology is commercial and at the very edge of competitiveness, when we consider the power prices of about 7 cents/kWh at which large commercial projects were awarded recently for solar with storage. Our conference continues to be the world’s largest and most complete technical conference on concentrating solar technologies, and this year is offering more than 350 oral and poster contributions.

Also, the SolarPACES community has grown up over the years and while technology in the infant stage may rely on a protected environment, today we have to find our position in a competitive marketplace. Research and innovation need to focus on the most relevant aspects to improve competitiveness and characteristics of solar technologies to serve evolving market needs, which now include also replacing fossil fuels in high temperature industrial direct heat applications, and with solar fuels, as well as providing a dispatchable form of solar electricity. I am convinced that our conference creates the right forum to identify and discuss these aspects and serves as a catalyzer to address them in international joint activities.

I wish to express my sincere thanks to our Korean hosts for their support in the conference preparation and wish all of us a fruitful conference and enjoyable days in Daegu. Do not forget to download our conference app that allows not only an excellent overview and scheduling of our conference program but can also facilitate appointments between conference participants as well as other communication features.

Thanks for joining us!

Robert Pitz-Paal
Chair of the SolarPACES Executive Committee
### Tuesday, October 01, 2019

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Room</th>
</tr>
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<tbody>
<tr>
<td>08:00</td>
<td>Registration</td>
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<tr>
<td>09:00 - 10:10</td>
<td><strong>Opening</strong></td>
<td>ROOM 325</td>
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<tr>
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<td>Welcome from Daegu City</td>
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<td>Seung Ho Lee, <em>Daegu City</em></td>
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<td>Welcome from KIER</td>
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<td>Byong-Sung Kwak, <em>KIER</em></td>
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<td>Welcome from ESTELA</td>
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<td>José Luis Martinez Dalmau, <em>ESTELA</em></td>
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<td>Welcome from SolarPACES</td>
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<td>Avi Shultz, <em>US Department of Energy</em></td>
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<tr>
<td>10:10 - 10:40</td>
<td>Coffee Break</td>
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<td>10:40 - 12:40</td>
<td><strong>CSP Markets and Projects</strong></td>
<td>ROOM 325</td>
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<td><em>Chair: Luis Crespo, Protermosolar</em></td>
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<td>World Bank MENA KIP Program Overview</td>
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<td>Manuel Millan, <em>World Bank</em></td>
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<td>CSP from ACWA Power view</td>
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<td>José Barragan Jimenez, <em>ACWA Power International</em></td>
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<td>CSP in Morocco</td>
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<td>Hicham Bouzekri, <em>Masen</em></td>
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<td>NOOR 3 - One Year Operation Experience</td>
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<td>Sergio Relloso, <em>SENER</em></td>
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<td>CSP Technology and Industry Development in China</td>
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<td>Fengli Du, <em>China Solar Thermal Alliance</em></td>
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<td>Delingha 50MW and Gonghe 50MW Project Status</td>
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<td>Andy Zhao, <em>SUPCON</em></td>
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<td>Cerro Dominador Project Status</td>
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<td>Fernando Gonzalez, <em>Cerro Dominador</em></td>
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<td>12:40 - 14:00</td>
<td>Lunch Break</td>
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<tr>
<td>14:00 - 15:30</td>
<td>Panel: CSP/PV Hybrids: The Future of CSP?</td>
<td>Room 325</td>
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<td>Hybridization of CSP with PV installations represents a growing trend within the CSP development community. What is the business case for such “hybrid” systems? What is the definition of a hybrid system and what configurations are currently under development or being considered for the future markets? What is the value proposition for grid operators and/or utility off-takers? A select group of experts will speak toward these questions, representing perspectives from technology vendors, developers, off-takers, and system modelers.</td>
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<td>Chair: Mark Mehos, NREL</td>
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<td>Mark Schmitz, TSK Flagsol</td>
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<td>Michael Wagner, NREL</td>
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<td>Abderrahim Jamrani, Masen</td>
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<td>José Barragan Jimenez, ACWA Power International</td>
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<td>Cristina Prieto, Abengoa</td>
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<td>15:30 - 16:00</td>
<td>Coffee Break</td>
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<tr>
<td>16:00 - 17:30</td>
<td>Panel: Flexible Market Environments for CSP Operation</td>
<td>Room 325</td>
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<td>The panel will focus on the boundary conditions, flexible markets impose on the operation of CSP plants. Due to the storage and backup power capacity of CSP plants it can be expected that they will play an important role as balancing power in electricity grids with high shares of volatile renewables. The panel shall highlight the commercial exploitation of the electricity produced in CSP plants. The speakers will report about today's and future market boundary conditions. Speakers from R&amp;D will present which methods are developed to support the dispatching challenge.</td>
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<td>Chair: Paul Gauché, Sandia</td>
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<td>Ricardo Renedo, ENTSO-E</td>
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<td>Hank Price, Solar Dynamics</td>
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<td>Ana Carolina do Amaral Burghi, DLR</td>
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<td>Marcel Bial, Estela</td>
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<td>Johan Lilliestam, IASS-Potsdam</td>
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<td>17:30 - 19:00</td>
<td>Poster Session 1</td>
<td>Grand Ballroom A</td>
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<td>GRAND BALLROOM A</td>
<td>See page 33 for further details.</td>
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<tr>
<td>19:00 - 20:30</td>
<td>Welcome Reception</td>
<td>Grand Ballroom</td>
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</tbody>
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# Wednesday, October 02, 2019

## 08:30 - 10:10  CSP Technology Innovation

### Room 325

- **CSP Storage Beyond Sunbelt for Global Energy Transition from Fossil to Renewables - Converting Coal Plants into Storage Plants**
  - **Michael Geyer**, DLR
- **Progress Toward Commercial Deployment of sCO2 Brayton Power Cycles**
  - **Matthew Carlson**, Sandia National Laboratories
- **Fuels from Air and Sunlight**
  - **Philipp Furler**, ETH Zurich
- **Modular Tower CSP Technology for Record Low LCOE**
  - **Craig Wood**, Vast Solar

### Coffee Break

## 10:40 - 12:40  Session 2-A: Central Receiver Systems

### Room 325  
**Chair: Wesley Stein, CSIRO**

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
<th>Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:40</td>
<td>Study of the Optimum Discrete Structure Configuration in Obstructed Flow Particle Heating Receivers</td>
<td>Hany Al-Ansary¹, Abdelrahman El-Leathy¹, Abdulelah Alsawaiy¹, Shaker Alaqel¹, Nader Saleh¹, Rageh Saeed¹, Zeyad Al-Suhaibani¹, Syed Danish¹, Eldwin Djaadiwinata¹, Sheldon Jeter²</td>
<td>¹ King Saud University; ² Georgia Institute of Technology</td>
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<tr>
<td>11:00</td>
<td>Optimizing a Falling Particle Receiver Geometry using CFD Simulations to Maximize the Thermal Efficiency</td>
<td>Brantley Mills¹, Benjamin Schroeder¹, Lindsey Yue¹, Reid Shaeffer¹, Clifford Ho¹</td>
<td>¹ Sandia National Laboratories</td>
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<td>11:20</td>
<td>Multiresolution Analysis of the Thermal Stresses in an Absorber Bayonet Tube for SPT Receivers</td>
<td>Rafael Pérez-Álvarez¹, Antonio Acosta-Iborra¹, Domingo Santana¹</td>
<td>¹ University Carlos III of Madrid</td>
</tr>
<tr>
<td>11:40</td>
<td>The Effect of Wind Velocity and Turbulence Intensity on the Particle Egress from Falling Particle Receivers</td>
<td>Nima Sedaghatizadeh</td>
<td>University of Adelaide</td>
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<tr>
<td>12:00</td>
<td>Design of a Multi-Stage Falling Particle Receiver with Truncated-Cone Geometry</td>
<td>Jin-Soo Kim¹, Wilson Gardner¹, Daniel Potter¹, Yen Chean Soo Too¹</td>
<td>¹ CSIRO</td>
</tr>
<tr>
<td>12:20</td>
<td>Active Airflow for Reducing Advective and Particle Loss in Falling Particle Receivers</td>
<td>Lindsey Yue¹, Reid Shaeffer¹, Brantley Mills¹, Clifford Ho¹</td>
<td>¹ Sandia National Laboratories</td>
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### 10:40 - 12:40 Session 2-B: Thermal Energy Storage

**Room:** 320  
**Chair:** Pierre Garcia, CEA LITEN

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<tr>
<th>Time</th>
<th>Title</th>
<th>Author(s)</th>
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</table>
| 10:40| A New Reduced Model Based on Dimensionless Dual-Phase Approach for Thermocline Energy Storage Systems Optimization | Yousra Filali Baba¹, Ahmed Al Mers¹  
² École Nationale Supérieure d’Arts et Métiers Meknes (ENSAM)                                                   |
| 11:00| Prediction of Thermocline Zone Development at the Beginning of Dynamic Processes in Single Storage Tanks with Liquid Media | Rocío Bayón¹, Esther Rojas¹  
¹ CIEMAT-PSA                                                                                                                             |
| 11:20| Spray-Graphitization Against Molten Nitrate Salts Corrosion for Concentrated Solar Power Plants | Yaroslav Grosu¹, Udayashankar Nithiyanantham¹, Mikel Gonzales¹, Luis González¹, Abdelali Zaki¹, Abdessamad Faik¹  
¹ CIC Energigune                                                                                                                        |
| 11:40| Experience from Commissioning Tests on ENEA’s Thermocline Molten Salt/Pebbles Pilot Plant | Walter Gaggioli¹, Luca Turchetti¹, Salvatore Sau¹, Annachiara Tizzoni¹, Elisabetta Veca¹, Giuseppe Petroni¹, Carlo Rocca¹, Primo Di Ascenzi¹, Pasquale Pagano¹, Mauro Giorgetti¹  
¹ ENEA                                                                                                                                    |
| 12:00| Anodic and Cathodic Protection Assessment on Chloride Molten Salts for the Next Generation of CSP Plants | Angel G. Fernandez¹, Luisa F. Cabeza¹  
¹ University of Lleida                                                                                                                      |
| 12:20| Experimental and Numerical Investigation of a 4 MWh High Temperature Molten Salt Thermocline Storage System with Filler | Christian Odenthal¹, Freerk Klasing¹, Thomas Bauer¹  
¹ DLR                                                                                                                                     |

### 10:40 - 12:40 Session 2-C: Parabolic Trough Systems

**Room:** 321  
**Chair:** Loreto Valenzuela, PSA-CIEMAT

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<th>Time</th>
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<th>Author(s)</th>
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| 10:40| A Way to Increase Parabolic Trough Plant Yield by Roughly 2% Using All Sky Imager Derived DNI Maps | Bijan Nouri¹, Kareem Noureldin¹, Tim Schlichting¹, Stefan Wilbert¹, Tobias Hirsch¹, Marion Schroedter-Homscheidt¹, Pascal Kuhn¹, Andreas Kazantzidis¹, Luis Zarzalejo¹, Philippe Blanc¹, Zeyad Yasser¹, Jesús Fernández², Robert Pitz-Paal¹  
¹ DLR; ² University of Patras; ³ CIEMAT; ⁴ MINES ParisTech; ⁵ TSK Flagsol; ⁶ CIEMAT-PSA                                                                 |
| 11:00| Online Corrosion Monitoring System for Thermal Storage Tanks Using Molten Salts. Laboratory Scale-Up to Demonstration Parabolic-Trough Plant | F.J. Pérez¹, M.T. de Miguel¹, V. Encinas-Sánchez¹, M.I. Lasanta¹, A. Ilirana¹, G. García-Martín¹  
¹ Complutense University of Madrid                                                                                                             |
| 11:20| A Line-Focused Solar Furnace for Large Area Thermal Experiment       | Zhiying Cui¹, Fengwu Bai¹, Xiliang Zhang¹, Chuncheng Zang¹, Huibin Zhu¹, Zhifeng Wang¹  
¹ Institute of Electrical Engineering, CAS                                                                                                      |
## Wednesday

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Presentation Title</th>
<th>Authors</th>
</tr>
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<tbody>
<tr>
<td>11:40</td>
<td>CFD Modeling of Nitrate Salts in a Receiver Tube for Freeze Recovery</td>
<td>Guangdong Zhu, Luca Imponenti</td>
<td>1 NREL; 2 Solar Dynamics</td>
</tr>
<tr>
<td>12:00</td>
<td>Dynamic Modeling of Molten Salt Parabolic Trough Loop</td>
<td>Li Xiao, Zijiang Yang, Yann Le Moulec, Arnaud Barthet</td>
<td>1 EDF</td>
</tr>
<tr>
<td>12:20</td>
<td>Hydrogen Mitigation Process Installation at Nevada Solar One</td>
<td>Greg Glatzmaier, Koenraad Beckers</td>
<td>1 NREL; 2 Heateon</td>
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### 10:40 - 12:00 Session 2-D: Commercial Projects

**Room:** 322  
**Chair:** Luis Crespo, Protermosolar

<table>
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<th>Time</th>
<th>Title</th>
<th>Presenter</th>
<th>Authors</th>
</tr>
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<tbody>
<tr>
<td>10:40</td>
<td>CSP Plant Construction, Start-Up, and O&amp;M Best Practices Study</td>
<td>Hank Price</td>
<td>Solar Dynamics</td>
</tr>
<tr>
<td>11:00</td>
<td>Feasibility of a Stamped Concentrator Structure for the Stellio Heliostat</td>
<td>Nicholas Rumsey-Hill, Bernd Zwingmann, Markus Balz, Gerhard Weinrebe</td>
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* *11:20* Cerro Dominador, the First CSP Plant That Will Operate in Latin-America After Having Risked Becoming a “White Elephant” Project

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<th>Time</th>
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<th>Presenter</th>
<th>Authors</th>
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<tbody>
<tr>
<td>11:40</td>
<td>The Largest CSP Project in the World: Technology, Modelling and Optimization</td>
<td>Jose Barragan Jimenez, Jose Maria Barea Garcia, Javier Lopez Carvajal</td>
<td>1 ACWA Power International</td>
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### 14:00 - 16:00 Session 3-A: Central Receiver Systems

**Room:** 325  
**Chair:** Zhifeng Wang, IEE-CAS

<table>
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<th>Time</th>
<th>Title</th>
<th>Presenter</th>
<th>Authors</th>
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<tbody>
<tr>
<td>14:00</td>
<td>Testing and Model Validation of a Prototype Moving Packed-Bed Particle-to-sCO₂ Heat Exchanger</td>
<td>Kevin Albrecht, Matthew Carlson, Hendrik Laubscher, Robert Crandell, Nicolas Delovato, Clifford Ho</td>
<td>1 Sandia National Laboratories</td>
</tr>
<tr>
<td>14:20</td>
<td>Potential of CSP Power Plants in KSA and their Ability to Provide Cheap, Dispatchable and Secure Energy in Comparison to PV</td>
<td>Esmail Mokheimer, Mohammad Shakeel, Fahad S. Al-Ismaïl, Nicholas Fryars</td>
<td>1 KFUPM; 2 Sunntics</td>
</tr>
<tr>
<td>14:40</td>
<td>Long-Term Ageing and Angular Dependence Results for a High-Temperature Absorber Coating</td>
<td>Kaoru Tsuda, Juan Felipe Torres, Yasushi Murakami, Joe Coventry</td>
<td>1 Nano Frontier Technology; 2 Australian National University; 3 Shinshu University</td>
</tr>
</tbody>
</table>
15:00 Operational Experience of Hot Air Preheating at the PROTEAS Facility
Marios Georgiou¹, Aristides Bonanos¹, Konstantinos Stokos¹, Constantinos Roussos¹,
Efstatios Stiliaris¹, Costas Papanicolas¹
¹ The Cyprus Institute

15:20 Dynamic Wind Loads on a Heliostat in the Atmospheric Boundary Layer
Matthew Emes¹, Azadeh Jafari¹, Maziar Arjomandi¹
¹ University of Adelaide

15:40 Experimental Study of Heliostat Wind Loads
Maziar Arjomandi¹, Matthew Emes¹, Azadeh Jafari¹, Jeremy Yu¹, Farzin Ghanadi², Richard Kelso³,
Benjamin Cazzolato¹, Joe Coventry³, Mike Collins⁴
¹ University of Adelaide; ² University of Newcastle; ³ Australian National University; ⁴ CSIRO

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14:00 - 15:40 Session 3-B: Thermal Energy Storage
ROOM 320
Chair: Michael Krüger, DLR

14:00 Update on Unifying Capture, Storage and Discharge of Thermal Energy using Miscibility Gap Alloys
Mark Copus¹, Stuart Hands², Erich Kisi²
¹ University of Newcastle; ² CSIRO

14:20 Predictive Model for the Phase Diagrams of Ternary Mixtures Composed of Calcium, Lithium and Sodium/Potassium Nitrates
Tiziano Delise¹, Anna Chiara Tizzoni², Luca Turchetti², Natale Corsaro², Salvatore Sau²,
Silvia Licoccia¹
¹ University of Rome Tor Vergata; ² ENEA

14:40 Lessons Learned During the Manufacturing and Commissioning Phases of the ORC-PLUS Thermal Energy Storage System of 20 MWht
El Ghali Bennouna¹, Walter Gaggioli², Hassan Agalit³, Alessandro Prati¹, Roberto Lino¹,
Abdessamad Falih¹, Thomas Fluri¹, Martin Karl³, Theda Zoschke⁵
¹ IRESEN; ² ENEA; ³ Enerray Morocco; ⁴ CIC Energigune; ⁵ Fraunhofer ISE

15:00 Development and Factory Verification of the High-Energy Density Thermochemical Storage System
Hiroshi Kamiya¹, Yukio Ito¹, Takaami Yamauchi¹, Miyo Mochizuki¹, Hiroyuki Itahara¹,
Takashi Shimazu¹
¹ Aichi Steel Corporation; ² Toyota Central R&D Labs; ³ OMI Mining

15:20 Enhancing the Thermal Stability of Solar Salt to and Above 600 °C in Extended Lab-Scale
Alexander Bonk¹, Markus Braun¹, Andrea Hanke¹, Veronika Sötz¹, Thomas Bauer¹
¹ DLR

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14:00 - 16:00 Session 3-C: Power Cycles
ROOM 321
Chair: Ana Maria Ruz Frias, Solar Committee

14:00 Comparing Line-Focusing and Central Tower Solar Power Plants with s-CO₂ Binary Mixture Brayton Power Cycles
Robert Valencia-Chapi¹, Luis Coco-Enríquez¹, Javier Muñoz-Antón¹
¹ Technical University of Madrid

14:20 Current Status of the Supercritical CO₂ Power Cycle Study in KIER
Young-Jin Baik¹, Junhyun Cho¹, Hyungki Shin¹, Jongjae Cho¹, Bongsu Choi¹, Chulwoo Roh¹,
Beomjoon Lee¹, Gilbong Lee¹, Ho-Sang Ra¹
¹ Korea Institute of Energy Research
### Wednesday

**14:40** Dynamic Modeling andTransient Analysis of a Recompression Supercritical CO\textsubscript{2} Brayton Cycle  
*Pan Zhou*, Jinyi Zhang*, Yann Le Moullec*\textsuperscript{1}  
*EDF China*

**15:00** Off-Design Performance of CSP Plant Based on Supercritical CO\textsubscript{2} Cycles  
*Dario Alfani*\textsuperscript{1}, Marco Binotti\textsuperscript{1}, Marco Astolfi\textsuperscript{1}, Paolo Silva\textsuperscript{1}, Ennio Macchi\textsuperscript{1}  
*Presented by Marco Binotti*\textsuperscript{1}  
*Politecnico di Milano*

**15:20** Shouhang-EDF 10MWe Supercritical CO\textsubscript{2} Cycle + CSP Demonstration Project  
*Pan Zhou*  
*EDF China*

**15:40** Thermodynamic Analysis of an Indirect Supercritical CO\textsubscript{2} – Air Driven Concentrated Solar Plant with a Packed Bed Thermal Energy Storage  
*Silvia Trevisan*\textsuperscript{1}, Rafael Guédez*\textsuperscript{1}, Björn Laumert*\textsuperscript{1}  
*KTH Royal Institute of Technology*

### 14:00 - 15:20 Session 3-D: Hybridization  
**Room 322**  
**Chair: Mark Mehos, NREL**

**14:00** First-of-a-Kind Demonstration of a Direct Hybrid Between a Solar Receiver and the Radiant Burner Technology  
*Alfonso Chinnici*\textsuperscript{1}, Graham J. Nathan\textsuperscript{1}, Bassam B. Dally\textsuperscript{1}  
*University of Adelaide*

**14:20** Improvements of CSP/Biomass Hybridisation with Single-Phase Fluids  
*João Soares*\textsuperscript{1}, Armando Oliveira\textsuperscript{1}, Szabolcs Varga\textsuperscript{1}  
*CIENER-INEGI*

**14:40** Combined Heat/Cooling and Power Generation Using Hybrid Micro Gas Turbine in a CST Plant for a Residential Off-Grid Application  
*José González-Aguilar*\textsuperscript{1}, Francesco Rovensei\textsuperscript{1}, Miguel Ángel Reyes-Belmonte\textsuperscript{1}, Manuel Romero\textsuperscript{1}  
*IMDEA Energy Institute*

**15:00** Influence of the Solar-to-Fuel Ratio on the Performance of a Hybrid Solar Receiver Combustor Utilising Biomass-Derived Syngas  
*Alfonso Chinnici*\textsuperscript{1}, Graham J. Nathan\textsuperscript{1}, Bassam B. Dally\textsuperscript{1}  
*University of Adelaide*

### 16:00 - 16:30 Coffee Break

### 16:30 - 18:30 Session 4-A: Central Receiver Systems  
**Room 325**  
**Chair: Alain Ferriere, PROMES-CNRS**

**16:30** Investigating Environmental Impacts of Particle Emissions from a High-Temperature Falling Particle Receiver  
*Clifford Ho*\textsuperscript{1}, Christian Pattyn\textsuperscript{1}  
*Sandia National Laboratories*

**16:50** A Sensitivity Study on a Non-Intrusive Optical (NIO) Method to Measure Optical Errors of Heliostats in Utility-Scale Power Tower Plants  
*Guangdong Zhu*  
*NREL*
### Session 4-B: Thermal Energy Storage

**Room: 320**

**Chair:** Nicolas Calvet, Khalifa University

<table>
<thead>
<tr>
<th>Time</th>
<th>Talk Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>16:30</td>
<td>Pumped Thermal Electricity Storage with Supercritical CO₂ Cycles and Solar Heat Input</td>
<td>Joshua McTigue¹, Pau Farres-Antunez², Kevin Ellingwood³, Ty Neises³, Alexander White³</td>
</tr>
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<td>¹ NREL; ² Cambridge University; ³ University of Utah</td>
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<td>16:50</td>
<td>Lateral Thinking on Storage. Getting the Most When it is Empty</td>
<td>Luis Crespo Rodriguez</td>
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<td>17:10</td>
<td>System Level Analysis of a Sodium Boiler Receiver and Phase Change Storage for Solar Thermal Power Generation Using SolarTherm</td>
<td>Zebedee Kee¹, John Pye¹, Joe Coventry¹</td>
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<td>¹ Australian National University</td>
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<td>17:30</td>
<td>Multi-Scale Modelling of a Large Scale Shell-and-Tube Latent Heat Storage System for Direct Steam Generation Power Plants</td>
<td>Clément Beust¹, Pierre García¹, Erwin Franquet⁴, Jean-Pierre Bédéccarrats⁴, Jérôme Pouvreau⁴, Jean-François Fourmigué¹</td>
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<td>¹ CEA LITEN; ² UPPA-LaTEP</td>
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<td>17:50</td>
<td>Development of a Particle Heat Exchanger with a Vertical Pipe Array for Particle Thermal Energy Storage Systems</td>
<td>Yen Chean Soo Too¹, Jin-Soi Kim¹</td>
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<td>¹ CSIRO</td>
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<td>18:10</td>
<td>Cost Reduction by Internally Insulating Hot Tanks in Molten Nitrate Power Tower Plants</td>
<td>Youyang Zhao¹, Judith Vidal¹</td>
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<td>¹ NREL</td>
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### Session 4-C: Power Cycles

**Room: 321**

**Chair:** José Luis Martinez Dalmau, ESTELA

<table>
<thead>
<tr>
<th>Time</th>
<th>Talk Title</th>
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<tbody>
<tr>
<td>16:30</td>
<td>Techno-Economic Analysis of an Innovative Purely Solar Driven Combined Cycle System Based on Packed Bed TES Technology</td>
<td>Silvia Trevisan¹, Tianqi Ruan¹, Wujun Wang¹, Björn Laumert¹</td>
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<td>¹ KTH Royal Institute of Technology</td>
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### Wednesday

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<th>Time</th>
<th>Session Title</th>
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<tr>
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<td>1 Fraunhofer ISE; 2 PROMES-CNRS; 3 CEA LITEN; 4 CIEMAT-PSA; 5 KAEFER Isoliertechnik; 6 ORCAN Energy; 7 Aalborg CSP</td>
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<tr>
<td>17:10</td>
<td>Integrated Solar Combined Cycle Using Particles as Heat Transfer Fluid and Thermal Energy Storage Medium for Flexible Electricity Dispatch</td>
<td>Miguel Angel Reyes-Belmonte, Manuel Romero, José González-Aguilar</td>
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<td>1 IMDEA Energy Institute</td>
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<tr>
<td>17:30</td>
<td>Techno-Economic Analysis of a Solar Hybrid Combined Cycle Power Plant Integrated with a Packed Bed Storage at Gas Turbine Exhaust</td>
<td>Silvia Trevisan, Rosa Pillar Merchán Corral, Rafael Guédez, María Jesús Santos Sánchez, Alejandro Medina Domínguez, Björn Laumert, Antonio Calvo-Hernández</td>
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<td>1 KTH Royal Institute of Technology; 2 University of Salamanca</td>
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<tr>
<td>17:50</td>
<td>An Update on the Status of a Reduced Flow Test of a 10MW 700 °C sCO₂ Integrally Geared Comborder</td>
<td>Jason Wilkes, Rotating Machinery Group</td>
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### 16:30 - 18:30 Session 4-D: Policy & Marketing

**Room 322**

Chair: Piero de Bonis, European Commission

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<th>Time</th>
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<tr>
<td>16:30</td>
<td>The Near-to-Mid-Term Outlook for CSP: Mostly Cloudy, Chance of Sun</td>
<td>Johan Lilliestam, Lana Ollier, Richard Thonig</td>
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<td>1 Institute for Advanced Sustainability Studies (IASS)</td>
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<tr>
<td>16:50</td>
<td>Lessons from PV and Wind Power on How to Build an Internationally Competitive CSP Industry in China</td>
<td>Alina Gilmanova, Jorrit Gosens, Johan Lilliestam</td>
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<td>1 Institute of Electrical Engineering, CAS; 2 Aalborg University; 3 ETH Zurich</td>
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<tr>
<td>17:10</td>
<td>LCOE Reduction Potential of Parabolic Trough and Solar Tower Technology in G20 Countries Until 2030</td>
<td>Juergen Dersch, Simon Dieckmann, Klaus Hennecke, Robert Pitz-Paal, Michael Taylor, Pablo Palon</td>
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<td>1 DLR; 2 International Renewable Energy Agency (IRENA)</td>
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<td>17:30</td>
<td>Identifying Optimum CSP Plant Configurations for Spot Markets Using a Dispatch Optimization Algorithm – A Case Study for Chile</td>
<td>Adriana Zurita, Anna Strand, Rafael Guédez, Rodrigo Escobar</td>
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<td>1 Pontificia Universidad Católica de Chile; 2 KTH Royal Institute of Technology</td>
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<td>17:50</td>
<td>Analysing the Barriers and Drivers to CSP in the EU. Policy Implications</td>
<td>Christoph Kiefer, Pablo del Río</td>
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<td>1 Spanish National Research Council (CSIC)</td>
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<td>1 Technical University of Madrid</td>
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</table>
18:30 - 19:30  **Poster Session 2**  
GRAND BALLROOM A  
See page 37 for further details.

18:45  **Gala Dinner**  
The Conference Dinner is sponsored by SQM. Thank you!  
It will take place at Hotel Interburgo Exco, right across the street from EXCO convention center.  

**Address:** Hotel Interburgo Exco  
Ballroom A  
80, Yutongdanji-ro,  
Buk-gu,  
41515 Daegu
Thursday, October 03, 2019

08:30 - 10:10  **Session 1-A: Central Receiver Systems**

**ROOM 325**

*Chair: Paul Gauché, Sandia*

<table>
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<th>Time</th>
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<tr>
<td>08:30</td>
<td>Overview and Design Basis for the Gen 3 Particle Pilot Plant (G3P3)</td>
<td>Clifford Ho¹, Kevin Albrecht¹, Lindsey Yue¹, Brantley Mills¹, Jeremy Sment¹, Joshua Christian¹, Matthew Carlson¹</td>
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<tr>
<td>*08:50</td>
<td>The Synhelion Absorbing Gas Solar Receiver: A Route Towards 1500°C Process Heat</td>
<td>Philipp Furler¹, Philipp Good¹, Simon Ackermann¹, Lukas Geissbühler¹</td>
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<td>¹ Synhelion SA</td>
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<td>09:10</td>
<td>A High Temperature Receiver for a Solarized Micro-Gas-Turbine</td>
<td>Pinchas Doron</td>
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<td>Azrieli College of Engineering</td>
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<tr>
<td>09:30</td>
<td>The Synhelion Absorbing Gas Solar Receiver for 1500 °C Process Heat: CFD Modeling</td>
<td>Simone A. Zavattoni², Davide Montorfano², Philipp Good², Gianluca Ambrosetti², Maurizio C. Barbato²</td>
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<td>² SUPSI - DTI - MEMTi, Synhelion SA</td>
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<td>09:50</td>
<td>Techno-Economic Optimization and Benchmarking of a Solar-Only Powered Combined Cycle with High-Temperature TES Upstream the Gas Turbine</td>
<td>Fritz Zaversky¹, Iñigo Les¹, Marcelino Sanchez¹, Benoît Valentin¹, Jean-Florian Brau¹, Frédéric Siros², Jonathon McGuire³, Flavien Berard³</td>
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<td>¹ CENER, ² EDF, ³ Bluebox Energy</td>
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08:30 - 10:10  **Session 1-B: Measurement Systems**

**ROOM 320**

*Chair: Peter Nitz, Fraunhofer ISE*

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<th>Time</th>
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<tbody>
<tr>
<td>08:30</td>
<td>Indirect Method to Determine Solar-Weighted Sun-Conic Reflectance</td>
<td>Florian Sutter¹, Aranzazu Fernandez-Garcia¹, Marco Montecchi³</td>
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<td>¹ DLR, ² CIEMAT-PSA, ³ ENEA</td>
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<tr>
<td>08:50</td>
<td>Enhanced Equivalent Model Algorithm for Solar Mirrors</td>
<td>Marco Montecchi¹, Florian Sutter², Aránzazu Fernández-García¹, Anna Heimsath¹, Francisco Torres¹, Cristina Pelayo³</td>
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<td>¹ ENEA, ² DLR, ³ CIEMAT-PSA, ⁴ Fraunhofer ISE, ⁵ Universidad de Zaragoza</td>
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<td>09:10</td>
<td>A Robotic Vision System for Inspection of Soiling at CSP Plants</td>
<td>Joe Coventry¹, Charles-Alexis Asselineau¹, Ehab Salahat¹, Robert Mahony¹</td>
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<td>¹ Australian National University</td>
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<td>09:30</td>
<td>Determination of Isobaric Enthalpy Differences of Heat Transfer Fluids</td>
<td>Christian Jung¹, Anke Nietsch¹, Carsten Spenke¹</td>
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<td>09:50</td>
<td>Soiling of Solar Mirrors – Study on the Impact of Incidence Angles on CSP Plant Performance</td>
<td>Anna Heimsath¹, Peter Schöttl¹, Peter Nitz¹, Claudia Sutarthio²</td>
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<td>¹ Fraunhofer ISE, ² University of Freiburg</td>
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</table>
**08:30 - 10:10 Session 1-C: Water Consumption Management**

**Room:** 321  
**Chair:** Christoph Richter, SolarPACES

**08:30**

T-TraCS - an Automated Method to Measure Soiling Losses at Parabolic Trough Receiver Tubes  
*Fabian Wolfertstetter*, Stefan Wilbert¹, Philipp Bellmann¹, Sergio Gonzalez-Rodriguez¹, Lothar Keller¹, Tomas Reche-Navarro¹, Aranzazu Fernandez-Garcia¹  
¹ DLR; ² Technical University of Dresden; ³ CIEMAT-PSA

**08:50**

Cleaning Concentrating Solar Power Mirrors Without Water  
*Adam Bennett*, Christopher Sansom¹, Peter King¹, Katherine Gobey¹, Herbert Merkle¹  
¹ Cranfield University

**09:10**

Saving Water on Concentrated Solar Power Plants: The Holistic Approach of the WASCOP Project  
*Delphine Bourdon*, Fabian Wolfertstetter², Aranzazu Fernandez Garcia³, Christopher Sansom⁴, Itziar Azpitarte⁵, Sahar Bouaddi⁶, Gema Perez⁷, Augusto Maccari⁸, Peter Van Nijnatten⁹, Eric Surquin¹⁰, Fabrizio Perrotta¹¹  
¹ CEA; ² DLR; ³ CIEMAT-PSA; ⁴ Cranfield University; ⁵ IK4-TEKNIKER; ⁶ Masen; ⁷ RioGlass Solar; ⁸ Archimede Solar Energy; ⁹ OMT Solutions; ¹⁰ Hamon D’ Hondt; ¹¹ AMIRES

**09:30**

Simulation of the Effect of Dust Barriers on the Reduction of Mirror Soiling in CSP Plants  
*Peter King*¹, Christopher Sansom¹, Heather Almond¹, Mounia Karim¹, Lander Rodríguez Idiazabal¹  
¹ Cranfield University

**09:50**

Water Consumption and Cost of Treatment in CSP Plants Based on Operational Data; Influencing Factors and Optimization Potentials  
*Shahab Rohani*¹, Joachim Went¹, Ron Gerards², D. Frank Duvenhage³, Christof Wittwer¹, Thomas Fluri¹  
¹ Fraunhofer ISE; ² Waterleau; ³ Stellenbosch University

---

**08:30 - 10:10 Session 1-D: CSP-PV Hybrids**

**Room:** 322  
**Chair:** Ana Carolina do Amaral Burghi, DLR

**08:30**

Performance Assessment of a Spectrum-Splitting PV/CSP Hybrid Plant  
*Nicholas Liew*, Zhengshan Yu¹, Zachary Holman²  
¹ Kookmin University; ² Arizona State University

**08:50**

System Analysis of Hybrid CSP-PV Plants with Integrated Thermal Storage  
*Klaus-Juergen Riffelmann*, Gerhard Weinrebe¹, Markus Balz², Mark Schmitz², Oliver Baudson³  
¹ sbp sonne; ² TSK Flagsol

**09:10**

Experimental Results of 2018 Test Campaign of the Alsolen 450 Prototype for Direct Steam Generation and Storage  
*Valéry Vuillerme*, Pierre Garcia¹, Pascal Aubouin¹, Adrien Camus¹, Elena Carnacina¹, Matthieu Manzoni¹, Etienne Bregeard²  
¹ CEA-INES; ² CEA

**09:30**

Methodology to Elaborate a Roadmap for a 100% Renewable Energy Mix in Isolated Grids Using GRIDSOIL's SRH-M  
*Eduardo Cerrajero*, Jorge Servet¹, Robert Valencia¹, Juliette Martí¹, José M. Estebaranz², Eirini Stavropoulou¹, Maria Kourasi¹, Aris Dimeas⁴, Mattia Baldini¹  
¹ IDIE; ² Cobra Industrial Plants & Energy; ³ HEDNO; ⁴ National Technical University of Athens; ⁵ Technical University of Denmark

**09:50**

Hybrid Parabolic-Type Thermosolar Gas-Turbine Power Plants: Working Fluid Analysis  
*Irene Heras*, Judit García-Ferrero¹, Maria J. Santos¹, Rosa P. Merchán¹, Alejandro Medina¹, Antonio Calvo-Hernández¹  
¹ University of Salamanca
## Thursday

**10:10 - 10:40** Coffee Break

### 10:40 - 12:40 Session 2-A: Central Receiver Systems

**Room 325**  
**Chair:** Reiner Buck, DLR

<table>
<thead>
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<th>Time</th>
<th>Title</th>
<th>Authors and Affiliations</th>
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</table>
| 10:40 | Experimental Assessment of Simultaneous in Situ Heliostats Calibration Methodology Heliocatrol at Themis Facility | Gregor Bern¹, Moritz Bitterling¹, Peter Schöttl¹, Anna Heimsath¹, Peter Nitz¹, Alain Ferriere², Yann Volut²  
¹ Fraunhofer ISE; ² PROMES-CNRS |
| 11:00 | Methodology for Identifying Improvements to a Heliostat Field Layout                                       | Willem A. Landman¹, Fabian Gross¹, Gerhard Weinrebe¹  
¹ sbp sonne |
| 11:20 | Experimental Testing of the Bladed Receiver                                                                 | John Pye  
Australian National University |
| 11:40 | Low Cost, High Accuracy 1.5 m Heliostat                                                                     | Derek Schulte¹, Kyam Krieger¹, Carl Chin¹, Alexander Sonn¹  
¹ Edisun Microgrids |
| 12:00 | Post Installation Heliostat Field Aiming Strategy Optimization Based on Heliostat Flux Distribution Measurements | Dong Ni¹, Ruidi Zhu¹, Tianfeng Yang¹, Jiamin Yang¹, Jinli Chen¹, Gang Xiao¹  
¹ Zhejiang University |
| 12:20 | An Experimental Investigation of Unsteady Pressure Distribution on Tandem Heliostats                        | Azadeh Jafari¹, Matthew Emes¹, Benjamin Cazzolato¹, Farzin Ghanadi², Maziar Arjomandi²  
¹ University of Adelaide; ² University of Newcastle |

### 10:40 - 12:20 Session 2-B: Measurement Systems

**Room 320**  
**Chair:** Luca Turchetti, ENEA

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<th>Time</th>
<th>Title</th>
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</table>
| 10:40 | Airborne Soiling Measurements of Entire Solar Fields with QFly                                             | Fabian Wolfertstetter¹, Robin Fonk¹, Christoph Prahl¹, Marc Röger¹, Stefan Wilbert¹, Jesus Fernandez-Reche²  
¹ DLR; ² CIEMAT-PSA |
| 11:00 | Characterization and Efficiency Test of a Novel Small Parabolic Trough Collector for Medium Temperature Applications | Giacomo Pierucci¹, Sahand Hosouli¹, Michele Salvestroni¹, Matteo Messeri¹,*  
Federico Fagioli², Francesco Taddei¹, Maurizio De Lucia¹  
¹ University of Florence |
| 11:20 | Hybrid Optical Method for Characterizing a Heliostat Field in a Concentrated Solar Power Plant                | Pierre-Henri Defieux¹, Cyril Caliot¹, François Hénault²  
Presented by Gilles Flamant¹  
¹ PROMES-CNRS; ² IPAG CNRS |
<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>11:40</td>
<td>Physical Models of the Bidirectional Reflectance of a Solar Receiver Paint</td>
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<td>Moritz Bitterling¹, Gregor Bern¹, Peter Schöttl¹, Sophie Gledhill¹, Helen Rose Wilson¹, Anna Heimsath¹, Peter Nitz¹</td>
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<td>¹ Fraunhofer ISE</td>
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<tr>
<td>12:00</td>
<td>Parallel Soiling Measurements for 4 Mirror Samples During Outdoor Exposure with TraCS</td>
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<td>Fabian Wolfertstetter², Natalie Hanrieder¹, Philipp Bellmann², Abdellatif Ghennoui³, Johannes Wette¹, Arantzazu Fernandez-Garcia⁴</td>
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<td>¹ DLR; ² Technical University of Dresden; ³ IRESEN; ⁴ CIEMAT-PSA</td>
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### 10:40 - 12:40 Session 2-C: Reliability

**Room 321**

**Chair:** Keith Lovegrove, ITP Renewables

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<thead>
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<th>Time</th>
<th>Title</th>
<th>Authors</th>
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<tr>
<td>10:40</td>
<td>10,000 h of Corrosion Testing on Molten Solar Salt of IN617 and Uncoated and Aluminide Coated Ferritic Steels at 580 °C</td>
<td>Alina Agüero Bruna¹, Pauline Audigié¹, Sergio Rodríguez¹</td>
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<td>¹ Instituto Nacional de Técnica Aeroespacial INTA</td>
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<td>11:00</td>
<td>Comparative Study on Hydrogen Issues of Biphenyl/Diphenyl Oxide and Polydimethylsiloxane Heat Transfer Fluids</td>
<td>Christian Jung¹, Senholdt Marion¹</td>
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<td>¹ DLR</td>
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<tr>
<td>11:20</td>
<td>Effect of Concentrated Solar Power Plants on the Socio-Economic and Livelihood Assets of the Local Community and Environment</td>
<td>Mounia Karim¹, Heather Almond¹, Chris Sanssom¹, Nazmiye Balta Ozkan¹, Pegah Mirzania¹, Peter King¹</td>
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<td>¹ Cranfield University</td>
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<tr>
<td>11:40</td>
<td>Forty Shades of Black: A Benchmark of High Temperature Sprayable Black Coatings Applied on Haynes 230</td>
<td>Simon Caron¹, Jorge Garrido², Eneko Setien³, Ivan Jerman⁴, Luka Noc⁵, Marc Röger¹, Florian Sutter¹</td>
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<td>¹ DLR; ² KTH Royal Institute of Technology; ³ CIEMAT-PSA; ⁴ National Institute of Chemistry</td>
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<tr>
<td>12:00</td>
<td>Thermal Shock Resistance of Multilayered Silicon Carbide Receiver Tubes for 750°C Molten Salt Concentrating Solar Power Application</td>
<td>Kenneth Armijo¹, Matthew Walker¹, Joshua Christian¹, Herbert Feinroth¹, Mark Stavig¹, Steven Oliverio¹, Dimitri Madden¹</td>
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<td>¹ Sandia National Laboratories; ² Ceramic Tubular Products</td>
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<tr>
<td>12:20</td>
<td>High Reliability Steam Generator System Developed by CMI Energy for Peaker Plants</td>
<td>Ildo Agnetti, John Cockerill</td>
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**Thursday**

### 10:40 - 12:00 **Session 2-D: Heat Transfer Fluids**

ROOM 322  
*Chair: Massimo Falchetta, ENEA*

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<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
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</table>
| *10:40* | Comparative Study on Forced Heat Transfer Performance of Molten Salt Based Nanofluid | **Canccan Zhang**  
*Beijing University of Technology* |

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speakers</th>
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</table>
| 11:00  | Component Testing with Molten Salt at the TESIS:com Facility         | **Dirk Krüger**  
**Joshua Tholen**, **Heiko Schenk**, **Christian Odenthal**, **Daniel Högemann**,  
**Andrew Lochbrunner**, **Mirko Saur**, **Dietmar Fehlberg**  
*1 DLR; 2 heat11; 3 Senior Flexonics; 4 etherm* |

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<tr>
<th>Time</th>
<th>Title</th>
<th>Speakers</th>
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</thead>
</table>
**Jaap Hoffmann**  
*1 Stellenbosch University* |

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<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speakers</th>
</tr>
</thead>
</table>
| 11:40  | Particle Flow and Heat Transfer in Fluidized Bed-in-Tube Solar Receivers | **Alex Le Gal**  
**Benjamin Grange**, **Ronny Gueguen**, **Mickael Donovan**, **Jean-Yves Peroy**,  
**Gilles Flamant**  
*1 PROMES-CNRS* |

**12:40 - 14:00** Lunch Break

### 14:00 - 15:40 **Session 3-A: Process Heat**

ROOM 325  
*Chair: Markus Haider, TU Wien*

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
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</table>
| 14:00  | Technical Feasibility of Integrating Concentrating Solar Thermal Energy in the Bayer Alumina Process | **Woei Lean Saw**  
*University of Adelaide* |

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
</table>
| 14:20  | Solar Rotary Kiln for Continuous Treatment of Particle Material: Chemical Experiments from Micro to Milli Meter Particles Size | **Stefania Tescari**  
**Pradeepkumar Sundarraj**, **Gkiokchan Moumin**, **Juan Pablo Rincon Duarte**,  
**Christos Agrafiotis**, **Lamark de Oliveira**, **Christian Willsch**, **Martin Roeb**,  
**Christian Sattler**  
*1 DLR* |

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
</table>
| 14:40  | Optical-Thermal-Mechanical Coupled Analysis for Efficiency Calculation of a New Innovative Concentrating Solar Collector for Medium-Temperature Applications | **Leticia Aldaz Asurmendi**  
**Amaia Mutuberria**, **Ana Bernardos**  
*1 DLR* |

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
</table>
| 15:00  | Numerical Simulation and Economic Assessment of Solar Process Heat and Cooling for a Portuguese Brewing Factory | **João Soares**  
**André Parente**, **Szabolcs Varga**,  
**Armando Oliveira**  
*1 CIENER-INEGI; 2 University of Porto* |

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
</table>
| 15:20  | First-of-a-Kind Investigation on Performance of a Directly-Irradiated Windowless Vortex-Based Particle Receiver | **Alfonso Chinnici**  
**Dominic Davis**, **Timothy C.W. Lau**,  
**Zhao F. Tian**, **Woei Saw**,  
**Graham J. Nathan**  
*1 University of Adelaide* |
### 14:00 - 15:20 Session 3-B: Thermochemical Energy Storage

**ROOM 320**  
*Chair: Gilles Flamant, CNRS-PROMES*

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Presenters</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:00</td>
<td>Techno-Economic Analysis of Thermochemical Storage for CSP Systems</td>
<td>Reiner Buck, Stefania Tescari, Martin Schmücker, Nicole Preisner, Christos Agrafiotis</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>DLR</em></td>
</tr>
<tr>
<td>14:20</td>
<td>Thermochemical Heat Storage for CSP Using Mn$_2$O$_3$/Mn$_3$O$_4$: Effects of Si Doping in Cyclability Improvement</td>
<td>Daniel Bielsa, Abdelali Zaki, Abdessamad Faik, Pedro L. Arias</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>CIC Energigune; University of the Basque Country</em></td>
</tr>
<tr>
<td>14:40</td>
<td>Design and Techno-Economic Analysis of a Fluidized Bed-Based CaO/Ca(OH)$_2$ Thermochemical Energy Combined Storage/Discharge Plant with Concentrated Solar Power</td>
<td>Shiladitya Ghosh, Paul Fennell</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Imperial College London</em></td>
</tr>
<tr>
<td>15:00</td>
<td>A Novel Fluidized Bed Thermochemical Battery for Chemical Energy Storage in Concentrated Solar Power Systems</td>
<td>Roberto Solimene, Claudio Tregambi, Fabio Montagnaro, Piero Salatino</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Istituto di Ricerche sulla Combustione - CNR; Università di Napoli Federico II</em></td>
</tr>
</tbody>
</table>

### 14:00 - 16:00 Session 3-C: Reliability

**ROOM 321**  
*Chair: Florian Sutter, DLR*

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Presenters</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:00</td>
<td>Effect of Long Term Outdoor Exposure on Anti-Soiling Coatings for Solar Reflectors</td>
<td>Johannes Wette, Florian Sutter, Francisco Buendía-Martínez, Aránzazu Fernández-García</td>
</tr>
<tr>
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<td><em>DLR; Ciemat-PSA</em></td>
</tr>
<tr>
<td>14:20</td>
<td>Operational Modes of a 2.0 MW$_\text{th}$ Chloride Molten-Salt Pilot-Scale System</td>
<td>Kenneth Armijo, Matthew Carlson, Dwight Dorsey, Jesus Ortega, Dimitri Madden, Craig Turchi, Joshua Christian</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Sandia National Laboratories; Bridger's and Paxton; NREL</em></td>
</tr>
<tr>
<td>*14:40</td>
<td>Investigating and Modeling the Effect of Moroccan Weather Conditions on Solar Reflectors Degradation</td>
<td>Mohamed Guerguer, Sanae Naamane, Olivier Raccurt, Hassan Bouaouine</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Ecole Mohammadia d’Ingénieurs; MAScIR; CEA LITEN</em></td>
</tr>
<tr>
<td>15:00</td>
<td>Durability of Anti-Reflective Coatings for Parabolic Trough Receivers</td>
<td>Florian Sutter, Tomás Jesús Reche Navarro, Gema San Vicente, Aranzazu Fernandez-Garcia</td>
</tr>
<tr>
<td></td>
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<td><em>DLR; Ciemat</em></td>
</tr>
<tr>
<td>15:20</td>
<td>Accelerated Erosion of Coated Glass Mirrors</td>
<td>Amal Matal, Sanae Naamane</td>
</tr>
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<td><em>MAScIR</em></td>
</tr>
<tr>
<td>15:40</td>
<td>Towards the Choice of Concentrated Solar Power and Photovoltaic Materials for Moroccan Conditions</td>
<td>Sanae Naamane, Abdelouahed Chhihi, Sofia Boukheir, Mustapha Mouadine, Khadija Tahri, Sahar Bouaddi, Moulay Hafid Bouhamidi</td>
</tr>
<tr>
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<td><em>MAScIR; Masen</em></td>
</tr>
</tbody>
</table>
Thursday

### 14:00 - 15:40  Session 3-D: Advanced Materials & Manufacturing

**Room 322**  
*Chair: Avi Shultz, US Department of Energy*

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Presenter(s)</th>
<th>Affiliation(s)</th>
</tr>
</thead>
</table>
| 14:00 | Development of Nickel Superalloy Inconel Alloy 740H for uSC02 Power Cycles and Molten Salt Receivers Operating Between 600 °C to 800 °C | Stephen McCoy\(^1\), John J. de Barbadillo\(^1\), Brian Baker\(^1\), Ronald Gollihue\(^1\)  
\(^1\) Special Metals Corporation |                                                   |
| 14:20 | Identifying Structural Integrity Issues for Molten Salt Phase Change Material Thermal Storage Systems from Corrosion Behavior | Veronica Gray\(^1\), Kaleb Lippiatt\(^1\), Stuart Bell\(^1\), Salar Delkasar Maher\(^1\), Madjid Sarvghad\(^1\), Teng-Cheong Ong\(^1\), Geoffrey Will\(^1\), Theodore Steinberg\(^1\)  
\(^1\) Queensland University of Technology |                                                   |
| 14:40 | Influencing Parameters on the Sintering Process of Steel Slag-Based Ceramics for High-Temperature Thermal Energy Storage | Khlooud Al Naimi\(^1\), Nicolas Calvet\(^1\), Jean-Francois Hoffmann\(^1\), Khalid Al Ali\(^1\)  
\(^1\) Khalifa University of Science & Technology |                                                   |
| 15:00 | A Novel Low-Stress Tower Solar Receiver Design for Use with Liquid Sodium | Nicholas Bartos\(^1\), Kurt Drewes\(^1\), Allan Curtis  
\(^1\) Vast Solar |                                                   |
| 15:20 | (ZnO/Sn-In\(_2\)O\(_3\))\(_n\)/SS Multilayer Spectrally Selective Coating Structure for Solar Thermal Application | Ambesh Dixit\(^1\), Rajesh Kumar\(^1\)  
\(^1\) Indian Institute of Technology Jodhpur |                                                   |

### 16:00 - 16:30  Coffee Break

### 16:30 - 18:10  Session 4-A: Emerging Concepts

**Room 325**  
*Chair: Craig Turchi, NREL*

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Presenter(s)</th>
<th>Affiliation(s)</th>
</tr>
</thead>
</table>
| 16:30 | Design and Demonstration of a 10-meter Metallic Reflector Based Fresnel Lens, with Lower Focal Point Fixed to the Ground | Ayman Al-Maaitah\(^1\), Maryam Alansaari\(^1\), Jean-Francois Hoffmann\(^2\), Tareq Farrah\(^2\), Nicolas Calvet\(^2\)  
\(^1\) Wahaj Solar; \(^2\) Masdar Institute, Khalifa University |                                                   |
| 16:50 | Design and Analysis of a Helical Receiver for Solar Bowl Systems | Mattia Cagnoli\(^3\), Jens Jørgen Falsig\(^3\), Íñigo Pagola\(^3\), Adrian Peña Lapuente\(^3\), Laura Savoldi\(^3\), Cristóbal Villasante\(^3\), Roberto Zanino\(^1\)  
\(^1\) Politecnico di Torino; \(^2\) Aalborg CSP; \(^3\) CENER; \(^4\) IK4-TEKNIKER |                                                   |
Technion (Israel Institute of Technology) |                                                   |
| 17:30 | Moonlight Concentration Experiments of Badaling Solar Tower Power Plant in Beijing | Minghuan Guo\(^1\), Xinyu Wang\(^1\), Nan Wang\(^1\), Feihu Sun\(^1\), Xiliang Zhang\(^4\), Zhifeng Wang\(^4\)  
\(^1\) Institute of Electrical Engineering, CAS |                                                   |
| 17:50 | Feasibility Study of the Carnot-Battery Energy Storage to Utilize the Renewable Energy as a Base Power Source | Chulwoo Roh\(^1\), Junhyun Cho\(^1\), Hyungki Shin\(^1\), Jongjae Cho\(^1\), Bongsu Choi\(^1\), Young-Jin Baik\(^1\), Beomjoon Lee\(^1\), Gilbong Lee\(^1\)  
\(^1\) Korea Institute of Energy Research |                                                   |
# Program Overview

## Tuesday  
**October 1, 2019**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:00</td>
<td>Registration (ongoing)</td>
<td>Room 325</td>
</tr>
<tr>
<td>08:30</td>
<td>Opening Session</td>
<td>Room 325</td>
</tr>
<tr>
<td>10:10</td>
<td>Coffee Break</td>
<td>Room 325</td>
</tr>
<tr>
<td>10:40</td>
<td>CSP Market &amp; Projects</td>
<td>Room 325</td>
</tr>
<tr>
<td>12:40</td>
<td>Lunch</td>
<td>Room 325</td>
</tr>
<tr>
<td>14:00</td>
<td>Panel: CSP/PV Hybrids</td>
<td>Room 325</td>
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<tr>
<td>15:30</td>
<td>Coffee Break</td>
<td>Room 325</td>
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<tr>
<td>16:00</td>
<td>Panel: Flexible Market Environments</td>
<td>Room 325</td>
</tr>
<tr>
<td>17:30</td>
<td>Poster Session 1</td>
<td>Room 325</td>
</tr>
<tr>
<td></td>
<td>(Grand Ballroom A)</td>
<td>(Grand Ballroom A)</td>
</tr>
<tr>
<td>18:30</td>
<td>Welcome Reception</td>
<td>Room 325</td>
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<tr>
<td></td>
<td>(Grand Ballroom A)</td>
<td>(Grand Ballroom A)</td>
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## Wednesday  
**October 2, 2019**

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<tbody>
<tr>
<td>08:00</td>
<td>Registration (ongoing)</td>
<td>Room 325</td>
</tr>
<tr>
<td>08:30</td>
<td>CSP Technology Innovation</td>
<td>Room 325</td>
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<tr>
<td>10:10</td>
<td>Coffee Break</td>
<td>Room 325</td>
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<tr>
<td>10:40</td>
<td>CSP Market &amp; Projects</td>
<td>Room 325</td>
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<tr>
<td>12:40</td>
<td>Lunch</td>
<td>Room 325</td>
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<tr>
<td>14:00</td>
<td>Panel: CSP/PV Hybrids</td>
<td>Room 325</td>
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<tr>
<td>15:30</td>
<td>Coffee Break</td>
<td>Room 325</td>
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<tr>
<td>16:00</td>
<td>Panel: Flexible Market Environments</td>
<td>Room 325</td>
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<tr>
<td>17:30</td>
<td>Poster Session 2</td>
<td>Room 325</td>
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<tr>
<td></td>
<td>(Grand Ballroom A)</td>
<td>(Grand Ballroom A)</td>
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<tr>
<td>18:00</td>
<td>Gala Dinner</td>
<td>(ExCo Interburgo Hotel)</td>
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**Thursday**  
**October 3, 2019**

<table>
<thead>
<tr>
<th>Room 325</th>
<th>Room 320</th>
<th>Room 321</th>
<th>Room 322</th>
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<tbody>
<tr>
<td>Central Receiver Systems</td>
<td>Measurement Systems</td>
<td>Water Consumption Management</td>
<td>CSP-PV Hybrids</td>
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<tr>
<td>Coffee Break</td>
<td></td>
<td></td>
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<tr>
<td>Central Receiver Systems</td>
<td>Measurement Systems</td>
<td>Reliability &amp; Service Life</td>
<td>Heat Transfer Fluids</td>
</tr>
<tr>
<td>Lunch</td>
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<tr>
<td>Coffee Break</td>
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<tr>
<td>Emerging Concepts</td>
<td>Thermal Energy Storage</td>
<td>Software Tools</td>
<td>Solar Fuels</td>
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**Friday**  
**October 4, 2019**

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<th>Room 325</th>
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<th>Room 321</th>
<th>Room 322</th>
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</thead>
<tbody>
<tr>
<td>Central Receiver Systems</td>
<td>Solar Resource Assessment</td>
<td>Water Desalination &amp; Detoxification</td>
<td>Solar Fuels</td>
</tr>
<tr>
<td>Coffee Break</td>
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<tr>
<td>Central Receiver Systems</td>
<td>Solar Resource Assessment</td>
<td>Reliability &amp; Service Life</td>
<td>Solar Fuels</td>
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<tr>
<td>Lunch</td>
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<tr>
<td>Coffee Break</td>
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<tr>
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<td>Thermal Energy Storage</td>
<td>Software Tools</td>
<td>Solar Fuels</td>
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</table>

**Closing Session**  
(Room 325)
### Session 4-B: Thermal Energy Storage

**Room 320**  
**Chair: Rocío Bayón, CIEMAT**

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Author(s)</th>
<th>Institution(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:30</td>
<td>Ultra-High Temperature Energy Storage and Conversion: A Review of the AMADEUS Project Results</td>
<td>Alejandro Datas</td>
<td>Technical University of Madrid</td>
</tr>
<tr>
<td>16:50</td>
<td>Slag as an Inventory Material for Heat Storage in a Concentrated Solar Tower Power Plant: Final Project Results of Experimental Studies on Design and Performance of the Thermal Energy Storage</td>
<td>Michael Krüger1, Jürgen Haunstetter1, Stefan Zunft1</td>
<td>DLR</td>
</tr>
<tr>
<td>17:10</td>
<td>Predictive Model for the Ternary Mixture Composed of Calcium, Sodium and Potassium Chlorides</td>
<td>Tiziano Delise1, Tiziano Tizzoni2, Natale Corsaro2, Salvatore Sau2, Silvia Licoccia2</td>
<td>University of Rome Tor Vergata; ENEA</td>
</tr>
<tr>
<td>17:30</td>
<td>Macroscopic Investigation into the Interaction of Liquid Sodium and a Molten Carbonate PCM</td>
<td>John Severino1, Pegah Haseli1, Rhys Jacob1, Ming Liu1, Martin Belusko1, Frank Bruno1</td>
<td>University of South Australia</td>
</tr>
<tr>
<td>17:50</td>
<td>Industrial Scale cTES Cold Thermal Energy Storage: Demonstrator in La Africana CSP Power Plant and Evaluation of Benefits - SOLWATT Project</td>
<td>Arnaud Bruch1, Kumar Patchigolla2, Faisal Afsand1, Luis Millan Monte1, Sylvie Douard1</td>
<td>CEA; Cranfield University; TSK Electrónica y Electricidad</td>
</tr>
<tr>
<td>18:10</td>
<td>Design Considerations for a High-Temperature Particle Storage Bin</td>
<td>Jeremy Sment1, Kevin Albrecht1, Mario Martinez1, Clifford Ho1</td>
<td>Sandia National Laboratories</td>
</tr>
</tbody>
</table>

### Session 4-C: Software Tools

**Room 321**  
**Chair: Manuel Blanco, The Cyprus Institute**

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Author(s)</th>
<th>Institution(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:30</td>
<td>Optimal Heliostat Assignment Strategy for Multiple-Receiver Systems</td>
<td>Michael Wagner1, Megan Watkins2, Shaun Sullivan2</td>
<td>NREL; Brayton Energy</td>
</tr>
<tr>
<td>16:50</td>
<td>Object-Oriented Modelling of an External Cylindrical Receiver for Solar Tower Application</td>
<td>Giovanni Picotti1, Edoardo De Lena2, Francesco Casella2, Marco Binotti2, Giampaolo Manzolini2, Michael Cholette1, Pietro Borghesani1, Ted Steinberg2</td>
<td>Queensland University of Technology; Politecnico di Milano; University of New South Wales</td>
</tr>
<tr>
<td>17:10</td>
<td>Heliostat Aiming Strategies for Arbitrary Flux Profiles for High Temperature Gas-Based Receivers</td>
<td>Megan Watkins1, Michael Wagner2, Jacob Hinze1, Shaun Sullivan1, Eric Vollnogle1, Jake Boxleitner1</td>
<td>Brayton Energy; NREL</td>
</tr>
<tr>
<td>17:30</td>
<td>Forecasting of Power Production of a Parabolic Trough Plant Using EO and NWP Data</td>
<td>Zeyad Yasser1, Mark Schmitz1, Detlef Glum1, Marion Schroedter-Homscheid2</td>
<td>TSK Flagsol; DLR</td>
</tr>
</tbody>
</table>
# Thursday

## 17:50
Black-Box Optimization for Design of Concentrating Solar Power and Photovoltaic Hybrid Systems with Optimal Dispatch Decisions

**William Hamilton**\(^1\), Michael Wagner\(^2\), Alexandra Newman\(^1\), Robert Braun\(^1\)

\(^1\) Colorado School of Mines; \(^2\) NREL

## 18:10
Edisun Solar Field Modeling and Verification

**David A. Gross**\(^1\), Max Schmitz\(^2\), Nathan H. Thomas\(^1\), Sarah Nathanson\(^1\), Dan S. Reznik\(^3\)

\(^1\) Edisun Microgrids; \(^2\) pquadrum engineering; \(^3\) Upper West Solutions

### 16:30 - 18:10 Session 4-D: Solar Fuels

**Room 322**

**Chair:** Nikolaos Tsongidis, APTL-CERTH

#### 16:30
Production of C\(_2\)-Olefins and Hydrogen from Methane Pyrolysis with Concentrated Solar Energy

**Stephane Abanades**\(^1\)

**Presented by Hiroyuki Kimura**\(^2\)

\(^1\) PROMES-CNRS; \(^2\) IHI Corporation

#### 16:50
Experimental Study of Mn-CeO\(_2\) Coated Ceramic Foam Device for Two-Step Water Splitting Cycle Hydrogen Production with 3kW Sun-Simulator

**Hyunseok Cho**\(^1\), Tatsuya Kodama\(^1\), Nobuyuki Gokon\(^1\), Selvan Bellan\(^1\), Naoyoshi Nishigata\(^1\)

\(^1\) Niigata University

#### 17:10
Ammonia and Nitrogen-Based Fertilizer Production by Solar Thermo-Chemical Processes

**Josua Vieten**\(^1\), Dorotyta Gubán\(^1\), Martin Roeb\(^1\), Bruno Lachmann\(^1\), Sebastian Richter\(^1\), Christian Sattler\(^1\)

\(^1\) DLR

#### 17:30
Solar Fuel Production in a Modular Solar Dish Reactor System

**Philipp Furler**\(^1\), Remo Schäppi\(^2\), David Rutz\(^2\), Fabian Dähler\(^2\), Alexander Muroyama\(^2\), Philipp Haueter\(^2\), Aldo Steinfeld\(^2\)

\(^1\) Synhelion SA; \(^2\) ETH Zurich

#### 17:50
Modeling and Upscaling of a Pilot Bayonet-Tube Reactor for Indirect Solar Mixed Methane Reforming

**Carlos Rendón**\(^1\), Christian Schwager\(^1\), Mona Ghiasi\(^1\), Pascal Schmitz\(^1\), Fakhri Bohang\(^1\), Ricardo Alexander Chico Caminos\(^1\), Cristiano Jose Teixeira Boura\(^1\), Ulf Herrmann\(^1\)

\(^1\) Solar-Institut Jülich

### 18:30 - 19:30 Poster Session 3

**Grand Ballroom A**

See page 40 for further details.
## Session 1-A: Central Receiver Systems

**Room 325**  
**Chair:** John Pye, Australian National University

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
</tr>
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| 08:30  | Camera-Based Measurement of Directional and Spatial Distribution of Radiosity from High-Flux Cavity-Like Receivers by 3D Reconstruction | Ye Wang\(^1\), Wojciech Lipinski\(^1\), John Pye\(^1\)  
Australian National University |
| 08:50  | Optimization of Asymmetric Solar Receiver Design in High-Performance Thermosolar Plant in Synergy with PV-Hybrid Autonomous Heliostats | Stephanie Sigvert Sørensen\(^1\), Jens Jørgen Falsig\(^1\), Jens Taggart Pelle\(^1\), José Fernando Gallego\(^2\),  
Maria Elena Rodríguez\(^2\), Marco Antonio Carrascosa\(^3\), José Manuel Blázquez\(^1\), Severo De la Calle\(^3\)  
Aalborg CSP;\(^1\) Acciona Industrial;\(^1\) Thermal Power Engineering |
| 09:10  | Detailed and Complete-Panel Analyses of Molten Salt SPT Receivers Composed of Bayonet and Circular Tubes | Rafael Pérez-Álvarez\(^1\), Ralf Uhlig\(^2\), Domingo Santana\(^1\), Antonio Acosta-Iborra\(^1\)  
University Carlos III of Madrid;\(^2\) DLR |
| 09:30  | EvoRec: Simulation and Optimization of Solar Tower Receivers Based on Annual Performance Assessment with ANN and Evolutionary Algorithms | Peter Schötti\(^1\), Sowjanya Gunturu\(^1\), Theda Zoschke\(^1\), Gregor Bern\(^1\), Thomas Fluri\(^1\), Anna Heimsath\(^1\), Peter Nitz\(^2\)  
Fraunhofer ISE |
| 09:50  | Design of ASTRI’s High-Temperature Liquid Sodium Receiver Prototype | Charles-Alexis Asselineau\(^1\), Felix Venn\(^1\), William Logie\(^1\), Daniel Potter\(^2\), Jin-Soo Kim\(^2\), John Pye\(^1\), Joe Coventry\(^1\)  
Australian National University;\(^1\) CSIRO |

## Session 1-B: Solar Resource Assessment

**Room 320**  
**Chair:** El Ghali Bennouna, IRESEN

<table>
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<tr>
<th>Time</th>
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<th>Authors</th>
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</table>
| 08:30  | Aerosol Classification and Bias Adjustment of Global Horizontal Irradiance for Middle East–North Africa Region | Andreas Kazantzidis\(^1\), Vasilios Salamalikis\(^1\), Stavros Andreas Logothetis\(^1\), Ioannis Vamvakas\(^1\)  
University of Patras |
| 08:50  | Relations Between the Probabilities of Exceedance of Solar Radiation and Production of Concentrating Solar Thermal Systems | Miguel Larrañeta\(^1\), Daniel Álvarez-Zambrano\(^2\), Manuel A. Silva-Pérez\(^2\), Isidoro Lillo-Bravo\(^2\)  
Andalusian Association for Research and Industrial Cooperation (AICIA);\(^2\) University of Seville |
| 09:10  | Comparison of AHP and Fuzzy AHP Methods Combined with GIS for Large Scale CSP Site Selection. Case Study in Morocco | Ouafae Jbaihi\(^1\), Mohamed Cherkaoui\(^1\), Abdellatif Ghenniou\(^2\)  
Mohammed V University;\(^1\) IRESEN |
| 09:30  | Long Time Series Solar Spectra Used for Solar Field Performance Evaluation | Antoine Grosjean\(^1\), Estelle Le Baron\(^1\), Anne-Claire Pescheux\(^1\), Angela Disdier\(^4\)  
Presented by Valéry Vuillerme\(^2\)  
CEA;\(^1\) CEА-INES |
| 09:50  | The Impact of Circumsolar Diffuse Radiation on the Numerical Simulation of DNI | Yu Xie\(^1\), Mananjit Sengupta\(^1\), Yangang Liu\(^1\), Hai Long\(^1\)  
NREL;\(^2\) Brookhaven National Laboratory |
### Session 1-C: Desalination
**Room 321**
**Chair:** Diego Alarcón, PSA-CIEMAT

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>08:30</td>
<td>Assessment of a Concentrating Solar Power Plant Coupled to a Multi-Effect Distillation Unit with an Air-Cooled Condenser</td>
<td>Carlos Mata-Torres¹, Adriana Zurita¹, Patricia Palenzuela¹, Diego C. Alarcón-Padilla¹, Rodrigo A. Escobar¹</td>
<td>¹ Pontificia Universidad Católica de Chile; ² CIEMAT-PSA</td>
</tr>
<tr>
<td>08:50</td>
<td>SmallSolDes - Development of a Small-Scale Desalination Unit Driven by Solar Energy Using a Variable Geometry Ejector</td>
<td>João Soares¹, Szabolcs Varga¹, Behzad Shahzamanian¹, André Felício², Armando Oliveira¹</td>
<td>¹ CIENER-INEGI; ² University of Porto</td>
</tr>
<tr>
<td>*09:10</td>
<td>Thermoeconomic Diagnosis of Solar Desalination Plant</td>
<td>Roberto Leiva</td>
<td>Federico Santa María Technical University</td>
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### Session 1-D: Solar Fuels
**Room 322**
**Chair:** Philipp Furler, ETH Zurich

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<th>Time</th>
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<tr>
<td>08:30</td>
<td>Analysis of the Biomass Gasification Rate in a Continuous Particle-Fed Solar-Irradiated Gasifier</td>
<td>Srirat Chuayboon¹, Sylvain Rodat²</td>
<td>¹ PROMES-CNRS; ² Université Grenoble Alpes /INES</td>
</tr>
<tr>
<td>08:50</td>
<td>Lessons Learnt During the Construction and Start-Up of 3 Cylindrical Cavity-Receiver Facility Integrated in a 750 kW Solar Tower Plant for Hydrogen Production</td>
<td>Aurelio González-Pardo¹, Thorsten Denk¹, Alfonso Vidal Delgado¹</td>
<td>¹ CIEMAT-PSA</td>
</tr>
<tr>
<td>09:10</td>
<td>Solar Redox Cycling of Ceria in a Monolithic Reactor for Two-Step H₂O/CO₂ Splitting: Isothermal Methane-Induced Reduction Versus Temperature-Swing Cycle</td>
<td>Anita Haeussler¹, Srirat Chuayboon¹</td>
<td>Presented by Srirat Chuayboon¹</td>
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<td>¹ PROMES-CNRS</td>
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<td>09:30</td>
<td>Valorization of Organic Waste with the Aid of Solar Hydrothermal Liquefaction Technology</td>
<td>Nikolaos Tsongidis¹, Charikleia Poravou¹, Vasiliki Zacharopoulou¹, Dimitrios Dimitrakis¹, Athanasios Konstandopoulos¹</td>
<td>¹ APTL/CERTH</td>
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**10:10 - 10:40 Coffee Break**
### 10:40 - 12:20 Session 2-A: Central Receiver Systems

**ROON 325**  
*Chair: Clifford Ho, Sandia*

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<th>Time</th>
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| 10:40 | High Quality Heliostat Leading to New Optimal Field Layouts Coupled with an Asymmetric Receiver Geometry  
*Marco Antonio Carrascosa*, Jose Manuel Blazquez, Severo N. De La Calle, Jose F. Gallego, Maria Elena Rodriguez, Stephanie S. Sørensen, Jens Jørgen Falsig  
| 11:00 | Heliostat Aiming Corrections with Bad Data Detection  
*Mark Ayres*, Rebecca Dunn, Gary Raczką, Roger Buck  
| 11:20 | Robust Aim Point Strategy for Dynamic Solar Tower Plant Operation  
*Fabian Gross*, Willem A. Landman, Markus Balz, Dengke Sun  
1. *sbp sonne*; 2. *Dongfang Boiler Group* |
| 11:40 | System-Level Simulation of Molten Salt Small Scale CSP  
*Armando Fontalvo*, Ali Shirazi, John Pye  
1. *Austrian National University* |
| 12:00 | Cold-State Experimental Study on Discharge Characteristics of Solid Particles in a Gravity Driven Moving Bed Solar Receiver  
*Fuliang Nie*, Zhiying Cui, Ziwei Zhao, Zhifeng Wang  
1. *Institute of Electrical Engineering, CAS* |

### 10:40 - 12:20 Session 2-B: Solar Resource Assessment

**ROON 320**  
*Chair: Manuel Silva, University of Seville*

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| 10:40 | Cloudiness Characterization in Seville Using Ceilometer Measurements  
*Miguel Larrañeta*, Alberto Pérez-Gallego, Manuel. A. Silva-Pérez, Isidoro Lillo-Bravo  
1. *Andalusian Association for Research and Industrial Cooperation (AICIA)*; 2. *University of Seville* |
| 11:00 | Evaluation of an All Sky Imager Based Nowcasting System for Distinct Conditions and Five Sites  
*Bijan Nouri*, Stefan Wilbert, Niklas Blum, Pascal Kuhn, Thomas Schmidt, Zeyad Yasser, Thomas Schmidt, Luis Zarzalejo, Francisco Lopes, Hugo Silva, Marion Schröder-Homscheidt, Andreas Kazantzidis, Christian Raeder, Philippe Blanc, Robert Pitz-Paal  
| 11:20 | International Standards and Best Practices for Solar Radiation  
*Mananjit Sengupta*, Aron Habte  
1. NREL |
| 11:40 | A Moroccan LCOE Map for Concentrating Solar Power Systems  
*El Ghali Bennouna*, Abdellatif Ghennioui, Fatima Zahra Ouchani, Hachem Saadaoui  
1. IRESEN |
| 12:00 | Solar Resource Modeling for CSP: Current Status of Aerosol-Related Errors in South-Eastern Asia  
*Jose A. Ruiz-Arias*, Vicente Lara-Fanego, Tomas Cebecauer  
Presented by Tomas Cebecauer  
1. *Solargis s.r.o.* |
### Friday

#### 10:40 - 12:00  
**Session 2-C: Reliability**

**ROOM 321**  
*Chair: Fabian Wolfertstetter, DLR*

**10:40**  
Operational Modes and System Design of a 2.0 MW<sub>m</sub> Sodium-Molten Salt Pilot System  
*Kenneth Armijo<sup>1</sup>, Matthew Carlson<sup>1</sup>, Dwight Dorsey<sup>2</sup>, Jesus Ortega<sup>1</sup>, Dimitri Madden<sup>1</sup>, Craig Turchi<sup>3</sup>*  
<sup>1</sup>Sandia National Laboratories;  
<sup>2</sup>Bridgers and Paxton;  
<sup>3</sup>NREL

**11:00**  
New Equipment for Measurement of Soiling and Specular Reflectance on Solar Mirrors  
*Estelle Le Baron<sup>1</sup>*  
*Presented by Delphine Bourdon<sup>1</sup>*  
<sup>1</sup>CEA

**11:20**  
Flexible Hose Interconnect Testing for Parabolic Troughs with Nitrate Salt  
*Ryan Shininger<sup>1</sup>, Kyle Kattke<sup>1</sup>, Mark Anderson<sup>2</sup>, Francisco Ortiz Vives<sup>1</sup>, Mirko Saur<sup>1</sup>, Matthew Boyd<sup>4</sup>, Hank Price<sup>1</sup>*  
<sup>1</sup>Solar Dynamics;  
<sup>2</sup>Madison Scientific;  
<sup>3</sup>Senior Flexonics;  
<sup>4</sup>NREL

**11:40**  
Durability Testing of Solar Receiver Coatings: Experimental Results for T91 and VM12 Substrates  
*Simon Caron<sup>1</sup>, Yaniv Binyamin<sup>2</sup>, Alina Agüero<sup>3</sup>, Mathias Galetz<sup>4</sup>, Christina Hildebrandt<sup>5</sup>, Florian Sutter<sup>1</sup>*  
<sup>1</sup>DLR;  
<sup>2</sup>BrightSource Industries Israel;  
<sup>3</sup>Instituto Nacional de Técnica Aeroespacial INTA;  
<sup>4</sup>DECHEMA-Forschungsinstitut;  
<sup>5</sup>Fraunhofer ISE

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#### 10:40 - 12:40  
**Session 2-D: Solar Fuels**

**ROOM 322**  
*Chair: Seo Taebeom, Inha University*

**10:40**  
Synhelion Solar Fuels Technology  
*Philipp Furler<sup>1</sup>, Gianluca Ambrosetti<sup>1</sup>, Philipp Good<sup>1</sup>, Simon Ackermann<sup>1</sup>, Lukas Geissbühler<sup>1</sup>*  
<sup>1</sup>Synhelion SA

**11:00**  
Solar Energy Conversion and Storage Through Sulphur-Based Thermochemical Cycles Implemented on Centrifugal Particle Receivers  
*Christos Agrafiotis<sup>1</sup>, Dennis Thomey<sup>1</sup>, Lamark de Oliveira<sup>1</sup>, Nicolas Overbeck<sup>1</sup>, Vamshi Krishna Thanda<sup>1</sup>, Martin Roeb<sup>1</sup>, Christian Sattler<sup>1</sup>*  
<sup>1</sup>DLR

**11:20**  
Near-Isotermal Two-Step Water Splitting Cycle Using Metal-Doped Ceria Below 1300°C  
*Tatsuya Kodama*  
*Niigata University*

**11:40**  
*Alireza Rahbari<sup>1</sup>, Ali Shirazi<sup>1</sup>, Mahesh Venkataraman<sup>1</sup>, John Pye<sup>1</sup>*  
<sup>1</sup>Australian National University

**12:00**  
Characterization of a Pilot Fluidized Bed Reactor for Solar Calcination Processes  
*Thibaut Esence<sup>1</sup>, Emmanuel Guillot<sup>1</sup>, Mouâd Elidrissi<sup>1</sup>, Damien Poncin<sup>1</sup>, Michael Tessonneaud<sup>1</sup>, Jean-Louis Sans<sup>1</sup>, Gilles Flamant<sup>1</sup>, Antoine Saraiva<sup>1</sup>, Alex Le Gal<sup>1</sup>*  
<sup>1</sup>PROMES-CNRS

**12:20**  
Optical Design and Experimental Evaluation of a Directly Irradiated Solar Reactor for the Catalytic Dry Reforming of Methane  
*Konstantinos Kakosimos<sup>1</sup>, Tayseir Mohamed<sup>1</sup>, Jawad Sarwar<sup>2</sup>*  
<sup>1</sup>Texas A&M University at Qatar;  
<sup>2</sup>University of Engineering Technology
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<th>Time</th>
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<tr>
<td>12:40 - 14:00</td>
<td>Lunch Break</td>
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<td>14:00 - 16:00</td>
<td><strong>Closing Session</strong></td>
<td>ROOM 325</td>
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<td>Trends in CSP Technology</td>
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<td>SolarPACES Awards</td>
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<td>Announcement Next Conference</td>
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Poster Sessions

Poster Session 1  Tuesday, October 01, 2019, 17:30 - 19:00
GRAND BALLROOM A

The poster numbers are based on the topics:

| A | Advanced Materials and Manufacturing |
| B | Central Receiver Systems |
| C | Commercial Projects in the World |
| D | CSP-PV Hybrids |
| E | Dish/Engine Systems |
| F | Emerging Concepts |
| H | Heat Transfer Fluids |
| I | Hybridization |
| J | Linear Fresnel Systems |

A-01 Thermoplate CST/CSP Receivers: A Dish-Based Prototype
Daniel Codd¹, Christopher Spitler¹, Jacob Platz¹, Alex Benson¹, Hayden Spencer¹
¹ University of San Diego

B-01 A New Figure of Merit (FOM) for the Analysis of Selective Coatings
Ruben Barbero¹, Antonio Rovira¹, María José Montes¹, Fernando Varela¹
¹ Universidad Nacional de Educación a Distancia (UNED)

B-02 Analysis of the Uncertainty and Stability of ATMOS System for the Measurement of Atmospheric Attenuation of Solar Radiation at the Terrestrial Level
Ana Bernardo¹, Marcelino Sanchez¹, Carlos Fernandez-Peruchena¹, Carlos Heras¹, Iñigo Salinas¹, Sonia Escorza¹
¹ CENER; ² Universidad de Zaragoza

B-03 Advanced Control System for a High Temperature Sodium Solar Receiver
Nicole Blinco¹, Immanol Traver¹, Kurt Drewes¹, Eduardo Camacho¹
¹ Vast Solar

B-04 Particle Lift Design for a Third Generation Falling Particle Receiver
Joshua Christian¹, Clifford Ho¹, Sheldon Jeter²
¹ Sandia National Laboratories; ² Georgia Institute of Technology

B-05 Thermal Storage and Fossil Backup Level Effect on a Central Receiver Power Plant
Daniel Costa¹, Jose Neto¹
¹ Centro Federal de Educación Tecnológica de Minas Gerais

B-06 Making Central Receiver Plants Modular, More Efficient and Scalable
Luis Crespo¹, Francisco Ramos²
¹ Protermosolar; ² Nevada Software

B-07 Track-Mounted Heliostat
Christian Davila-Peralta¹, Roger Angel¹, Nick Didato¹, Matt Rademacher¹, Rafael Cabanillas¹, Pablo Sosa¹, Nick Emerson¹, Gilberto Chavez-Lopez², Noe Flores-Montijo²
¹ University of Arizona; ² University of Sonora

B-08 Basic Engineering of a High Performance Molten Salt Tower Receiver System
Miriam Ebert
DLR

B-09 Material Compatibility Between Discrete Structures in a Particle Heating Receiver and Candidate Particulates
Abdelrahman El-Leathy¹, Hany Al-Ansary¹
¹ King Saud University
| B-10 | The Capability of a Novel Jet Impingement Heat Transfer Device for the Application in Future Solar Thermal Receivers  
Derwalt Erasmus¹, Matti Lubkoll¹, Theodor Von Backström², Ken Craig²  
¹ Stellenbosch University; ² University of Pretoria |
| B-11 | Experimental and Numerical Evaluation of Drift Errors in a Solar Tower Facility with Tilt-Roll Tracking-Based Heliostats  
José González-Aguilar¹, Alejandro Martínez Hernández², Iván Bravo Gonzalo¹, Manuel Romero¹  
¹ IMDEA Energy Institute |
| B-12 | Installation and Testing of a Dense Particle Receiver Associated with a Hybrid Gas Turbine for the Next-CSP Project  
Benjamin Grange¹, Alex Le Gal¹, Gilles Flamant¹  
¹ PROMES-CNRS |
| B-13 | Potentially Confusing Coordinate Systems for Solar Tower Plants  
Fabian Gross¹, Markus Balz¹  
¹ sbp sonne |
| B-14 | Design and Configuration of Solar Thermal Multi-Tower Field Layout  
Zaharadeen Hussaini¹, Peter King¹, Chris Sansom¹  
¹ Cranfield University |
| B-15 | Effect of an External Electric Field on Free-Falling Polydisperse Particles in a Receiver  
Apurv Kumar¹, Zhenzhen Mu¹, Joe Coventry¹  
¹ Australian National University |
| B-16 | Thermal Stresses in an Elliptical Tube for Solar Power Tower Receivers  
Marta Laporte¹, Rafael Pérez Álvarez¹, Domingo Santana¹, María de los Reyes Rodríguez Sánchez¹  
¹ University Carlos III of Madrid |
| B-17 | Optimal Implementation of Scalable HeliOstat calibRation system (SHORT) in Large Heliostat Fields  
Iñigo Les¹, Marcelino Sanchez¹, Adrian Peña-Lapuente¹, Aitor Olarra², Cristobal Villasante², David Olasolo²  
¹ CENER; ² IK4-TEKNIKER |
| B-18 | Deep Learning Algorithms for Heliostat Field Calibration  
Daniel Maldonado¹, Max Pargmann¹  
¹ DLR |
| B-19 | Models of Transient Heat Transfer for Central Tower Receivers: A Review  
Juliette Marti¹, Javier Muñoz-Antón¹, Jorge Servert del Rio²  
¹ Technical University of Madrid; ² STA Solar |
| B-20 | Non-Uniformly Spaced Clips on Solar Central Receiver Tubes  
Andrés Montoya¹, María Reyes Rodríguez-Sánchez², Jorge López-Puente³, Domingo Santana¹  
¹ University Carlos III of Madrid |
| B-21 | Using Finned Bayonet Tubes in External Molten Salt Receivers  
Rafael Pérez-Álvarez¹, Ralf Uhlig², Antonio Acosta-Iborra³, Domingo Santana¹  
¹ University Carlos III of Madrid; ² DLR |
| B-22 | Detailed Process Simulation of Operational Transitions with a Molten Salt Receiver System  
Christian Schwager¹, Cristiano J. Teixeira Boura¹, Peter Schwarzbüzli², Ulf Herrmann¹  
¹ Solar-Institut Jülich; ² DLR |
| B-23 | Air Entrainment Within the Particle Curtain in a Free Falling Receiver  
Nima Sedaghatizadeh¹, Maziar Arjomandi¹, Graham Nathan¹  
¹ University of Adelaide |
| B-24 | Drop-C: The Drop-In, Ring-of-Power Heliostat: Azimuth Drive and Foundation Testing and Selection  
Rick Sommers¹, Nathan Stegall¹, Kyle Kattke¹, Tim Wendelin¹, Patrick Marcotte¹  
¹ Solar Dynamics |
| B-25 | Development of a Tracking System for a Mini Heliostat  
Ababacar Thiam¹, Marie Pascaline Sarr¹  
¹ Alioune Diop University |
| B-26 | A Novel Uniform Illumination on Receivers in Central Tower Systems Using Ray Tracing Approach  
Narayanan Venkatakrishnan¹, Hardik Kothadia², Sanjoy Chatterjee¹  
Presented by Sanjoy Chatterjee¹  
¹ Indian Institute of Technology Jodhpur |
| B-27 | Badaling Molten Salt Campaign with Dynamic Model  
Li Xiao¹, Zijiang Yang¹, Yann Le Moullec¹  
¹ EDF |
| C-01 | The Partanna Project: A First of a Kind Plant Based on Molten Salts in LFR Collectors  
Massimo Falchetta  
ENEA |
|---|---|
| C-02 | Lowering LCOE with Technical & Commercial CSP Paradigms  
Jens Taggart Pelle¹, Stephanie Sigvert Sørensen¹, Hammad Soliman¹  
¹ Aalborg CSP |
| D-01 | Exergy Analysis and Experimental Study of a Novel Integrated Concentrated Photovoltaic Thermal System  
Nikhil Gakkhar¹, Manoj K. Soni², Sanjeev Jakhar³  
¹ Sardar Swaran Singh National Institute of Bio Energy; ² Birla Institute of Technology & Science; ³ Mody University of Science and Technology |
| D-02 | Modeling and Simulation of Parabolic Trough Collector Based Concentrating Photovoltaic Cooling System with Earth Liquid Heat Exchanger  
Sanjeev Jakhar¹, Nikhil Gakkhar²  
¹ Mody University of Science and Technology; ² Sardar Swaran Singh National Institute of Bio Energy |
| E-01 | Innovative Integrated Solar Receiver/Combustor Unit for Flexible Gas Turbine Based CSP  
Cristina Blajin¹, Wujun Wang¹, Jens Fridh¹, Anders Malmquist¹  
¹ KTH Royal Institute of Technology |
| E-02 | Fractal-Like Volumetric Receiver: Assessment of Radiation Propagation  
Luca Pratticò  
Sapienza University of Rome |
| E-03 | Thermal Performance Analysis of Cylindrical Receiver in Dish System with Experimental Investigation  
Yanping Zhang¹, Chongzhe Zou¹, Quentin Falcoz³, Pierre Neveu³, Cheng Zhang¹, Xiaohong Huang⁴  
¹ Huazhong University of Science and Technology; ³ PROMES-CNRS; ⁴ Guangdong Ocean University; ⁵ Institute of New Energy, Wuhan |
| F-01 | Materials and Systems for Liquid Metal Based CSP 2.0  
Wolfgang Hering¹, Michael Boettcher¹, Joachim Fuchs¹, Alexandru Onea¹, Angela Jianu¹, Sven Ulrich¹, Robert Stieglitz¹  
¹ Karlsruhe Institute of Technology (KIT) |
| F-02 | Minimal Movement Solar Concentrator of Segmented Heliostats and a Fresnel Lens for Sun Tracking Applications  
Carlos Alejandro Ramirez Paredes¹, Alejandro Gutiérrez Ortiz², Héctor Daniel García Lara², Noel León-Rovira³, Olga Delgado Carreño²  
¹ Universidad de Monterrey; ² Universidad Autónoma de Nuevo León; ³ Tecnológico de Monterrey |
| F-03 | Low-Cost Solar Electricity Using Stationary Solar Fields; Technology Potential and Practical Implementation Challenges to be Overcome. Outcomes from H2020 MOSAIC Project  
Cristobal Villasante¹, Saioa Herrero¹, Marcelino Sanchez²  
¹ IK4-TEKNIKER; ² CENER |
| H-01 | Performance Analysis and Optimization of Particle/sCO₂ Fluidized Bed Heat-Exchanger for Next Generation CPS  
Mengda Jia¹, Peixue Jiang², Chao Wang¹  
¹ Tsinghua University |
| H-02 | Optimal Chemical Composition of the Heat Transfer Fluid Using Commercial Chloride Salts for Gen3 CSP  
Judith Vidal¹, Youyang Zhao¹  
¹ National Renewable Energy Laboratory |
| H-03 | Modelling of the Three-Dimensional Distribution of the Irradiation in a Gradually Varied Porous Absorber  
Pei Wang  
Department of Renewable Energy, China |
| I-01 | Feasibility Analysis of Smart Renewable Hubs in Non-Interconnected Island Power Systems: A Case Study for GRIDiSOl  
Mattia Baldini², Alberto Dalla Riva², Luigi Bottecchia¹, Andrea Pasquali², Jose Miguel Estebananz³  
¹ Technical University of Denmark; ² EA Energy Analyses; ³ Cobra Industrial Plants & Energy |
| I-02 | Experimental Investigation of a Mini Hybrid CSP Plant Under Tunisian Climatic Conditions  
Souha Ferchichi¹, João Soares³, Dirk Krüger¹, Amani Jmili¹, Chiheb Bouden³, Ridha Ben Cheikh¹, Abdallah Baba¹, Hamdi Kessentini¹, Armando Oliveira²  
¹ Ecole Nationale d’Ingénieurs de Tunis (ENIT); ² CIENER-INEGI; ³ DLR; ⁴ Alternative Energy Systems |
| I-03 | Design, Installation and Experimental Tests of a Biomass System for a Small Hybrid CSP Plant  
**Amani Jmili**¹, Chiheb Bouden¹, Ridha Ben Cheikh¹, Essia Znouda¹, Armando Oliveira², João Soares², Dirk Krueger³, Souha Ferchichi¹  
¹ Ecole Nationale d’Ingénieurs de Tunis (ENIT); ² CIENER-INEGI; ³ DLR | I-08 | A Comparison Between Two Innovative Integrated Solar Combined Cycle Configurations and State-Of-The-Art Plants  
**Antonio Rovira**¹, Ruben Abbas², Maria Jose Montes³, Ruben Barbero¹  
¹ Universidad Nacional de Educación a Distancia (UNED); ² Technical University of Madrid | I-04 | Hybrid CSP Biomass CO₂-Gasification Process for Power Production: ASPEN Plus Simulation  
**Xinying Liu**¹, Shahid Ansari¹  
¹ University of South Africa | I-09 | Thermodynamic Performance of Solar Aided Coal-fired Power Generation (SACPG) System under Different Integration Modes  
**Junjie Wu**  
Nanjing Institute of Technology | I-05 | Development of Hybrid CSP Biomass Gasification Process with Super Critical Carbon Dioxide Cycle for Power Generation  
**Xinying Liu**¹, Lameck Nkhonjera¹, Shahid Ansari¹  
¹ University of South Africa | I-10 | Thermodynamics Study of a Solar Hybrid Allam Cycle Integrated with Methane Reforming  
**Cheng Xu**¹, Tuantuan Xin¹, Xin Liu¹, Shaokui Li², Yongping Yang¹  
**Antonio Rovira**¹, Ruben Abbas², Consuelo Sánchez², Andres Sebastian¹  
¹ Universidad Nacional de Educación a Distancia (UNED); ² Technical University of Madrid | J-01 | Thermal Performance Evaluation of Non Vacuum Tube CPC Type Receiver for Linear Fresnel System: Experimental Characterization and Numerical Assessment  
**Yousra Filali Baba**¹, Ahmed Al Mers¹  
**Antonio Rovira**¹, Ruben Abbas², Marta Muñoz², Sergio Sanz²  
¹ Universidad Nacional de Educación a Distancia (UNED); ² Technical University of Madrid | J-02 | Modeling, Design and Performance Study of Linear Fresnel Plant: Application in Sahelian Rural Areas  
**Sory Diarra**¹  
Presented by Ababacar Thiam²  
¹ Cheikh Anta Diop University of Dakar; ² Alioune Diop University | I-08 | A Comparison Between Two Innovative Integrated Solar Combined Cycle Configurations and State-Of-The-Art Plants  
**Antonio Rovira**¹, Ruben Abbas², Maria Jose Montes³, Ruben Barbero¹  
¹ Universidad Nacional de Educación a Distancia (UNED); ² Technical University of Madrid | I-09 | Thermodynamic Performance of Solar Aided Coal-fired Power Generation (SACPG) System under Different Integration Modes  
**Junjie Wu**  
Nanjing Institute of Technology | I-10 | Thermodynamics Study of a Solar Hybrid Allam Cycle Integrated with Methane Reforming  
**Cheng Xu**¹, Tuantuan Xin¹, Xin Liu¹, Shaokui Li², Yongping Yang¹  
¹ North China Electric Power University | J-01 | Thermal Performance Evaluation of Non Vacuum Tube CPC Type Receiver for Linear Fresnel System: Experimental Characterization and Numerical Assessment  
**Yousra Filali Baba**¹, Ahmed Al Mers¹  
¹ École Nationale Supérieure d’Arts et Métiers Meknes (ENSAM) | J-02 | Modeling, Design and Performance Study of Linear Fresnel Plant: Application in Sahelian Rural Areas  
**Sory Diarra**¹  
Presented by Ababacar Thiam²  
¹ Cheikh Anta Diop University of Dakar; ² Alioune Diop University | J-03 | Fast Coupled Optical and Thermal Model for a Trapezoidal Fresnel Solar Collector  
**Freddy Ordóñez**¹, Esteban Flores², Rafael Soria¹  
¹ Escuela Politécnica Nacional (EPN) |
K-01 In-Situ Thermal Losses Measurements of Parabolic Trough Receiver Tubes Based on Infrared Camera and Artificial Intelligence
Massaab El Ydrissi, Hicham Ghennioui, El Ghali Bennouna, Farid Abdi
1 IRESEN; 2 Sidi Mohamed Ben Abdellah University

K-03 Testing of Moonlight Flux Measurement Method Using RP3 Solar-Trough Mirror Heliostat
Minghuan Guo, Xinyu Wang, Nan Wang, Xiliang Zhang, Feihu Sun, Zhifeng Wang
1 Institute of Electrical Engineering, CAS; 2 Taiyuan University of Technology

K-04 A Comparison of Corrosion Measurements for High Temperature Molten Media Environments
Kaleb Lippiatt
Queensland University of Technology

K-05 Thermal Emittance and Solar Absorptance Measurement Comparison on Receiver Tubes Absorber Samples
Fabienne Sallaberry, Javier Barriga, Alberto García de Jalón, Francisco Goñi, Raquel Erice, Gonzalo Rincón
1 CENER; 2 IK4-TEKNIKER

K-06 Scanning Autocollimator for Heliostat Mirror Characterization
Derek Schulte, Nathan H. Thomas
1 Edisun Microgrids

L-01 HPS-2 - Design of Pre-Insulated Pipe Supports for Molten-Salt Technologies
Hugo Manuel Goncalves da Silva, Gonçalo Delgado, Paula Martins, Michael Wittmann, Kai Schmitz
Presented by Mark Schmitz
1 University of Évora; 2 DLR; 3 TSK Flagsol

L-02 HPS-2 - Demonstration of Molten-Salt in Parabolic Trough Plants - Simulation Results from System Advisor Model
Hugo Manuel Gonçalves da Silva, Telma Lopes, Thomas Fasquelle, Kai Schmitz
Presented by Mark Schmitz
1 University of Évora; 2 TSK Flagsol

L-03 Évora Molten Salt Platform - Status Update
Klaus Hennecke, Manuel Colares Pereira, Pedro Horta, Hugo G. Silva, Luis Guerreiro, Diogo Canavarro, Michael Wittmann, Tobias Hirsch
1 DLR; 2 University of Évora

L-04 Modeling with CFD Using Nanofluids to Improve Thermal Performance in Parabolic Channel Concentrators
Irma Paz Hernández Rosales, Rosario de Jesus García Chavez, Abraham Ulises Chavez Ramirez, Heidi Isabel Villafan Vidal, Citalli Marnay Lopez Martinez, Arturo Fernandez Madrigal
1 Universidad Autónoma de Nayarit; 2 Centro De Investigación y Desarrollo Tecnológico En Electroquímica; 3 Instituto de Energías Renovables UNAM

L-05 Impact of Roof-Top Installation in Reducing the LCOH of Solar Heat for Industrial Processes Systems: Case Study of Morocco
Nour Eddine Laadel
IRESEN
| L-06 | SunBeam CSP Parabolic Trough Collector Development Leveraging Advanced Digital Prototyping Methods  
*Patrick Marcotte*, Nathan Stegall, Tim Wendelin  
1 Solar Dynamics |
| L-07 | Laboratory Thermal Loss Test on Small Size Absorber Tube for Process Heat Application  
*Giacomo Pierucci*, Sahand Hosouli, Michele Salvestroni, Matteo Messeri, Federico Fagioli, Francesco Taddei, Maurizio De Lucia  
1 University of Florence |
| L-08 | Reducing LCOE Through Measurement-Based Quality Assurance in Solar Fields  
*Klaus Pottler*, Steffen Ulmer, Thomas Thaufelder, Thomas Schmidt, Kai Regina  
Presented by Steffen Ulmer  
1 CSP Services; 2 CSP Services España |
| L-09 | Design and Investigation of a Closed Parabolic Trough Performance  
1 Mansoura University |
| L-10 | Design and Construction of an Experimental Parabolic Trough Collector Using Low Cost Alternative Materials  
*Hugo Machado Tôrres*, Rubén Alexis Miranda Carillo, Nelson Martins Torres  
1 Universidade Federal de Itajubá; 2 No Affiliation |
| L-11 | Fast Solar Field Simulation Using Neural Networks  
*Gerhard Weinrebe*, Willem Landman  
1 sbp sonne |
| L-12 | Optical Characterization Comparison on the ENEA Parabolic Trough Collector  
*Guangdong Zhu*  
National Renewable Energy Laboratory |
| M-01 | Prospective Energy of Paraguay - Alternative Scenario with SCP, Challenges and Benefits  
*Enrique Buzarquins*  
Itaipu Technological Park, Paraguay |
| M-02 | Modified Levelized Energy Cost (LEC) Including Societal Impact  
*Pinchas Doron*, Jacob Karni, Alexander Slocum  
1 Azrieli College of Engineering; 2 Weizmann Institute of Science; 3 Massachusetts Institute of Technology |
| M-03 | The Optimum Scale Study of the CSP Plant and Sensitivity Analysis  
*Jianhua Li*, Jianxiang Jin, Neng Xu, Xiaoling Mi, Yina Wang  
1 Zhejiang SUPCON Solar Technology |
| M-04 | Market Potential of Linear Fresnel Collectors for Solar Heat Industrial Process in Latin-America - A Case Study in Ecuador  
*Rafael Soria*, Gabriel Calza, Nathaly Cartuche, Jesús López-Villada, Freddy Ordoñez  
Presented by Freddy Ordoñez  
1 Escuela Politécnica Nacional (EPN); 2 Peoples’ Friendship University of Russia |
| N-01 | SCARABEUS: Supercritical Carbon Dioxide/Alternative Fluid Blends for Efficiency Upgrade of Solar Power Plants  
*Marco Binotti*, Gioele Di Marcoberardino, Paolo Iora, Costante Invernizzi, Giampaolo Manzolini  
1 Politecnico di Milano; 2 Università degli Studi di Brescia |
| N-02 | Electric-Thermal Energy Storage for Large-Scale Renewables and a Supercritical Carbon Dioxide Power Cycle  
*Junhyun Cho*, Hyungki Shin, Jongjae Cho, Bongsu Choi, Chulwoo Roh, Beomjoon Lee, Gilbong Lee, Ho-Sang Ra  
1 Korea Institute of Energy Research |
| N-03 | Feasibility Study of Once Through Cooling for 50 MW Solar Thermal Power Plant  
*Abiola Kehinde*  
Stellenbosch University |
| N-04 | PROTEAS Power Cycle: A Solar Rankine Cycle for Research and Development  
*Costas Marakkos*, Konstantinos Stokos, Costas Papanicolas  
1 The Cyprus Institute |
| N-05 | Supercritical CO\(_2\) (sCO\(_2\)) Power Cycle with Heat Pump Heat Sink  
*Hafiz Ali Muhammad*, Beomjoon Lee, Gilbong Lee, Junhyun Cho  
1 Korea University of Science and Technology; 2 Korea Institute of Energy Research |
| N-06 | Techno-Economic Evaluation of Cooling System Technologies for Solar Thermal Power Plants; The Relationship Between Water and Energy  
*Shahab Rohani*, Yao Wang, Riaan Terblanche, Albert Zapke, Christof Wittwer, Thomas Fluri  
1 Fraunhofer ISE; 2 Therm Development; 3 ENEXIO Germany |
Wednesday

O-01 Aluminium Melting with Indirect Solar Heating
Lars Amsbeck¹, Reiner Buck¹
¹ DLR

O-02 Integrating Concentrating Solar Technology into Mining Industry
Jesús Gómez-Hernández
University Carlos III of Madrid

O-03 The Evaluation of Solar Thermal Treatment of Manganese Ore Towards the Concept of a Solar Sinter
Lina Hockaday
MINTEK

George Karagiannakis
Centre for Research & Technology Hellas (CERTH)

O-05 Operational Experience and Behavior of a Parabolic Trough Collector System with Concrete Thermal Energy Storage for Process Steam Generation in Cyprus
Johannes Christoph Sattler¹, Ricardo Alexander Chico Caminos¹, Nicolas Ürings², Siddharth Dutta², Victor Ruiz², Soteris Kalogirou³, Panayiotis Kitisis⁴, Rafaela Agathokleous⁴, Christian Jung⁴, Spiros Alexopoulos⁴, Vikrama Atti³, Cristian Teixeira Boura³, Ulf Herrmann³
¹ Solar-Institut Jülich; ² protarget AG; ³ CADE Soluciones de Ingeniería; ⁴ Cyprus University of Technology; ⁵ DLR

O-06 A CFD-Based Approach to Selecting Acstplant Site Location Around a Ferromanganese Smelter Plant
Milan Swart¹, Susanna Hockaday¹
Kenneth Craig²
¹ MINTEK; ² University of Pretoria

O-07 Numerical Study of Fluidized Bed Particle/sCO₂ Heat Transfer
Chao Wang¹, Ruina Xu¹, Mengda Jia¹, Peixue Jiang¹
¹ Tsinghua University

O-08 A Multifunction System Based on Solar Energy for Space Heating and Steam Production
Changchun Liu¹, Zefeng Wang¹, Wei Han¹, Qilan Kang¹, Meng Liu¹
¹ Institute of Engineering Thermophysics, CAS; ² China National Institute of Standardization

P-01 Physical and Chemical Reactivity of Mechanically Primed Glass Surfaces of CSP Reflectors
Sofia Boukheir¹, Abdelouahed Chbihi¹, Amal Matal¹, Sara Lakhouil¹, Sanae Naamane¹, Mustapha Moudine¹, Moulay Hafid Bouamidi¹
¹ MASrL; ² Masen

P-02 Effect of the Solarization in Concentrating Solar Thermal Components Under Accelerating Aging Tests
Francisco Buendía-Martínez¹, Aránzazu Fernández-García¹, Florian Sutter¹, Johannes Wette¹, Lucía Martínez-Arcos², Tomas Jesús Reche-Navarro²
¹ CIEMAT-PSA; ² DLR

P-03 High Temperature Thermal Emittance and Oxidation Study of Inconel 617 as CSP Absorber Material
Luka Noc¹, Ivan Jerman¹
¹ National Institute of Chemistry

P-04 Experimental Testing of Particle Erosion and Attrition in CSP Systems
Todd Otanicar¹, Nipun Goel¹, Taylor Brown¹, Evan Gietzen¹, Michael Keller¹, Siamack Shirazi¹
¹ Boise State University; ² University of Tulsa

P-05 Building a Test Bench to Estimate the Reliability of Solar Receivers
Eneko Setien Solas¹, Jorge Garrido², Simon Caron¹, Jesus Fernandez¹, Loreto Valenzuela¹
Presented by Loreto Valenzuela¹
¹ CIEMAT-PSA; ² KTH Royal Institute of Technology; ³ DLR

P-06 How AI Technology Improving Heliostat Tracking and Control System Performance Without Increasing Cost
Wei Zhu¹, Bo Xin¹
¹ Thermal Focus
<table>
<thead>
<tr>
<th>Poster Session 3</th>
<th>Thursday, October 03, 2019, 18:30 - 19:30</th>
<th>GRAND BALLROOM A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The poster numbers are based on the topics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Software Tools for CSP Analysis and Simulation</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Solar Fuels and Chemical Commodities</td>
<td></td>
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<tr>
<td>S</td>
<td>Solar Resource Assessment</td>
<td></td>
</tr>
<tr>
<td>Q-01</td>
<td>DEM-Analysis of Granular Flow Phenomena in Particle Heat Exchangers in Solar Thermal Power Plants</td>
<td></td>
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<tr>
<td></td>
<td><strong>Philipp Bartsch</strong>: Stefan Zunft <strong>1</strong></td>
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<td></td>
<td><strong>Presented by Michael Krüger</strong>: <strong>1 DLR</strong></td>
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<tr>
<td>Q-02</td>
<td>INSHIP Dimensioning Tool for the Balance of Plant of Solar Heat for Industrial Processes Systems</td>
<td></td>
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<tr>
<td></td>
<td><strong>Rosa Christodoulaki</strong>: Loreto Valenzuela <strong>2</strong></td>
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<td><strong>Mario Biencinto</strong>: Lourdes Gonzalez <strong>1</strong></td>
<td></td>
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<td></td>
<td><strong>Presented by Loreto Valenzuela</strong>: <strong>1 Centre for Renewable Energy Sources and Savings; 2 CIEMAT-PSA; 3 CIEMAT</strong></td>
<td></td>
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<tr>
<td>Q-05</td>
<td>On Target Heliostat Calibration Using Locally Weighted Projection Regression for Trajectory Detection and Matching</td>
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<td></td>
<td><strong>Mark Geiger</strong>: <strong>1 DLR</strong></td>
<td></td>
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<tr>
<td>Q-06</td>
<td>Automatized Design of the Cyprus Institute's Nonimaging High-Flux Facility Using Novel Open Source Software Tools and Strategies</td>
<td></td>
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<tr>
<td></td>
<td><strong>Kypros Milidonis</strong>: Manuel Blanco <strong>1</strong></td>
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<td></td>
<td><strong>Aristides Bonanos</strong>: Victor Grigoriev <strong>1</strong></td>
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<td><strong>Marios Constantinou</strong>: Manuel Collares-Pereira <strong>1</strong></td>
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<td><strong>Costas N. Papanicolas</strong>: John Pye <strong>1</strong></td>
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<td><strong>Charles-Alexis Asselineau</strong>: <strong>1 The Cyprus Institute; 2 University of Évora; 3 Australian National University</strong></td>
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<tr>
<td>Q-07</td>
<td>Vast Solar Dynamic High Temperature Models and Implications for Process and Component Design</td>
<td></td>
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<tr>
<td></td>
<td><strong>Buddhi Ranasinghe</strong>: Kurt Drewes <strong>1</strong></td>
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<tr>
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<td><strong>1 Vast Solar</strong></td>
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<tr>
<td>Q-08</td>
<td>Dynamic Simulation Tool for Performance Evaluation, Sensitivity Study and Measurement Sensor Calibration of a Parabolic Trough Collector System with Concrete Thermal Energy Storage</td>
<td></td>
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<td><strong>1 Solar-Institut Jülich; 2 protarget AG; 3 CADE Soluciones de Ingeniería; 4 Cyprus University of Technology</strong></td>
<td></td>
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<tr>
<td>Q-09</td>
<td>Determination of Loads and Boundary Conditions Causing Deformations of Concentrating Solar Mirrors Using Non-Derivative Optimization Methods and Finite Element Analysis</td>
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<tr>
<td></td>
<td><strong>Simon Schneider</strong>: Eckhard Lüpfert <strong>1</strong>, Andreas Reinholz <strong>2</strong>, Robert Pitz-Paal <strong>1</strong></td>
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<td><strong>1 DLR; 2 AROpt-Consulting</strong></td>
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<tr>
<td>Q-10</td>
<td>Application of sbpRay for Simulation and Optimization of a Heliostat Field and Cavity Receiver</td>
<td></td>
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<td><strong>Vanessa Schöpfel</strong>: Thomas Keck <strong>1</strong></td>
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<td><strong>Presented by Gerhard Weinreb</strong>: <strong>1 sbp sonne</strong></td>
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<tr>
<td>Q-12</td>
<td>Performance Analysis of Supercritical CO₂ Cycles for CSP</td>
<td></td>
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<td><strong>Dhinesh Thanganadar</strong>: Faisal Asfand <strong>1</strong></td>
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<td><strong>1 Cranfield University</strong></td>
<td></td>
</tr>
</tbody>
</table>
| R-01 | Technico-Economic Assessment of Decentralized CSP System for Hydrogen Production Via the Water Electrolysis Process  
Ahmed Alami Mermouri¹, Samir Touili², Samir Rachidi³, Yousef El Hassouani², Abdel-illah Amrani²  
¹ Mohammed 1st University; ² FST Errachidia; ³ IRESEN |
| R-02 | Techno-Economic Evaluation of Long-Term Energy Storage Options for CSP and Other Variable Renewable Energies in South Africa  
Johan De Vrye Burger¹, Thomas Harms¹, Ben Sebitosi¹  
¹ Stellenbosch University |
| R-03 | The Effect of Concentrating Characteristics on the Thermal Performance of Vortex Flow Solar Reactor with Compound Parabolic Concentrator  
Zheshao Chang¹, Shaomeng Dai¹  
¹ Institute of Electrical Engineering, CAS |
| R-04 | The Design and Analysis of a 10kW Vortex Flow Solar Reactor with Compound Parabolic Concentrator  
Zheshao Chang¹, Shaomeng Dai¹  
¹ Institute of Electrical Engineering, CAS |
| R-05 | Thermochemical H₂O Splitting Using LaxSr₁₋₃₅AlₓCr₈₋₄₀₃₀Mn₀₂O₃₀ of Perovskite Oxides for Solar Hydrogen Production  
Nobuyuki Gokon  
Niigata University |
| R-06 | Thermochemical CO₂ Splitting Using Laₓ₅Sr₃₀₃₀₃₀₀Mn₀₂O₃₀₃₃₃₀₀₃₃₃₀₀₃₃₃₀₀₃₃ of Perovskite Oxide for Solar Fuel Production  
Nobuyuki Gokon  
Niigata University |
| R-07 | Solar Pyrolysis of Methane for CO₂ Free Hydrogen Production  
Mehdi Jafarian  
University of Adelaide |
| R-08 | Potential Value and Technical Gaps of CSP/T-Assisted High Temperature Electrolysis  
Yen Chean Soo Too¹, Jin-Soo Kim¹  
¹ CSIRO |
| R-09 | Production of Magnesium-Based Cements by Means of Solar-Driven Calcination of MgCO₃-Containing Natural Sources  
Claudio Tregambi¹, Francesca Di Lauro², Fabio Montagnaro¹, Piero Salatino¹, Roberto Solimene¹, Antonio Telesca¹, Milena Marroccoli³  
¹ Università di Napoli Federico II; ² Istituto di Ricerche sulla Combustione - CNR; ³ Università degli Studi della Basilicata |
| R-10 | Solar-Driven Syngas Production from Methane in a Cyclic Redox Scheme  
Xinhe Wang¹, Yanshuo Liu¹, Wenbo Yu¹, Junshe Zhang¹  
¹ Xi'an Jiaotong University |
| R-11 | Combustion-Assisted Solar Gasification of Biomass Particles in a High-Temperature Conical Jet Spouted Bed Reactor  
Houssame Boujijat¹, Sylvain Rodat¹, Srirat Chuaiboon¹  
¹ Presented by Srirat Chuaiboon⁵ |
| R-12 | Degradation Analysis of Ionic-Electronic Conductor-Iron Oxide Mixed Oxygen Carriers for Chemical-Looping Applications  
Won Chul Cho¹, Chang Hee Kim¹, Hyun-Seok Cho¹  
¹ Korea Institute of Energy Research |
| S-01 | Comparison of Satellite-Derived Solar Irradiance Between HIMAWARI and COMS-2 Platforms  
Chang Kim¹, Yong-Heack Kang¹, Hyun-Goo Kim¹, Chang-Yeol Yun¹  
¹ Korea Institute of Energy Research |
| S-02 | Prediction of Direct Normal Irradiance Derived from NWP Model in Korea  
Jin-Young Kim¹, Chang-Yeol Yun¹, Chang Ki Kim¹, Hyun-Goo Kim¹  
¹ Korea Institute of Energy Research |
| S-03 | Measured Solar Irradiation Data Collecting System and Degradation of Pyranometers  
Boyoung Kim¹, Yunho Jang¹, Byeonggil Lee¹, Hyun-Goo Kim¹, Chang-Yeol Yun¹  
¹ Korea Institute of Energy Research; ² Chungnam National University |
| S-04 | Development and Improvement of Empirical Models for EUV Estimation Using Total Solar Radiation in Korea  
Jaemin Kim¹, Yun-Gon Lee¹  
¹ National Institute of Meteorological Sciences; ² Chungnam National University |
| S-05 | Data Structure Analysis of Typical Meteorological Year Using Principal Component Analysis  
Shin Young Kim¹, Gil-Soo Jang¹, Chang Ki Kim¹, Chang-Yeol Yun¹, Yong-Heack Kang¹, Hyun-Goo Kim¹  
¹ Korea Institute of Energy Research; ² Korea University |
| S-06 | Solar Power Forecasting Model Using VAR Method at Daejeon Area in Korea  
Yung-Seop Lee¹, Dong-Hyun Lee¹, Ahyun Jung¹, Jin-Young Kim², Chang Ki Kim², Hyun-Goo Kim²  
¹ Dongguk University; ² Korea Institute of Energy Research |
| **S-07** | A Normalized Variability Index of Daily Solar Radiation  
*Sara Moreno Tejera*¹, Miguel Larrañeta², Manuel Silva Pérez¹, Isidoro Lillo-Bravo¹  
¹ University of Seville; ² Andalusian Association for Research and Industrial Cooperation (AICIA) |
| **S-08** | Simulation of Solar Eclipses in a Satellite Solar Radiation Model  
*Jose A. Ruiz-Arias*¹, Vicente Lara-Fanego², Marcel Suri²  
¹ Solargis s.r.o. |
| **T-01** | Susceptibility of Lining Materials of Thermal Energy Storage Tanks to Erosion Due to Particulate Flow in Particle-Based Power Tower Systems  
*Hany Al-Ansary*¹, Abdelrahman El-Leathy¹, Shaker Alaql¹, Rageh Saeed¹, Nader Al-Absi¹, Eldwin Dijadiwinita¹, Zeyad Al-Suhaibani¹, Syed Danish¹, Abdulelah Alswaiyd¹, Sheldon Jeter¹  
¹ King Saud University; ² Georgia Institute of Technology |
| **T-02** | Three Dimensional Thermoconvection in a Molten Salt Filled Cylindrical Enclosure Heated by Non-Uniform Solar Radiation  
*Ityona Amber*¹, Tadhg O’Donovan¹  
¹ Heriot Watt University |
| **T-03** | Numerical Analysis on Solidification Process of PCM in Triplex-Tube Thermal Energy Storage System  
*Selvan Bellan*¹, Koya Hirai¹  
¹ Niigata University |
| **T-04** | Novel Coupled Heat/Moisture Energy Storage – Experimental Characterization and Numerical Predictions  
*Arnaud Bruch*  
CEA |
| **T-05** | Cold Thermal Energy Storage (cTES) for Water Consumption Reduction and Performances Increase of Condenser Cooling WASCOP Project  
*Arnaud Bruch*¹, Delphine Bourdon¹, Anthony Blaise¹, Christophe Dumas¹  
¹ CEA |
| **T-06** | Overview of Development Progress of Molten Chloride Salts for Thermal Energy Storage  
*Wenjin Ding*¹, Carolina Villada Vargas¹, Alexander Bonk¹, Thomas Bauer¹  
¹ DLR |
| **T-07** | Thermal Conductivity Enhancement of Molten Nitrate Salt by Core-Shell Nanoadditive for Efficient Thermal Energy Storage Applications  
*Abdessamad Faik*¹, Udayashankar Nithiyanantham¹, Abdelali Zaki¹, Yaroslav Grosu¹, Luis González-Fernández¹, Josu Igartua²  
¹ CIC Energigune; ² University of the Basque Country |
| **T-08** | Innovative Use of Zeolite Adsorption/Desorption Thermal Storage for Medium-High Solar Thermal Application  
*Roberto Gabbielli¹*, Michelangelo Di Palo¹, Francesco Del Medico¹, Piero Castrataro²  
¹ University of Pisa; ² Glaxyx |
| **T-09** | Salt Melting and Tank Design for Gen 3 CSP-TES Systems  
*Samuel Gage*  
National Renewable Energy Laboratory |
| **T-10** | Experimental Tests of Characterization of an Innovative Thermal Energy Storage System Based on Low Melting Molten Salt Thermocline Tank Integrated with an Oil Exchanger  
*Walter Gaggioli*¹, Raffaele Liberatore¹, Primo Di Ascenzi¹, Domenico Mazzei¹, Valeria Russo¹  
¹ ENEA |
| **T-11** | Chemical Compatibility of Cu-Ge Alloy with Container Materials for Latent Heat Storage System  
*Nobuyuki Gokon*  
Niigata University |
| **T-12** | An Integrated Model for Solar-Driven Biochar Production  
*Toby Green*  
University of Leeds |
| **T-13** | Molten Nitrate Corrosion Testing and Creep Data for Stainless Steels  
*Björn Helmersson*¹, Marta Navas², Adela Martínez-Tarifa¹, Rui Wu¹, Andrew Backhouse¹  
¹ Outokumpu Stainless; ² CIEMAT |
| **T-14** | Novel Geopolymer for Use as a Sensible Storage Option in High Temperature Thermal Energy Storage Systems  
*Rhys Jacob*¹, Neil Trout¹, Aran Sole¹, Stephen Clarke¹, Ana Inés Fernández¹, Luisa Cabeza¹, Wasim Samani¹, Frank Bruno¹  
¹ University of South Australia; ² Care of Our Environment; ³ Universitat Jaume I; ⁴ Universitat de Barcelona; ⁵ University of Lleida |
<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
</table>
| T-15    | Simulation and Assessment of Thermal Ratcheting in Thermocline Storage with Filler Material | Philipp Knödler\textsuperscript{1}, Christian Odenthal\textsuperscript{1}  
Presented by Michael Krüger\textsuperscript{1}  
\textsuperscript{1} DLR |
| T-16    | A New Methodology for Designing and Assessing Latent Heat Thermal Energy Storage Systems | Ming Liu  
University of South Australia |
| T-18    | Design and Testing of a Pilot Scale Air-Rock Thermal Energy Storage for Concentrated Solar Power Plant Cooling Applications | Kumar Patchigolla\textsuperscript{1}, Jonathon Gillard\textsuperscript{1}, Peter Turner\textsuperscript{1}, Faisal Asfand\textsuperscript{1}  
\textsuperscript{1} Cranfield University |
| T-19    | In-Situ Analysis of Aluminium Carbide Formation in High Temperature Miscibility Gap Alloy Thermal Storage Systems | Samuel Reed\textsuperscript{1}, Erich Kisi\textsuperscript{1}, Heber Sugo\textsuperscript{1}  
\textsuperscript{1} University of Newcastle |
| T-20    | Novel Thermal Insulation Concept for a High Temperature Molten Salt Thermal Storage Tank for CSP Plants | Soheila Riahi\textsuperscript{1}, Ming Liu\textsuperscript{1}, Rhys Jacob\textsuperscript{1}, Martin Belusko\textsuperscript{1}, Craig Turchi\textsuperscript{1}, Frank Bruno\textsuperscript{1}  
Presented by Ming Liu\textsuperscript{1}  
\textsuperscript{1} Barbara Hardy Institute;  
\textsuperscript{2} National Renewable Energy Laboratory;  
\textsuperscript{3} Future Industries Institute |
| T-21    | Melt Path Formation in a High Temperature Molten Salt Horizontal Shell and Tube Storage System for CSP Plants | Soheila Riahi\textsuperscript{1}, Ming Liu\textsuperscript{1}, Rhys Jacob\textsuperscript{1}, Martin Belusko\textsuperscript{1}, Frank Bruno\textsuperscript{1}  
Presented by Ming Liu\textsuperscript{1}  
\textsuperscript{1} Barbara Hardy Institute;  
\textsuperscript{2} Future Industries Institute |
| T-22    | Improvement of the Temperature Control System of the Ternary Mixture LiNO\textsubscript{3}-NaNO\textsubscript{3}-KNO\textsubscript{3} in a Pilot Scale Plant | Carlos Soto\textsuperscript{1}, Claudio Ayala\textsuperscript{1}, Mauro Henriquez\textsuperscript{1}, Abdiell Malloco\textsuperscript{1}, Luis Guerreiro\textsuperscript{2}  
\textsuperscript{1} University of Antofagasta;  
\textsuperscript{2} University of Évora |
| T-23    | High-Temperature Thermal Energy Storage (HT-TES) System – A Renewable Energy Hybrid Solution | Jens Taggart Pelle\textsuperscript{1}, Peter Badstue Jensen\textsuperscript{1}, Hammam Soliman\textsuperscript{1}  
\textsuperscript{1} Aalborg CSP |
| T-24    | Thermodynamic Analysis of a High Temperature Multi-Layered Sensible-Latent Thermal Energy Storage for CSP Plant | Silvia Trevisan\textsuperscript{1}, Rafael Guédez\textsuperscript{2}  
\textsuperscript{1} KTH Royal Institute of Technology |
| T-25    | Design of a Direct Thermal Oil Based Thermocline Thermal Energy Storage for a Concentrating Solar Power Plant | Nicolas Ürlings\textsuperscript{1}, Ederson Luiz Pereira\textsuperscript{2}  
\textsuperscript{1} protarget AG;  
\textsuperscript{2} RTB Holding Energia |
| T-26    | Optimization and Assessment of Minimum Melting Mixtures of the NaCl-KCl-MgCl\textsubscript{2} Ternary Chloride Salt System for Next Generation High-Temperature Thermal Energy Storage | Carolina Villada\textsuperscript{1}, Wenjin Ding\textsuperscript{1}, Alexander Bonk\textsuperscript{1}, Thomas Bauer\textsuperscript{1}  
\textsuperscript{1} DLR |
| T-27    | Thermal Storage Performance Investigation in Airflow Packed Bed Cascade Thermal Storage with Thin Tanks | Yan Wang\textsuperscript{1}, Zhifeng Wang\textsuperscript{1}, Bei Yang\textsuperscript{1}, Fengwu Bai\textsuperscript{1}  
\textsuperscript{1} Institute of Electrical Engineering, CAS |
| T-28    | Cost Reduction and Performance Improvement of Low Melting Point Molten Salts for High Temperature Heat Transfer and Storage | Yuting Wu\textsuperscript{1}, Chongfang Ma\textsuperscript{1}, Yuanwei Lu\textsuperscript{1}, Xia Chen\textsuperscript{1}, Lixia Sang\textsuperscript{2}, Canzcan Zhang\textsuperscript{1}  
\textsuperscript{1} Beijing University of Technology |
| U-01    | Numerical Simulation of CaCO\textsubscript{3}/CaO Charging Process in a Spiral Coil Reactor | Qibin Liu\textsuperscript{1}, Haifeng Wu\textsuperscript{1}, Zhang Bai\textsuperscript{2}  
\textsuperscript{1} Institute of Engineering Thermophysics, CAS;  
\textsuperscript{2} China University of Petroleum (East China) |
| U-02    | Tunable Hydration/Dehydration Temperature Using CaO-Al\textsubscript{2}O\textsubscript{3} Mixed Structures | Abdessamad Faik\textsuperscript{1}, Abdelali Zaki\textsuperscript{1}, Daniel Bielsa\textsuperscript{1}  
\textsuperscript{1} CIC Energigune |
| U-03    | Investigation of a Solar-Biomass-Driven Polygeneration System with the Production of Power and SNG | Shaun Sullivan\textsuperscript{1}, Jack Hinze\textsuperscript{1}  
\textsuperscript{1} Brayton Energy |
### U-05

**Mayenite-Supported CaO for Thermochemical Storage Applications: Analysis of Dynamic Behavior Under Charging/Discharging Cycles**

Luca Turchetti¹, Anna Chiara Tizzoni¹, Francesca Varsano¹, Natale Corsaro¹, Michela Lanchi¹, Raffaele Liberatore¹, Maria Cristina Annesini²

¹ ENEA; ² Sapienza University of Rome

### U-06

**Experimental and Density Functional Theory Study of Cascade Thermochemical Heat Storage for Concentrated Solar Power**

Peng Yuan¹, Gang Xiao¹, Mingjiang Ni¹, Kefa Cen¹

¹ Zhejiang University

### V-01

**Soiling Mitigation in Concentrated Solar Power Plants**

Talib Kayani¹, Chris Sansom¹, Peter King¹

¹ Cranfield University

### V-02

**Pilot Scale Hybrid Cooling System for Optimizing the Water Consumption at CSP Plants**

Patricia Palenzuela¹, Lidia Roca¹, Ginés García¹, José Liria¹, Diego-César Alarcón-Padilla¹, Charles-André Marié², Adèle Caròn¹, Faisal Asfand³, Kumar Patchigolla³

¹ CIEMAT-PSA; ² Hamon D’Hondt; ³ Cranfield University

### V-03

**Soiling Study on Antireflective Coated Glass Samples and Antisoiling/Antireflective Coated Glass Samples**

Gema San Vicente¹, Nuria Germán², Augusto Maccari¹, Arantxa Fernández-García¹, Ángel Morales¹

¹ CIEMAT-PSA; ² CIEMAT; ³ Archimede Solar Energy
General Information

Conference Proceedings

Accepted papers will be published online with AIP, the American Institute of Physics. All papers published with AIP feature individual DOI numbers and are, therefore, fully citable.

Conference Registration

Before attending the sessions, pre-registered participants have to present themselves in person at the registration desk to collect a conference bag and their name badge.

Regular conference registration (full ticket) includes:

- Access to all conference sessions and the poster area
- Access to the sponsoring and exhibition area during the conference
- The printed conference program
- Daily coffee breaks and lunches
- Free entrance to the Welcome Reception
- The Conference Dinner
- Access to a password-secured area on the website including the list of participants and all accepted abstracts. Presentations as well as papers will be published after the conference (if cleared for publication). Papers will be available on the website until publication with AIP.

Currency

The local currency in South Korea is South Korean Won (KRW). On September 9, 2019, 1 US Dollar equaled 1.192,62 KRW; 1 Euro equaled 1.315,76 KRW. You are advised to check the conversion rate at www.xe.com for the days of your visit.

Language

The conference language is English.

Name Badge

Delegates are requested to wear their official identification name tag at all time within the Conference Center and during the Conference Dinner.

Venue

The SolarPACES 2019 Conference will take place at the EXCO Conference Center Daegu:

EXCO Conference Center
10 Exco-ro, Buk-gu
Daegu 41515
Korea
Technical Tour

The technical tour this year will visit Daesung CSP Tower System in the morning and three different touristic sites in the region in the afternoon, which you can choose when booking the tour.

Day: Saturday, 5th October, 2019

Start Time: 9:20

Meeting Point: EXCO Conference Center, Gate 3

Option 1: Gyeongju UNESCO 1 Price: 70,000 won (including lunch), returning 18:20

Option 2: Gyeongju UNESCO 2 Price: 90,000 won (including lunch and dinner), returning 21:30

Option 3: Andong Hahoe Village Price: 70,000 won (including lunch), returning 18:00

For more detailed information and current booking options, please check the conference website. If you have already made a tour reservation, please confirm and pay it at the Travel Information Desk SolarPACES2019 at the conference venue.