

# 3rd European Conference on Supercritical CO<sub>2</sub> (sCO<sub>2</sub>) Power Systems – September 19<sup>th</sup> & 20<sup>th</sup>

Conference address: Paris, EDF, 7 boulevard Gaspard Monge, 91120 Palaiseau



Thursday - September 19 <sup>th</sup>	
	<b>Room: Large Auditorium</b>
09:00 – 09:15	Welcome and Introduction <i>Dieter Brillert<sup>1</sup> and Albannie Cagnac<sup>2</sup></i> 1: University of Duisburg – Essen / UDE 2: Électricité de France / EDF
09:15 – 09:45	European Commission View on Future Energy Systems in Europe <i>Carmine Marzano and Roberto Passalacqua, European Commission</i>
09:45 – 10:15	Coffee break
	<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p><b>Heat Exchanger and Transfer (Session 1)</b> <b>Room: Amphithéâtre 1 (AT1)</b>      <b>Chairman: Martin Rohde, TU Delft</b></p> </div> <div style="width: 48%;"> <p><b>Turbomachines and Power Systems (Session 2)</b> <b>Room: Amphithéâtre 2</b>      <b>Chairman: Giuseppe Bianchi, Brunel University London</b></p> </div> </div>
10:15 – 10:45	<div style="display: flex;"> <div style="width: 48%;"> <p>108 - Turbulence Modelling for Supercritical CO<sub>2</sub> Flows in a Vertical Tube <i>Otero Rodriguez, Gustavo Jose (1); González Portillo, Luis F. (2); Pecnik, Rene (1)</i> 1: Delft University of Technology, the Netherlands; 2: Universidad Politécnica de Madrid, Spain</p> </div> <div style="width: 48%;"> <p>109 - Assessment of Performance and Costs of CO<sub>2</sub> Based Next Level Geothermal Power (NLGP) Systems <i>Glos, Stefan; Hansper, Jil; Wechsung, Michael; Langer, Marcel</i> <i>Siemens AG, Germany</i></p> </div> </div>
10:45 – 11:15	<div style="display: flex;"> <div style="width: 48%;"> <p>110 - Direct-Numerical Simulation of Flow and Heat Transfer within Channels of a Supercritical-CO<sub>2</sub> Cooler <i>Laurien, Eckart; Pandey, Sandeep</i> <i>University of Stuttgart, Germany</i></p> </div> <div style="width: 48%;"> <p>114 - Hybridization of a Small Modular Reactor with a Solar Power Plant using a Supercritical Carbon Dioxide Brayton Cycle <i>Tauveron, Nicolas; Pham, Quynh Trang; Alpy, Nicolas</i> <i>CEA, France</i></p> </div> </div>
11:15 – 11:45	<div style="display: flex;"> <div style="width: 48%;"> <p>111 - Investigation of a Correlation Based Model for sCO<sub>2</sub> Compact Heat Exchangers <i>Hofer, Markus; Buck, Michael; Strätz, Marcel; Starflinger, Jörg</i> <i>Institute of Nuclear Technology and Energy Systems, University of Stuttgart, Germany</i></p> </div> <div style="width: 48%;"> <p>156 - Part-Load Operation of Coal Fired sCO<sub>2</sub> Power Plants <i>Dario, Alfani; Astolfi, Marco; Binotti, Marco; Macchi, Ennio; Silva, Paolo</i> <i>Politecnico di Milano</i></p> </div> </div>
11:45 – 12:15	<div style="display: flex;"> <div style="width: 48%;"> <p>115 - A Review of the Criteria for the Onset of Heat Transfer Deterioration with Supercritical CO<sub>2</sub> in Vertical Heated Single Circular Tubes <i>Theologou, Konstantinos; Mertz, Rainer; Laurien, Eckart; Starflinger, Jörg</i> <i>Institute of Nuclear Technology and Energy Systems (IKE), University of Stuttgart, Germany</i></p> </div> <div style="width: 48%;"> <p>119 - Dynamic Modelling and Transient Analysis of a Molten Salt Heated Recompression Supercritical CO<sub>2</sub> Brayton Cycle <i>Zhou, Pan; Zhang, Jinyi; Le Moullec, Yann</i> <i>EDF R&amp;D China, Beijing, China</i></p> </div> </div>
12:15 – 13:15	Lunch
	<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p><b>sCO<sub>2</sub> Experiments and Loops / Application of sCO<sub>2</sub> Usage (Session 3)</b> <b>Room: AT1</b>      <b>Chairman: Stefan Glos, Siemens AG</b></p> </div> <div style="width: 48%;"> <p><b>Turbomachines and Power Systems (Session 4)</b> <b>Room: AT2</b>      <b>Chairman: Dieter Brillert, University Duisburg-Essen</b></p> </div> </div>
13:15 – 13:45	<div style="display: flex;"> <div style="width: 48%;"> <p>148 - Experimental Investigations and Simulations of the Control System in Supercritical CO<sub>2</sub> Loop <i>Vojacek, Ales (1); Melichar, Tomas (1); Doubek, Frantisek (1); Hajek, Petr (1); Hoppe, Timm (2)</i> 1: Research Centre Řež, Czech Republic; 2: XRG Simulation GmbH, Germany</p> </div> <div style="width: 48%;"> <p>120 - Shouhang-EDF 10MWe Supercritical CO<sub>2</sub> Cycle + CSP Demonstration Project <i>Le Moullec, Yann (1); Qi, Zhipeng (2); Zhang, Jinyi (1); Zhou, Pan (1); Yang, Zijiang (1); Wang, Xihua (2); Chen, Wenlong (2); Wang, Shuai (2)</i> 1: EDF R&amp;D China, Beijing, China;      2: Shouhang, Beijing, China</p> </div> </div>

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13:45 – 14:15	<p><b>118 - A Systematic Comparison of Supercritical CO<sub>2</sub> Brayton Cycle Layouts for Concentrated Solar Power with a Focus on Thermal Energy Storage Utilization</b>                      Zhang, Jinyi; Le Moullec, Yann                      EDF R&amp;D China, Beijing, China</p>	<p><b>123 - Machine Learning Based Design of a Supercritical CO<sub>2</sub> Concentrating Solar Power Plant</b>                      Nabil, Tahar; Le Moullec, Yann; Le Coz, Adrien                      EDF R&amp;D China</p>
14:15 – 14:45	<p><b>125 - Development and Power Generating Operation of the Supercritical Carbon Dioxide Power Cycle Experimental Test Loop in KIER</b>                      Cho, Junhyun; Shin, Hyungki; Cho, Jongjae; Choi, Bongsu; Roh, Chulwoo; Lee, Beomjoon; Lee, Gilbong; Ra, Ho-Sang; Baik, Young-Jin                      Korea Institute of Energy Research, Korea, Republic of South Korea</p>	<p><b>124 - Design and Analysis of Direct-fired sCO<sub>2</sub> Combustors for Zero-emission Power Generation</b>                      Manikantachari, K.R.V. (1); Martin, Scott (2); Kapat, Jayanta (1); Vasu, Subith (1)                      1: Center for Advanced Turbomachinery and Energy Research (CATER), University of Central Florida, Orlando, FL, USA;                      2: Embry-Riddle Aeronautical University, Daytona Beach, FL, USA</p>
14:45 – 15:15	<p><b>132 - Operational Experiences and Design of the sCO<sub>2</sub>-HeRo Loop</b>                      Hacks, Alexander Johannes (1); Freutel, Thomas (2); Strätz, Marcel (3); Vojacek, Ales (4); Hecker, Frieder (5); Starflinger, Jörg (3); Brillert, Dieter (1)                      1: University of Duisburg-Essen, Germany; 2: Kraftwerks-Simulator-Gesellschaft mbH (KSG);                      3: University of Stuttgart; 4: Research Centre Řež;                      5: Gesellschaft für Simulatorschulung mbH (GfS)</p>	<p><b>129 - Development of a Partial-admission Axial Turbine for a tens-kWe under Supercritical CO<sub>2</sub> Condition</b>                      Cho, Jongjae; Shin, Hyungki; Cho, Junhyun; Choi, Bongsu; Baik, Young-Jin; Lee, Beomjoon; Roh, Chulwoo; Ra, Ho-Sang                      Korea Institute of Energy Research, Korea, Republic of South Korea</p>
15:15 – 15:45	Coffee break	
	<p><b>Materials and sCO<sub>2</sub> Mixtures (Session 5)</b>                      Room: AT1 Chairman: Uwe Gampe, TU Dresden</p>	<p><b>Turbomachines and Power Systems (Session 6)</b>                      Room: AT2 Chairman: Alexander Hacks, University Duisburg-Essen</p>
15:45 – 16:15	<p><b>113 - Development and Application of INCONEL Alloy 740H in uSCO<sub>2</sub> Power Systems</b>                      McCoy, Stephen A. (1); Baker, Brian A. (2); Gollihue, Ronald D. (2); deBarbadillo, John J. (2)                      1: PCC Special Metals, United Kingdom;                      2: Special Metals Corporation, USA</p>	<p><b>138 - Modelling and Optimisation of Supercritical Carbon Dioxide Turbomachinery</b>                      Van Der Westhuizen, Ruan; Van Der Spuy, Johan; Groenwold, Albert; Dobson, Robert                      Department of Mechanical and Mechatronic Engineering, Stellenbosch University, South Africa</p>
16:15 – 16:45	<p><b>150 - Highly Efficient Plate-Fin Heat Exchanger (PFHE) Technical Development for s-CO<sub>2</sub> Power Cycles</b>                      Tioual-Demange, Sarah; Bergin, Gaëtan; Mazet, Thierry                      Fives Cryo, France</p>	<p><b>155 - Transient Response of Supercritical CO<sub>2</sub> Axial Turbine for KAIST MMR</b>                      Son, In Woo; Heo, Jin Young; Oh, Bong Seong; Lee, Jeong Ik                      KAIST, Korea, Republic of South Korea</p>
16:45 – 17:15	<p><b>157 - Practical Challenges and Failure Modes during Fabrication of Haynes 230 Micro-Pin Solar Receivers for High Temperature Supercritical Carbon Dioxide Operation</b>                      McNeff, Patrick S. (1); Paul, Brian K. (1); Dogan, Omer (2); Rozman, Kyle (3); Kissick, Sean (1); Wang, Hailei (4); Drost, M. Kevin (1); Fronk, Brian M. (1)                      1: Oregon State University, Corvallis, USA; 2: National Energy Technology Lab., Albany, USA;                      4: Utah State University, Logan, USA 3: Leidos Research Support Team, Pittsburgh, USA</p>	<p><b>116 - Development and Testing of Dry Gas Seals for Turbomachinery in sCO<sub>2</sub> Applications</b>                      Fesl, Andreas; Hellmig, Benjamin; Laxander, Armin                      EagleBurgmann</p>
19:00	Dinner @ La Coupole - 102, boulevard de Montparnasse, 75014 Paris	

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	<b>Materials and sCO<sub>2</sub> Mixtures (Session 7)</b> <b>Room: AT1    Chairman: Sebastian Unger, Helmholtz-Zentrum Dresden-Rossendorf</b>	<b>Heat Exchanger and Transfer (Session 8)</b> <b>Room: AT2    Chairman: René Pecnik, TU Delft</b>
09:00 – 09:30	141 - Supercritical Carbon Dioxide / Alternative Fluid Blends for Efficiency Upgrade of Solar Power Plant <i>Binotti, Marco (1); Di Marcoberardino, Gioele (2); Iora, Paolo (2); Invernizzi, Costante (2); Manzolini, Giampaolo (1)</i> 1: Politecnico di Milano, Milano, Italy; 2: University of Brescia, Brescia, Italy	122 - Heat Transfer Characteristics of sCO <sub>2</sub> and Dynamic Analysis of Looping Conditions <i>Xiao, Gang (1); Xing, Kaixiang (1); Zhang, Jinyi (2); Le Moullec, Yann (2); Zhou, Pan (2); Yang, Tianfeng (1); Ni, Mingjiang (1); Cen, Kefa (1)</i> 1: Zhejiang University, China; 2: EDF R&D, China
09:30 – 10:00	126 - Accurate and Predictive Mixture Models Applied to Mixtures with CO <sub>2</sub> <i>Jäger, Andreas; Mickoleit, Erik; Bretkopf, Cornelia</i> TU Dresden, Dresden, Germany	131 - Experimental Investigation of Heat Transfer and Pressure Drop in Tubes to Cool CO <sub>2</sub> Near the Critical Point <i>Wahl, Andreas; Mertz, Rainer; Eckart, Laurien; Jörg, Starflinger</i> University Stuttgart, Germany
10:00 – 10:30	142 - Effect of Impurities on Supercritical CO <sub>2</sub> Compatibility <i>Pint, Bruce A.; Unocic, Kinga A.; Keiser, James R.</i> Oak Ridge National Laboratory, Oak Ridge, USA	136 - Large Eddy Simulation of sCO <sub>2</sub> Flow with a Discontinuous Galerkin Method <i>Hennink, Aldo; Lathouwers, Danny; Rohde, Martin; Kloosterman, Jan Leen</i> Delft University of Technology, Netherlands
10:30 – 11:00	Coffee break	
	<b>Application of sCO<sub>2</sub> Usage (Session 9)</b> <b>Room: AT1    Chairman: Markus Haider, Technical University Vienna</b>	<b>sCO<sub>2</sub> Experiments and Loops (Session 10)</b> <b>Room: AT2    Chairman: Eckart Laurien, University Stuttgart</b>
11:00 – 11:30	127 - Configuration of a Flexible and Efficient sCO <sub>2</sub> Cycle for Fossil Power Plant <i>Mecheri, Mounir (1); Bedogni, Stefano (2); Cagnac, Albannie (1)</i> 1: EDF R&D, France; 2: Edison, Italy	140 - Experimental Testing of a 1MW sCO <sub>2</sub> Turbo-Compressor <i>Rapp, Logan Madacey (1); Stapp, David (2)</i> 1: Sandia National Laboratories; 2: Peregrine Turbine Technologies
11:30 – 12:00	133 - Transient Modelling of a Supercritical CO <sub>2</sub> System for High Temperature Industrial Heat to Power Conversion <i>Marchionni, Matteo; Saravi, Samira Sayad; Bianchi, Giuseppe; Tassou, Savvas A</i> Brunel University London, United Kingdom	144 - Supercritical CO <sub>2</sub> Power Cycle Projects at gti Macadam, Scott; <i>Kutin, Michael</i> GTI, United States of America
12:00 – 12:30	Short Lunch	

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	<b>Application of sCO<sub>2</sub> Usage (Session 11)</b> <b>Room: AT1</b> <b>Chairman: Andreas Werner, Technical University Vienna</b>	<b>sCO<sub>2</sub> Experiments and Loops (Session 12)</b> <b>Room: AT2</b> <b>Chairman: Jörg Starflinger, University Stuttgart</b>
12:30 – 13:00	139 - Thermo-economic Modeling and Analysis of sCO <sub>2</sub> Brayton Cycles <i>Penkuhn, Mathias; Tsatsaronis, George</i> <i>Technische Universität Berlin, Germany</i>	145 - Study of Autonomous Control System for S-CO <sub>2</sub> Power Cycle Oh, Bong-Seong; Lee, Jeong Ik KAIST, Korea, Republic of South Korea
13:00 – 13:30	147 - Probabilistic Technique for Solving Computational Problem: Application of Ant Colony Optimization (ACO) to find the best sCO <sub>2</sub> Brayton Cycle Configuration <i>Mecheri, Mounir; Zhao, Qiao</i> <i>EDF R&amp;D, France</i>	151 - Thermo-economic Heat Exchanger Optimization for Electro-Thermal Energy Storage based on Transcritical CO <sub>2</sub> Cycles <i>Sanz Garcia, Luis; Jacquemoud, Emmanuel; Jenny, Philipp</i> <i>MAN Energy Solutions Zürich AG, Switzerland</i>
13:30 – 14:00	149 - Cooling System Cost and Performance Models for Economic sCO <sub>2</sub> Plant Optimization of Cooling Technology and Cold sCO <sub>2</sub> Temperature <i>Weiland, Nathan T. (1); Pidaparti, Sandeep R. (1,2); White, Charles W. (1,3)</i> <i>1: National Energy Technology Laboratory, Pittsburgh, PA, U.S.A.;</i> <i>2: KeyLogic, Pittsburgh, PA, U.S.A.;</i> <i>3: KeyLogic, Fairfax, VA, U.S.A.</i>	Blank by intention
14:00 – 14:15	Closing Session - Best paper award - Announcement of the conference location and date for 2021	

## Weblinks (also available on [www.sCO2.eu](http://www.sCO2.eu))

- [Conference website](#)
- [Conference venue](#)
- [Dinner venue](#)
- [Hotel and transportation](#)
- Conference proceedings are available after presentation of the paper on the conference: [www.sCO2.eu](http://www.sCO2.eu)