

# **eceee Industrial Summer Study Proceedings**

**Online version**

Industrial Efficiency 2016

12–14 September 2016  
Kalkscheune, Berlin  
Germany

## PROCEEDINGS PRODUCTION

### **Project manager**

*Therese Laitinen Lindström*  
Borg & Co, Stockholm, Sweden

### **Proceedings editing, layout and production**

*Therese Laitinen Lindström & Ylva Blume*  
Borg & Co, Stockholm, Sweden

### **Cover design**

*Klas Björkman*  
Björkman & Mitchell, Stockholm, Sweden

© eceee and the authors 2016  
Stockholm, Sweden 2016

ISSN 2001-7987  
ISBN 978-91-980482-9-2

The proceedings are also available in a printed version  
(ISSN 2001-7979, ISBN 978-91-980482-8-5).

### **Proceedings can be ordered from:**

eceee secretariat  
Sveavägen 98, 4 tr  
113 50 Stockholm  
Sweden

tel: +46 (0)8 673 11 30  
fax: +46 (0)8 673 04 44

**[eceee@eceee.org](mailto:eceee@eceee.org)**  
**[www.eceee.org](http://www.eceee.org)**

Disclaimer: The responsibility for the contents of the proceedings lies with the authors. The contents do not necessarily represent the opinion of eceee or the Summer Study supporters and partners.

# Acknowledgements

The eceee board would like to convey a special thanks to the partners, whose support makes this event possible. The board would also like to thank all the authors and the panel leaders for their intense efforts to contribute to these proceedings. We gratefully acknowledge the support of all the anonymous helpers who have assisted in making the eceee Industrial Efficiency 2016 conference a success.

## GOLD PARTNER

**Swedish Energy Agency**

## SILVER PARTNER

**Ademe, the French Environment and Energy Management Agency  
Enova SF, Norway**

## BRONZE PARTNER

**ISOVER Technical Insulation**

## PARTNERS

**Rockwool Technical Insulation  
Deneff  
University of Stuttgart, Institute for Energy Efficiency in Production  
Fraunhofer Institute for Systems and Innovation Research ISI  
The European Industrial Insulation Foundation (EiiF)  
Institute for Industrial Productivity  
The EU Steam-Up project**

## PANEL LEADERS

### PANEL 1. **Policies and programmes**

**Barbara Schlomann** Fraunhofer ISI, Germany

**Lea Gynther** Motiva Oy, Finland

### PANEL 2. **Sustainable production design and supply chain initiatives**

**Andrea Trianni** Politecnico di Milano, Italy

**Enrico Cagno** Politecnico di Milano, Italy

### PANEL 3. **Energy management: the nuts and bolts**

**Erik Gudbjerg** YourEnergy, Denmark

**Liam McLaughlin** GEN Europe, Ireland

### PANEL 4. **Technology, products and systems**

**Paula Fonseca** ISR – University of Coimbra, Portugal

**Sotirios Karellas** National Technical University of Athens/School of Mechanical Engineering, Greece

### PANEL 5. **Business models and financing: established practice and innovative approaches**

**Bettina Dorendorf** KfW, Germany

**Roman Doubrava** European Commission, Belgium

**Eva Hoos** European Commission, Belgium

## SUMMER STUDY CONFERENCE MANAGERS

*Christel Broussous, Therese Laitinen Lindström & Anne Bengtson*

## SUMMER STUDY CO-CHAIRS

*Maja Dahlgren & Claire Range*

## EXECUTIVE DIRECTOR

*Nils Borg*

## ECEEE BOARD

### **Board members 2015–16**

*Peter Bach*, Danish Energy Agency, Denmark (President and chair of the board)

*Andreas K. Enge*, Enova SF, Norway (Vice-President and vice-chair of the board)

*Agneta Persson*, WSP Sweden (Vice-President and vice-chair of the board)

*Randall Bowie*, Rockwool International, Denmark/Brussels

*Adrian Joyce*, EuroACE

*Rob Kool*, The Netherlands

*Juraj Krivošík*, SEVEN, Czech Republic

*Lorenzo Pagliano*, Kyoto Club, Italy

*Barbara Schlomann*, Fraunhofer Institute, Germany

*Julia Reinaud*, i24c – Industrial Innovation for Competitiveness, France

*Isabelle Vincent*, the French Environment and Energy Management Agency

*Joanne Wade*, UK

### **Alternates**

*Cédric Jeanneret*, SIG, Switzerland

*Clemens Rohde*, Fraunhofer Institute, Germany (alternate for Barbara Schlomann)

*Andrea Roscetti*, Politecnico di Milano, Italy (alternate for Lorenzo Pagliano)

# Table of contents

## **eceee 2016 Industrial Summer Study proceedings**

These are the proceedings from the Industrial Efficiency 2016 conference.

### **PANEL 1. POLICIES AND PROGRAMMES**

#### **Introduction to Panel 1**

	Panel leaders: <b>Barbara Schlomann &amp; Lea Gynther</b> .....	1
1-006-16	<b>Forecasting white certificate flows with system dynamics</b> Mathieu Bordigoni, Marc Berthou, Marielle Frechard & Edgard Ngaboyamahina .....	5
1-009-16	<b>How information and communication technologies will change the evaluation, measurement and verification of energy efficiency program performance</b> Ethan A. Rogers .....	17
1-016-16	<b>Stand-alone versus integrated energy audit programmes – a comparison of Flemish programmes</b> Barbara Govaert, Björn De Grande, Erwin Cornelis & Joachim Castelain .....	25
1-019-16	<b>A transition pathway for Germany's industry: which role for energy efficiency?</b> Tobias Fleiter, Matthias Rehfeldt & Benjamin Pfluger .....	39
1-026-16	<b>Spreading the energy management message in Turkey</b> Kubilay Kavak & Rod Janssen .....	51
1-031-16	<b>A bottom-up estimation of heating and cooling demand in the European industry</b> Matthias Rehfeldt, Clemens Rohde, Tobias Fleiter, Felipe Toro & Felix Reitze .....	59
1-035-16	<b>Mandatory energy conservation target: a case study of 1 % electricity saving in Taiwan's industrial sector</b> Tze-Chin Pan & Chien-Ming Lee .....	71
1-036-16	<b>Competitive tenders for energy efficiency – lessons learnt in Switzerland</b> Peter Radgen & Kurt Bisang .....	81
1-037-16	<b>International approaches to industrial energy efficiency: a comparison of countries</b> Meegan Kelly .....	91
1-062-16	<b>Dynamic foundations: the role of industrial efficiency in limiting 21<sup>st</sup> century warming to 2 degrees</b> Nate Aden .....	101
1-077-16	<b>Decision making in energy efficiency investments – a review of discount rates and their implications for policy making</b> Ruben J. Kubiak .....	109
1-097-16	<b>Energy efficiency networks for small and medium sized enterprises – boosting the energy efficiency potential by joining forces</b> Albin Carlén, Marie Rosenqvist, Svetlana Paramonova, Patrik Thollander & Susana Municio .....	129
1-116-16	<b>Chances for changes – tailoring energy-efficiency measures to target groups</b> Katharina Wohlfarth, Wolfgang Eichhammer, Barbara Schlomann & Dr. Ernst Worrell .....	137
1-141-16	<b>White certificates as a tool to promote energy efficiency in industry</b> Dario Di Santo, Enrico Biele & Daniele Forni .....	151
1-147-16	<b>Fundamentally rethinking efficiency to mobilise efficiency providers</b> Hans Nilsson .....	163

### **PANEL 2. SUSTAINABLE PRODUCTION DESIGN AND SUPPLY CHAIN INITIATIVES**

#### **Introduction to Panel 2**

	Panel leaders: <b>Andrea Trianni &amp; Enrico Cagno</b> .....	171
2-007-16	<b>Biogas in the Nordic forest industry: current state and future business potential</b> Mikael Ottosson, Hans Andersson & Thomas Magnusson .....	173
2-014-16	<b>Development of a methodology for the design and implementation of solar process heat systems in the food industry</b> Holger Mueller & Rick Greenough .....	185
2-017-16	<b>How well can the potential of industrial excess heat be estimated?</b> Erwin Cornelis & Johan Van Bael .....	199
2-033-16	<b>Modeling the cement industry in integrated assessment models: key factors for further improvement</b> Katerina Kermeli, Wina Crijns-Graus & Ernst Worrell .....	207

2-034-16	<b>A methodology for verified energy savings in manufacturing facilities through changes in operational behaviour</b> John Cosgrove, Frank Doyle, Mike O'Neill, John Littlewood & Paul Wilgeroth . . . . .	223
2-046-16	<b>Barriers to energy efficiency measures and the role of industrial sustainability</b> Alessandra Neri, Andrea Trianni & Enrico Cagno . . . . .	233
2-072-16	<b>Energy savings of inter-company heat integration: tapping potentials with spatial analysis</b> Ali Aydemir, Clemens Rohde & Dorothea Ko . . . . .	243
2-080-16	<b>Benchmarking energy efficiency in the German non-energy intensive industries</b> Katharina Mattes, Angela Jäger, Lisa Nabit, Simon Hirzel, Clemens Rohde & Oliver Som . . . . .	255
2-084-16	<b>Quantifying the overall impact of additive manufacturing on energy demand: the case of selective laser-sintering processes for automotive and aircraft components</b> Tim Hettesheimer, Han Byeol Roß & Simon Hirzel . . . . .	267
2-086-16	<b>Only non-energy benefits when adopting an EEM? Cases from industry</b> Enrico Cagno, Andrea Trianni & Davide Moschetta . . . . .	281
2-094-16	<b>Barriers to, drivers for and non-energy benefits for industrial energy efficiency improvement measures in compressed air systems</b> Ricardo Parra, Therese Nehler & Patrik Thollander . . . . .	293
2-104-16	<b>How companies respond to the emergence of 3D printing technology</b> Wen Liu & Steve Evans . . . . .	305
2-144-16	<b>Platform Climate Protection and Industry North-Rhine Westphalia – a multi stakeholder process for the advancement of energy efficiency and low-carbon technologies in energy intensive industries</b> Valentin Espert, Stefan Lechtenböhrer, Karin Arnold, Clemens Schneider & Daniel Vallentin . . . . .	311
2-151-16	<b>Worldwide resource efficient steel production</b> Maria Xylia, Semida Silveira, Jan Duerinck & Frank Meinke-Hubeny . . . . .	321

### PANEL 3. ENERGY MANAGEMENT: THE NUTS AND BOLTS

#### Introduction to Panel 3

	Panel leaders: <b>Erik Gudbjerg &amp; Liam McLaughlin</b> . . . . .	335
3-022-16	<b>Demand side management in industry– necessary for a sustainable energy system or a backward step in terms of improving efficiency?</b> Karin Arnold & Tomke Janssen . . . . .	339
3-024-16	<b>Behavioural change based energy efficiency at Volvo Construction Equipment, Braås, Sweden</b> Krushna Mahapatra, Rickard Alm, Ramona Hallgren, Lena Bischoff, Nil Tuglu, Le Kuai, Ye Yang & Ibrahim Umore . . . . .	351
3-038-16	<b>Energy study of a manufacturing plant</b> Chloé Desdouts, Jean-Louis Bergerand, Pierre-Alexis Berseneff, Claude Le Pape & Dimitri Yanculovici . . . . .	359
3-052-16	<b>Tackling the efficiency gap with capacity building in industrial energy optimisation</b> Rita Werle, Conrad U. Brunner & Rolf Tieben . . . . .	369
3-063-16	<b>Energy management: a driver to sustainable behavioural change in companies</b> Thomas Björkman, Catherine Cooremans, Therese Nehler & Patrik Thollander . . . . .	379
3-079-16	<b>The value of regression models in determining industrial energy savings</b> Peter Therkelsen, Prakash Rao, Darren Sholes, Aimee McKane, Bill Meffert, Randy Green & Sachin Nimbalkar . . . . .	389
3-081-16	<b>How can energy audits and energy management be promoted amongst SMEs? A review of policy instruments in the EU-28 and beyond</b> Lisa Nabit, Simon Hirzel, Clemens Rohde, Katharina Wohlfarth, Ian Behling & Rebecca Turner . . . . .	401
3-091-16	<b>New robes for NEB research – open and expanding data</b> Ida Stokkebye Christiansen, Kirsten Dyhr-Mikkelsen & Erik Gudbjerg . . . . .	417
3-117-16	<b>National programs to build capacity for effective ISO 50001 implementation in North America</b> Paul Sheaffer, Aimee McKane, Peter Therkelsen, Graziella Siciliano, Noé Villegas Alcántar & Fabian Allard . . . . .	427
3-124-16	<b>Steam, energy and management practices: how is industry doing? And what can we do to make them do better?</b> Ronald Vermeeren . . . . .	433

### PANEL 4. TECHNOLOGY, PRODUCTS AND SYSTEMS

#### Introduction to Panel 4

	Panel leaders: <b>Paula Fonseca &amp; Sotirios Karellas</b> . . . . .	443
4-011-16	<b>Energy efficiency with easy advanced control on screw compressors for poultry refrigeration</b> Benedicte Ballot-Miguet, Gregoire Duhot & Alain Reynaud . . . . .	447

4-023-16	<b>Biogas production feasibility in food industry clusters</b> Emma Lindkvist, Magnus Karlsson & Jenny Ivner . . . . .	455
4-030-16	<b>Energy saving options for industrial furnaces – the example of the glass industry</b> Clemens Frassine, Clemens Rohde & Simon Hirzel. . . . .	467
4-061-16	<b>Model-based quantification of the contribution of industrial heat pumps to the European climate change mitigation strategy</b> Stefan Wolf & Markus Blesl . . . . .	477
4-070-16	<b>Steel and food industries in Italy: analysis of the energy efficiency potential</b> Francesca Bazzocchi, Elena Gobbi & Claudio Zagano. . . . .	489
4-074-16	<b>Investigating operability issues of heat integration for implementation in the oil refining industry</b> Sofie Marton, Elin Svensson & Simon Harvey . . . . .	495
4-088-16	<b>How to decarbonise energy-intensive processing industries? Survey and conceptualisation of their specific innovation systems</b> Joeri Wesseling, Max Åhman, Ernst Worrell, Stefan Lechtenböhmer, Lars J. Nilsson & Lars Coenen . . . . .	505
4-096-16	<b>Extending building simulation software to include the organic Rankine cycle for factory waste heat recovery</b> Richard Greenough, Ivan Korolija & Michael Oates . . . . .	519
4-102-16	<b>Energy saving incentives for the European glass industry in the frame of the EU Emissions Trading Scheme</b> Christina-Stavrula Hatzilau, Sotirios Karellas, Ioannis Dolianitis, Dionysios Giannakopoulos, Georgios Skarpetis & Theodoros Zitounis . . . . .	531
4-106-16	<b>Industrial excess heat exploitation in energy intensive industries</b> Daniele Forni, Riccardo Vescovo, Dario Di Santo & Marco Baresi . . . . .	543
4-114-16	<b>IIoT based efficiency monitoring of a pick and place robot</b> Stefano Farné, Ezio Bassi, Francesco Benzi & Francesco Compagnoni. . . . .	555
4-126-16	<b>Technical demand response potentials of the integrated steelmaking site of Tata Steel in IJmuiden</b> Arzu Feta, Machteld van den Broek, Wina Crijns-Graus & Gerard Jägers . . . . .	563
4-132-16	<b>Hardware in the loop evaluation of a hybrid heating system for increased energy efficiency and management</b> G. Schumm, M. Philipp, F. Schlosser, J. Hesselbach, T.G. Walmsley & M.J. Atkins. . . . .	575
4-134-16	<b>Industrial site energy integration – the sleeping giant of energy efficiency? Identifying site specific potentials for vertical integrated production at the example of German steel production</b> Clemens Schneider & Stefan Lechtenböhmer. . . . .	587
4-156-16	<b>A prototype tool for automatically giving energy saving advice based on smart meter data</b> Osamu Kimura, Hidenori Komatsu, Ken-ichiro Nishio & Toshihiro Mukai . . . . .	599

## PANEL 5. BUSINESS MODELS AND FINANCING: ESTABLISHED PRACTICE AND INNOVATIVE APPROACHES

### Introduction to Panel 5

	Panel leaders: <b>Bettina Dorendorf, Roman Doubrava &amp; Eva Hoos</b> . . . . .	611
5-050-16	<b>Holistic investment decisions based on life cycle models</b> Matthias Harsch & Julian Maruschke. . . . .	615
5-082-16	<b>Regional energy efficiency networks – what factors make them successful?</b> Elisabeth Dütschke, Farikha Idrissova, Simon Hirzel, Lisa Nabitz, Ursula Mielicke & Michael Mai . . . . .	625
5-100-16	<b>Energy Efficiency Protect – insurance for energy efficiency guarantees</b> Christoph Tatje . . . . .	637
5-161-16	<b>Energy efficiency networks – a group energy management system as a business model?</b> Eberhard Jochem, Andreas Gerspacher, Michael Mai, Ursula Mielicke, Armin Eberle . . . . .	641

<b>AUTHOR INDEX</b> . . . . .	651
-------------------------------	-----

<b>KEYWORD INDEX</b> . . . . .	653
--------------------------------	-----