joined the commercial team within EA Technology responsible for seeking external funding from industry, the UK Government and EU. After the closure of the industrial division of EA Technology he moved to Petrie Technologies, later returning to Capenhurst to work part time at C-Tech Innovation in a technical role, working principally on RF and microwave processing until his retirement in 2015.

UIE congress 2024 - "Electrification of industrial thermal & manufacturing processes"

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Following a long tradition of UIE (International Union for Electricity applications), the 20th UIE Congress was organized in Nice (France) from 8 to 11 October 2024 by the Centre for Material Forming of the Ecole des Mines de Paris.

UIE congresses started more than 80 years ago in the Netherlands, and after the recent congresses taking place in Hannover (Germany) 2017 and Plsen (Czech Republic) 2021, in this 20th edition the focus was on the electrification of industrial thermal and manufacturing processes.

The audience was constituted by 60 participants (**Figure 1**), half coming from academe and half from industry. Participants were from 14 countries with a strong representation of France, Germany and Italy. 45 presentations were given, including 3 keynotes at the beginning of each day of the congress.

Fig. 1: UIE congress 2024 - ~60 participants.

Sessions discussed decarbonization of thermal and manufacturing processes by electrification, including induction heating, plasma heating, and dielectric heating (**Figure 2**).

Fig. 2: UIE congress 2024 – Session on decarbonization of thermal & manufacturing processes by electrification.

Sessions on numerical modeling showed the way to further optimization of electromagnetic processes. Also the quite new topic of machine learning was presented by speakers who became already real experts in this new field of study.

Besides keynotes and ordinary presentations, two round tables were organized bringing together academe and industry. These round tables triggered vivid interactions with the audience on the topics of decarbonization (**Figure 3**) and the usefulness of artificial intelligence in the design of industrial processes.

Fig. 3: UIE congress 2024 – Round table on decarbonization of industrial thermal & manufacturing processes by electrification.

For the sake of having some order of magnitudes for different figures and other factual information on industrial practice, I noted among many other things, the following:

- Currently, 15% of CO_2 emissions in Germany are caused by thermal processes in industry
- 38% in industrial heat demand is on the account of process temperatures higher than 1000°C
- 24% of natural gas consumption in Germany is used for process heat
- Neural networks seem to be more efficient for interpolation, but less for extrapolation (for extrapolation physical knowledge is needed)
- The cost reduction for photovoltaics is much larger than the cost reduction achievable in the manufacturing of wind turbines
- Thanks to the direct microwave interaction (i.e: without heat transfer) with material, the chemical reaction in cementation can be reduced to 1400°C (instead of 2000 °C needed for the heat transfer by gas burners).

As a general synthesis of the presentations and discussions, I summarize my learnings in the following three points.

Firstly, it is interesting to notice the re-emergence of feasibility studies on the use of electromagnetic technologies in industrial thermal and manufacturing processes. In the seventies and eighties of last century a lot of exploring studies have been done to give orientation concerning the optimal electrical technique to realize industrial added value. The research question was whether resistance, infrared, induction, dielectric heating, or any other electroheat technology was eligible to give the desired result in the interaction of electromagnetic energy with materials. In the nineties and the beginning of the 21st century, these electroheat technologies became proven technologies. Now, in the current dash for decarbonization, a second round of exploration needs to be done to check which technology has the highest potential for CO_2-free production cycles. The electrical possibilities need to be put again on a broad horizon in order to perform adequately feasibility studies to identify the optimal solution. Maybe even the production paradigma have to be changed (e.g. big scale production paradigm to be substituted by small scale production on site of demand). For this multidisciplinary approach, UIE is well placed, integrating induction heating, as well as dielectric heating and many other expertises.

Secondly, with artificial intelligence (AI) an additional engineering tool (besides analytical calculation, experimental exploration, and numerical modelling) has come to the fore. It is not fully clear yet where the boundaries are for AI. To my mind, AI, in spite of the huge database that is used as a source for this "intelligence", the creative aspect, the emergence of something new, seems by definition to be beyond AI's possibilities. Anyhow, in the current state of affairs, common sense engineering, which has maybe a little bit been overshadowed by numerical modelling, will become of paramount importance. An intuitive approach (the way of Michael Faraday) will be more necessary again (together with the mathematical rigor of James Maxwell).

And thirdly, when electrification of industrial thermal and manufacturing processes is to be a response indeed to climate change, a scientific base for the basic assumptions of the different impact scenarios is badly needed. UIE intends to write a manifesto on the position of electricity in the energy system of the future.

As a conclusion, it can be stated that the UIE 2024 congress was an inspiring event. The rather limited scale of the audience, together with the excellent accommodation and catering, facilitated social interaction.

Evolutions are intense, and the stakes are high. Therefore, it has been decided to organize the next UIE congress already in September 2026, together, for this time, with the Heating by Electromagnetic Sources (HES) conference at the university of Padua (Italy).

About the author

Koen Van Reusel received the degree of Master of Electrical Engineering from the KU Leuven (Belgium) in 1985, and the degree of Doctor of Engineering from the KU Leuven in 2010. Since 1992 he is at LABORELEC (Belgium), a technical competence center in energy processes and energy use. As senior expert he is member of the Power Networks Department. His current focus is on electrification of industrial thermal processes, lightning protection in wind turbines, and measuring the effects of electromagnetic fields from a human health perspective. He is visiting professor at the KU Leuven, where he teaches "Electromagnetic Processing of Materials" and "Power Quality". Koen Van Reusel is Member of the Management Committee of AMPERE; General Secretary to UIE, the International Union for Electricity applications; Member of the Board of Directors of FISUEL, the International Federation for the Safety of the Electricity Users; and Member of the International Electrotechnical Committee n° 27 "Industrial Electroheating and Electromagnetic Processing of Materials".

Ricky's Afterthought:

Thoughts on COP29 and the climate change crisis

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Last November Bacu, Azerbaijan, hosted the 2024 Climate change crisis with most countries participating, with an estimate of some 70000 delegates taking part. However, not all the top leaders were present, notable absentees being the Presidents of the USA, Russia, France and the Peoples Republic of China, as well as the Chief of the European Union. It is very worrying when the incoming President of the USA threatens to once again pull the USA out of the Paris Agreement promoting fears that many other countries might follow his lead and reduce their commitment to net zero policies. "Paris is one of those agreements where you need a critical mass of economic powers and emitters, past and present, to actually be able to address this challenge", said Oli Brown, an associate