

# The future of biocalorimetry and biothermodynamics as seen by a biotechnologist

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At the moment, the chemical industry seems to undergo a similar fundamental transformation as the first industrial revolution initiated by the invention of a new type of steam engine by James Watt <sup>1</sup> 250 years ago. The transformation is driven by the new challenges of moving from an oil-based economy to a bio-based economy.<sup>2</sup> But it can only be achieved by elucidation, application and exploitation of biocatalysis and mechanisms of action, which have been evolved over more than 4 billion years of evolution, in technical processes.<sup>3</sup> For the first time, it is possible today to catch complex biological systems both extensively and in great detail. This holds promises for processes at cellular level (systems biotechnology) and applies to environmental interactions (systems ecology). Here biotechnologists are in front of the Dilemma, which faces the explosively increasing wealth of detailed molecular knowledge through modern omics technologies with relatively few viable theories/models for the technical implementation. Thermodynamics could bridge the gap between high detail knowledge and practical models with high predictive confidence. Thermodynamics has already demonstrated this potential in thousands of different applications in physics, chemistry and biology. Nevertheless, the number of research groups that want to tap into thermodynamics and calorimetry for biotechnology is rather small. What are the causes? Are the results so far not sufficient and convincing? Are the biothermodynamic questions not up-to-date and relevant? Or are the necessary theories and measuring instruments too complex and too demanding? The lecture tries to approach potential answers on the basis of own research and thoughts from the very subjective point of view of the author.

**Keywords:** biothermodynamics, systems biology, environmental biotechnology, systems ecology, biotechnology

- 1 Watt, J. Steam Engine Patent (No. 913). (1769).
- 2 Bennich, T. & Belyazid, S. The Route to Sustainability—Prospects and Challenges of the Bio-Based Economy. *Sustainability* **9**, 887 (2018).
- 3 Lokko, Y. *et al.* Biotechnology and the bioeconomy-Towards inclusive and sustainable industrial development. *N Biotechnol* **40**, 5-10, doi:10.1016/j.nbt.2017.06.005 (2018).