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Editorial: Thermoeconomic and environmental analyses of energy systems

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Editorial on the Research Topic
Thermoeconomic and environmental analyses of energy systems

As we face environmental challenges that demand restructuring of our energy conversion processes, tools used to design, optimize, and evaluate their environmental impacts become more relevant. Methodologies for the analysis of energy systems can guide improvements and trigger innovation in energy conversion systems.

In this Research Topic on thermoeconomic and environmental analyses of energy systems, we gathered original articles that contribute to expanding the knowledge base and theory while exploring different perspectives of the design and optimization of energy systems, their operational diagnosis, and assessment of their costs and environmental impacts.

Four articles are included in this Research Topic with contributions from different countries, regions, and scopes, providing new insights on the special connection among thermodynamics, thermoeconomics, and environmental assessments.

- The article "*Is the Evolution of Energy System Productive Structures Driven by a Physical Principle?*" written by Reini and Casisi presents the thermoeconomic environment concept building upon the constructal theory to study the evolution of energy systems. The authors elaborate on the idea that efforts toward minimization of a specific exergetic cost of products pursued frequently in optimization of energy systems are a consequence of a physical law (the constructal law) that summarizes the requirements for systems to persist in time (to survive).

- The article "*Delving into Thermoeconomics: A Brief Theoretical Comparison of Thermoeconomic Approaches for Simple Cooling Systems*" written by Picallo-Perez et al. recognizes different ways thermoeconomics addresses the issue of dissipative components in cooling systems. The authors argue that there are different criteria that can be used to assess the impact of dissipative components in the cost distribution of cooling systems but with no unified consensus, hence the need for a global perspective of the current thermoeconomic methodologies, rational cost accounting in refrigeration systems, and for more research to guide toward common criteria to address these components. A case study on a simple vapor compression refrigeration cycle is developed to explain and compare the treatment given by different thermoeconomic approaches and their sub-methodologies, including the cost distribution ratio, negentropy, and entropy points of view. The overarching aim is to help select a thermoeconomic approach that best suits each case depending on the objective of the analysis of the cooling system.
- The article "*A Thermodynamic Measure of Sustainability*" written by Sciubba starts by presenting and discussing the concept of sustainability and then proposes a thermodynamic approach to quantify the degree of sustainability. The article presents the historical development of the environmental sustainability concept and environmental indicators. A novel indicator to consider the amount of primary exergy globally consumed including material, energy, labor, capital, and environmental remediation costs is advocated. This indicator, the Exergy Footprint, encompasses externalities and translates these into exergy terms of equivalent consumption of primary resources. It is used to select "thermodynamically least unsustainable" scenarios in the thermodynamic facet of "sustainable development," and it is to be complemented with indicators that cover the ethical and socioeconomic facets. The article emphasizes the importance of distinguishing the socioeconomic aspects of sustainability that may rely on societal value choices from those that are within the realm of thermodynamics.
- The mini-review "*Energy, Exergy, Entropy Generation Minimization, and Exergoenvironmental Analyses of Energy Systems—A Mini-Review*" written by Ordonez et al. presents a brief description of the main elements of the methodologies behind energy, exergy, entropy generation minimization, and exergoenvironmental assessments. The article concentrates on the advantages and applicability of these methods, illustration of their complementary nature, and recognition of existing controversies and conflicts associated with the conclusions reached by different methodologies.

Readers are invited to engage with these different perspectives, which we hope will expand the reader's appreciation of these subjects, trigger discussion, and inspire new ideas.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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