



Petar Sabev Varbanov

Process Integration Concepts for Sustainable Solutions to Urban Energy and Waste Management

Petar Sabev Varbanov, Yee Van Fan

Sustainable Process Integration Laboratory – SPIL, NETME Centre, Faculty of Mechanical Engineering, Brno University of Technology - VUT Brno, Czech Republic

The recent COVID-19 pandemic and inflation have revealed two critical bottlenecks – plastic pollution and energy management. To deal with these challenges, Process Integration is aimed at efficiently using resources – exploiting that the waste of one actor could be a resource for another. This contribution presents several recent PI-based solutions for enhancing sustainability.

Energy management and supply have grown in importance considering the increased demands, the rapidly increasing prices, the diminishing supply security, the GHG and other footprints. The Renewable Energy Sources Heat (RESHeat) system uses solar energy to supply electricity, heating and cooling to residential and public buildings. This is a new prototype system, and its environmental impact has to be evaluated. The footprint evaluation matrix for buildings, which accounts for the competition between utilities, is presented. The results indicate that the potential GHG emission savings can reach 70-90 % compared to grid electricity.

The problem of plastic pollution spans land, ocean, and air via macro-, micro-, and nano-plastics. Methods for the optimal design and operation of entire plastic value chains are presented. These include machine learning and Pinch Analysis, Life Cycle Assessment of recycling and upcycling, integration of renewable resources, and energy implications of recycling. The results indicate theoretical recycling rates of 38 % for PET, 100 % for polyethylene and 92 % for polypropylene. Accounting for energy implications can reduce these maximum values. Sustainable urban energy and waste management solutions from macro and micro-level strategies will be presented.

Acknowledgement

The research was supported by the GACR (Grant Agency of the Czech Republic) under No. 21-45726L

and from the Slovenian Research Agency for project No. J7-3149.

The research was supported by European Commission and is a part of the HORIZON 2020 project RESHeat based on Grant Agreement No. 956255