Dr. Kokossis, National Technical University of Athens

Short Bio

Professor Kokossis holds a Diploma in Chemical Engineering from NTUA and a PhD from Princeton University. He returned to his alma mater in 2009 following an overseas academic career in UK at the University of Manchester (formerly UMIST) and the University of Surrey. He holds expertise in process systems design and process integration, recently with a strong emphasis on renewable energy systems, process intensification and the design of biorefineries and industrial symbiosis networks. His research has addressed the design of multiphase reactors, complex separation and reactive-separation systems, energy and power networks, and environmental problems across a wide spectrum of applications (water reuse, recycle, and regeneration systems, wastewater management, gasification, waste to energy projects). He has established collaboration with several industrial companies including several industries dedicated to the development of renewable energy and chemicals. He has graduated 25 PhD and 46 MSc students. He holds 142 communications in International conferences, 129 publications in peer-reviewed journals, and 70 invited lectures in conferences universities, and multinational companies. He has served as the National Representative of the International Energy Agency (IEA), and currently as the National Representative of the IBISBA EU research infrastructure on Industrial Biotechnology, and the Computer Aided Process Engineering (CAPE) Group of the European Federation of Chemical Engineering (EFCE).

Prof Kokossis is a Fellow of IChemE and an elected member of the Executive Board of the European Federation of Chemical Engineering (EFCE).

Title: Process systems engineering as a technology driver in the transition to renewable industrial production

Abstract: Process systems engineering assumes a pivotal and critical role in the development of renewable energy processes as the integration of technologies is, often, much more important than targeted technological innovations. Digitalization and advances in data modelling and data engineering provide a basis to address non-conventional

feedstocks and processing streams (e.g. agricultural residues, municipal waste, recycled products, etc). The general view is increasingly supported by results and analysis that prove the significance of energy systems engineering in future developments. The design and synthesis of biorefineries, for instance, constitutes a complex problem challenged to cope with the large and unknown product portfolios as they arise from different chemical itineraries and processing paths (value chain analysis) as well as process engineering options to select units and integrate them into a plant (process synthesis, process integration).

The presentation explains a systems framework tested on real-life applications. The work combines methods in process synthesis and integration, optimization, and process modelling. A systematic methodology has been applied to several real-life renewable energy systems that include lignocellulosic and oleochemical biorefineries, halophytic algal biorefineries and, more recently, waste biorefineries. Other than systematically screening and scoping integrated paths for the plant, the analysis reduces energy by 70% and the water use by 50-60%. Research is strongly coordinated with LCA. Results demonstrate that, unless fully integrated, the use of renewable resources remain unsustainable. Instead, integrated industries stand as viable and operational options, offering a strong promise in their future development. Applications are rich in opportunities to combine reaction and separation (in-situ product recovery for industrial biotechnology; additive manufacturing in CO2 valorization etc.). The systems framework relied on a new generation of data-embedded models that combine synthesis and process integration at different levels, further building high-throughput capacities for analysis.

Examples are extended to address the use of waste as resource. In this context systems methods are presented in the context of Industrial Symbiosis with a view to explore links (mass and energy exchanges) between industries and resources available at urban sites. Results and applications will be shared from recent work to evaluate the bioenergy potential at four different EU ports, the production of chemicals from end-of-life textiles, and the integration of high technology-readiness technologies with fossil-based facilities. Other than embedding data to models, data engineering and semantics are used to coordinate the screening of engineering options with a parallel screening for materials, strains, resources, and chemistries (primarily synthetic biology with process engineering). Work in progress includes data modelling to produce ex-ante LCA technology and the use of machine learning for multiclass classification and surrogate models. The presentation concludes with highlights of game-theoretical methods as they have been applied to analyze strategies and interactions in the formulation of public-private-partnerships (PPPs).