



**ΕΘΝΙΚΟ ΜΕΤΣΟΒΙΟ ΠΟΛΥΤΕΧΝΕΙΟ**  
**ΣΧΟΛΗ ΧΗΜΙΚΩΝ ΜΗΧΑΝΙΚΩΝ**

**ΕΠΙΤΡΟΠΗ ΣΕΜΙΝΑΡΙΩΝ, Καθηγητής Α. Κοκόσης**

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**ΣΕΜΙΝΑΡΙΟ ΧΗΜΙΚΗΣ ΜΗΧΑΝΙΚΗΣ**

**Πέμπτη 17 Φεβρουαρίου 2011, 13:00**

**Αίθουσα Σεμιναρίων «Ν. Κουμούτσου»**

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**Process design methods for sustainable energy  
systems**

Today, energy is the driver of the modern society, allowing for transforming raw materials and resources into "useful" products and services. Concerns on climate change and resources scarcity together with the increasing importance put on the environmental impacts are redefining the problem of the energy usage in the society. In this context, developing a sustainable energy systems means designing the system that will convert in an optimal way the available resources into useful products and services, reaching the maximization of the resources productivity and minimizing its environmental impact.

In a given socio-economical and environmental context, the goal of the process design is to select the type and the size of the technologies, the way they are interconnected and the way they are operated.

A computer aided methodology and the corresponding process system engineering tools for the analysis and the synthesis of efficient processes and energy conversion systems will be presented. It combines the use of thermo-economic and environomic models of sub-systems that are structured in an equipment data base. These models include the representation of the possible interfaces that a technology will present when it is integrated to build the integrated system. A systematic method based on process integration and optimization techniques is then used to generate process superstructure and process configurations. Models are then used to calculate the system performances in terms of thermodynamic performances, operating and investment cost together with Life cycle impact assessment indicators. Multi-objective optimization techniques are then used to decide the best values of the design decision variables and to generate thermo-economic Pareto sets of process configurations where the trade-off between economical criteria and thermodynamical or environmental impact criteria are represented.

Such tools are used to support decisions in the process engineering work. In this iterative procedure, one has to recognize that the problem is never perfectly defined at the beginning of the project. The methodology includes therefore solutions analysis tools such as exergy analysis and sensitivity analysis and graphical representations that are used to understand the energetics of the solutions and refine the process design problem definition.

The tools developed are applied in different fields : rational use of energy, water and waste management in the industrial processes, energy conversion systems design like power plants with CO<sub>2</sub> capture, fuel cell systems and biofuels production and in the study of urban energy systems. In the presentation, examples of the biofuel production process design will be used to illustrate the different steps of the methodology and demonstrate the role of process design in the development of sustainable energy systems.