Laboratory of Industrial and Energy Economics

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The Laboratory of Industrial and Energy Economics (LIEE) is an educational and research unit at the National Technical University of Athens (NTUA), one of the oldest and most prestigious academic institutions of Greece. The unit is part of the Chemical Engineering Department, having strong links with other departments of NTUA in both teaching and research activities. LIEE currently employees 6 faculty members and a total of 18 researchers and PhD candidates and is directed by Prof. L. Papagiannakis.

The activities of LIEE are developed in two parallel but interrelated streams:

· **Industrial Economics and Policy,** with emphasis on corporate strategies and the impact of technological change on industrial dynamics, headed by Assistant Prof. Y. Caloghirou.

· **Energy/Environmental Economics and Policy,** with emphasis on energy system planning under environmental and economic limitations, headed by Associated Prof. D. Diakoulaki.

The research subjects addressed in both streams entail the analysis of complicated, ill-defined and highly uncertain systems with implications on the whole economy and society. Thus, MCDA methods take up a dominant place in the methodological arsenal used to deeply investigate relevant issues and assist in the policy making procedure, with emphasis on the following research areas:

· **Energy system analysis and planning.** The research conducted in LIEE focuses on the problems related with the penetration of new energy sources and technologies with emphasis on renewable energies. MOLP and MIMOLP models are developed for identifying efficient investment combinations, which are further analyzed to find out the most preferred operational plans, at the national and regional level, as well as on a single unit level such as hotel units and hospitals. On the other side, MCDA methods are used for the comparative evaluation of discrete energy plans and policies with the active involvement of relevant stakeholders.

· **Analysis and design of environmental policies.** The emphasis here is on the optimal implementation of economic policy instruments, such as energy taxation and emissions trading. The main objective is to investigate the impact of such policies on the competitiveness of different economic entities –sectors or firms- by means of MCDA classification methods. Another research topic is the use of MOLP models in the optimal allocation of allowances in an emissions trading system.

· **Financial analysis and firm or project selection.** Besides the ranking/classification of firms on the basis of the multiple aspects of their financial performance –mainly related with courses' exercises- research is principally oriented in multicriteria combinatorial problems handled with the use of MCDA methods jointly with integer programming models.

Although relevant research activities are primarily concerned with MCDA applications, methodological advances are also achieved. The CRITIC method was developed for assisting the weights elicitation procedure by quantifying in the form of 'objective' weights the intrinsic information carried by the decision criteria. The MultiCriteria Branch and Bound (MCBB) method developed in the PhD thesis of G.Mavrotas (actually lecturer in LIEE) generates all the efficient solutions of a Mixed Integer MOLP problem by first identifying all efficient combinations, thus providing a particularly useful information to the DM. Moreover, the exploitation of fuzzy set theory in MIMOLP formulations has also been advanced. Finally, a recent research task is to investigate the association between CBA and MCDA in order to exploit their mutual strengths.

At the educational level, the aim is to equip future engineers with knowledge on MCDA theory and applications. Besides seminars in the course 'System Analysis and Decision Making', 3-6 diploma theses are elaborated in LIEE each year, while 4 PhD students have successfully completed their thesis in this field (E. Georgopoulou-1998, G. Mavrotas-2000, Y. Sarafidis-2003 and V. Hontou-2004).

As an epilogue, we would like to mention that our participation in the EWG on MCDA was very helpful for us to get in touch with the progress and debates of the European MCDA community on crucial issues of theory and practice. It was a pleasure and honor for LIEE to organize in co-operation with HELORS the 53rd Meeting of the Group in Athens and we look forward to host our friends in a future Meeting.

MCDA-relevant publications of the last 10 years

G.Mavrotas, D. Diakoulaki and Y.Caloghirou, *"Project prioritization Under Policy Restrictions. A Combination of MCDM with 0-1 Programming"* Eur. J. of Oper. Res., forthcoming.

D.Diakoulaki and V.Hontou, *"A Multicriteria approach to burden sharing among industrial branches for combating climate change"* Clean Technologies and Environmental Policy, Vol. 5, 1, (2003).

G.Mavrotas, H.Demertzis, A.Meintani, D.Diakoulaki, *"Energy Planning in Buildings under uncertainty in fuel costs: The case of a hotel unit in Greece"*, Energy Conversion & Management, 44, 8, pp. 1303-1321, 2003.

G.Mavrotas, D. Diakoulaki and P.Capros, *"Combined MCDA- IP approach for project selection in the electricity market"*, Annals of Operational Research, 120, pp.159-170, 2003.

G.Mavrotas, D. Diakoulaki and Y.Caloghirou, *"A Project prioritization Under Policy Restrictions. A Combination of MCDM with 0-1 Programming"* Operations Research, Bulletin of the Hellenic Operations Research Society, 2002.

G.Mavrotas and D. Diakoulaki, *"A fuzzy extension of a Mixed Integer MOLP model for solving the power generation problem"*, in Recent Developments and Applications in Decision-Making, Eds. S.Zanakis, G.Doukidis, C.Zopounidis. Kluwer Acad. Publ., Dordrecht, 2000.

K.Liaskas, G.Mavrotas, M.Mandaraka, D.Diakoulaki, *"Decomposition of Industrial CO_2 emissions in European Union"*, Energy Economics, Vol.22, 4, pp. 383-394, 2000.

D.Diakoulaki, C.Zopounidis, G.Mavrotas, M.Doumpos, *"The use of a preference disaggregation method in energy analysis and policy making"*, Energy, Vol. 24, pp. 157-166, 1999.

G.Mavrotas, D.Diakoulaki, L.Papayannakis, *"An energy planning approach based on mixed 0-1 MOLP"*, Int. Transactions in Operational Research, Vol. 6, pp. 231-244, 1999.

S.Mirasgedis, G.Mavrotas, D.Diakoulaki, *"The use of fuzzy sets in the assessment of the social cost of electricity generation"*, Fuzzy Economic Review, Vol. IV, pp.3-20, 1999.

G.Mavrotas, D.Diakoulaki, *"A Branch and Bound Algorithm for Mixed 0-1 Multiple Objective Linear Programming"*, Eur. J. of Oper. Res., Vol. 107, pp. 530-541, 1998.

G.Mavrotas, D.Diakoulaki, D.Assimacopoulos, *"Bounding MOLP Objective Functions: Effect on Efficient Set Size"*, J. of Oper. Res. Society., Vol. 49, pp. 549-537, 1998.

E.Georgopoulou, Y.Sarafidis, D.Diakoulaki, *"Design and Implementation of a Group DSS for Sustaining Renewable Energies Exploitation"*, Eur. J. of Oper. Res., Vol. 109, pp. 483-500, 1998.

S.Mirasgentis, D.Diakoulaki, *"Multicriteria analysis vs Externalities assessment for the comparative evaluation of electricity generation systems"*, Eur. J. of Oper. Res., Vol. 102, pp. 364-379, 1997.

D.Diakoulaki, G.Mavrotas, L.Papayannakis, *"Determining Objective Weights in Multiple Criteria Problems. The CRITIC method"*, Computers & Oper. Res., Vol 22 (7), pp. 763-770, 1995.