

Increasing energy efficiency in industry through cogeneration, trigeneration and measures for reducing primary energy consumption

Habilitation thesis

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Abstract

The habilitation thesis “Increasing energy efficiency in industry through cogeneration, trigeneration and measures for reducing primary energy consumption” contains three parts:

- Part I – there are synthetically presented the scientific activity and evolution of teaching carrier.
- Part II – there are presented the main fields of scientific research and major achievements within these fields.
- Part III – there are presented perspectives and main directions of future personal scientific development.

Part I – scientific activity and evolution of teaching carrier.

Since 2003 I have started my teaching activity at the Faculty of Power Engineering of the University Politehnica of Bucharest and the main stages are presented below:

- 2003-2004 period – university assistant.
- Period 2004-2014 – lecturer.
- 2014-present period – associate professor.

The teaching activity at the Faculty of Power Engineering included course and application activities in the undergraduate and master programs at the following disciplines:

- Energy audit.
- Heat supply.
- Heat utilization.
- District heating.
- Economic efficiency of energy systems.
- Cogeneration.
- Energy balances and optimization.
- Energy and environment.
- Measurement equipment.
- Financing of energy projects.
- Energy management.
- Power management for sustainability.

During this period I have had several research internships in Italy and Slovenia. At the same time I was involved in continuous formation courses for energy auditors and energy managers. I have also been involved in a number of educational projects for students and personnel from Romanian energy sector.

The scientific research activity has aimed the following fields:

- Cogeneration, trigeneration and combined energy production.
- Energy efficiency.
- Heat supply and district heating.
- Energy audit.

- Renewable energy sources.
 - Environmental impact of energy sector.
- During this period I have also been involved in some other activities:
- Member of EBRD research and consulting projects: expert on energy efficiency, cogeneration, heat supply, energy efficiency trainer in industry.
 - Energy Efficiency Expert within the Romanian Energy Efficiency Fund (FREE).
 - Consultancy activity within different companies at different levels of competence in the field of energy.
 - Member of Working Group 3 “Flexible Generation” of European Technology and Innovation Platform-Smart Networks for Energy Transition (ETIP-SNET).
 - Scientific reviewer for different ISI and other international database journals and conferences.

The entire activity of the last 14 years has been based on interdependence between teaching, educational, research and consulting activities. This activity was interdisciplinary with the involvement of students, young researchers and other colleagues both within the faculty and other institutions/companies.

Part II – the main fields of scientific research and major achievements within these fields.

The main fields of scientific research presented in the thesis are the following:

- Combined energy production - cogeneration and trigeneration.
- Increasing energy efficiency in different sectors.

The main contributions in the field of cogeneration/trigeneration can be synthesized in the following aspects:

- Algorithms and methodologies of multi-criteria, energy, ecological and economic analysis on the opportunity of the power supply solution in cogeneration and trigeneration, using different technologies.
- Complex models for environmental impact analysis of different cogeneration technologies (internal combustion engines, gas turbines, steam turbines) using fossil fuels as well as renewable energy resources.
- Models of economic quantification of ecological effects of energy production based on eco-taxes.
- Multi-criteria, energy and economic analysis based on algorithms to demonstrate the opportunity to use alternative energy sources in cogeneration, such as biomass, biogas, fuel cells etc.
- Strategies and solutions regarding the use of cogeneration and centralized heat supply for various cities in Romania.
- Strategies and solutions regarding the use of trigeneration for different types of industrial and tertiary consumers.

The scientific work developed over years of activity covers a wide range of industries. There have also being analyzed different cogeneration and trigeneration solutions for different consumers in the tertiary sector. It has been demonstrated on the basis of energy, ecological and economic indicators the efficiency of cogeneration and trigeneration in relation to separate energy production, for different modern technologies of low and medium power cogeneration/trigeneration energy generating facilities equipped with gas turbines, internal combustion engines, which supply both urban and industrial consumers.

The main research results in the field of cogeneration/trigeneration:

- Pn1. Contract PNIII-P2-Bridge Grant 2016 no. 66BG/2016 „Increasing competitiveness of ENET SA Focșani through development and diversification of services and optimization of modern technologies for combined production of heat and power”, 2016-2018 (director).

- Contract EBRD No. C2334/AMIF-2011-09-06 for Romania: Brasov District Heating Project – Feasibility Study, 2012 (responsible).
- Vis10. Patrascu, R; **Minciuc, E**, *A model for internalization of environmental effects for different cogeneration technologies*, PROCEEDINGS OF THE 2ND WSEAS/IASME INTERNATIONAL CONFERENCE ON ENERGY PLANNING, ENERGY SAVING, ENVIRONMENTAL EDUCATION Book Series: Energy and Environmental Engineering Series Pages: 25-29 Published: 2008, Accession Number: WOS:000263153400002, IDS Number: BIV45, ISBN: 978-960-474-016-1.
- Vis9. Patrascu, R; **Minciuc, E**, *Comparative analysis of different combined heat and power generation: fuel cells, gas turbine, internal combustion engine*, NEW ASPECTS OF ENERGY, ENVIRONMENT, ECOSYSTEMS AND SUSTAINABLE DEVELOPMENT, PT 1 Book Series: Energy and Environmental Engineering Series Pages: 27-31 Published: 2008, Accession Number: WOS:000258371100002, IDS Number: BIC35, ISBN: 978-960-6766-71-8.
- Vis1. A. Bădicu, R. Pătrașcu and **E. Minciuc**, *Comparative Analysis of Different Means of Biogas Production Used in Cogeneration*, a 9-a Conferință Internațională EPE-2016, 20-22.10.2016, Iași, România.
- Vis4. **E. Minciuc**, R. Pătrașcu și I. Diaconescu, *Trigeneration in tertiary sector: a case study*, a 2-a WSEAS Conferință internațională pentru Tehnologii și Echipamente din Energie și Mediu (EEETE'13), Iunie 1-3, 2013, Brașov, România, ISBN 978-1-61804-188-3, pag. 81-85.
- Ris8. R. Pătrașcu and **E. Minciuc**, *Cogeneration plant for energy supply of a meat processing company: case study*, Buletin UPB, seria C, vol. 75, nr. 4, 2013, ISSN 2286-3540, pag. 269-276.

The main contributions in the field of energy efficiency in industry can be synthesized in the following aspects:

- Elaboration of procedures for elaborating energy audits, for simple and complex contours, validated on a large diversity of case studies and applied within the framework of research contracts.
- Elaboration of energy management procedures validated for industrial contours as well as for urban areas.
- Development of energy efficiency plans, evaluation and implementation of proposed solutions.
- Initiation and further development of three learning programs in the field of energy efficiency, industrial and urban energy management and thermo-energetic audit.
- Methodologies and models of complex energy, ecological and economic analysis of energy use for complex energy systems, validated in research projects.
- Good practice guidelines for SMEs in the field of energy efficiency.

The scientific work developed over years of activity covers a wide range of industries, but also various solutions for increasing energy efficiency for different consumers in the tertiary sector. Within these, energy efficiency, environmental and economic indicators have demonstrated the efficiency of different solutions for reducing energy consumption.

The main research results in the field of energy efficiency in industry:

- I2. R. Pătrașcu and **E. Minciuc**, *Audit energetic. Aplicații*. Editura Politehnica Press, București, 2013, ISBN 978-606-515-443-8, 113 pages.
- Vis8. Patrascu, R; **Minciuc, E**; Darie, G, *Complex analysis and evaluation of processes from the glass industry*, RECENT ADVANCES IN ENERGY AND ENVIRONMENT Book Series: Energy and Environmental Engineering Series Pages: 183-187 Published: 2009, Accession Number: WOS: 000265673500025, IDS Number: BJG65, ISBN: 978-960-474-055-0.
- Vis6. Patrascu, R. , **Minciuc, E.** , Darie, G. , Bitir-Istrate, I., *Aspects regarding the impact on the environment of the flue-gas utilization in an industrial contour*, Recent

Researches in Environment, Energy Planning and Pollution - Proc. of the 5th WSEAS Int. Conf. on Renewable Energy Sources, RES'11, EPESE'11, WWAI'11,; Iasi; Romania; 1 July 2011 through 3 July 2011; Code 87780, 2011, Pages 205-209, ISBN: 978-161804012-1.

▪ Vis7. Patrascu, R., **Minciuc, E.**, Diaconescu, I., Darie, G., *Implementation opportunity of an industrial waste incinerator*, Proceedings of the International Conference on Energy and Environment Technologies and EquipmProceedings of the International Conference on Energy and Environment Technologies and Equipment, EEETE '10, International Conference on Energy and Environment Technologies and Equipment, EEETE '10; Bucharest; Romania; 20 April 2010 through 22 April 2010; Code 84111, 2010, Pages 72-77, ISBN: 978-960474181-6.

The didactic and scientific activity resulted in the elaboration as author and coauthor of 14 books and chapters from books, 50 articles in scientific journals and at international conferences and 27 articles in scientific journals and conferences in Romania.

Part III – perspectives and main directions of future personal scientific development.

University career development is still linked to the Energy Production and Use Department, of which I am a member. During the years of activity within the department I developed and maintained professional and friendly relations with our colleagues. I have also developed relationships with colleagues from other departments within the Faculty of Power Engineering. The development of these relations with colleagues within the department and faculty was done in three directions: didactic, research and professional. In addition to the relationships I have developed with UPB colleagues, I have also developed relationships with partners through various teaching and research projects both in the country (technical universities, energy research institutes, industrial companies, energy consulting companies) Outside Romania (universities in Europe). I want to continue developing these collaborative relationships and keep them benefic for all

The research plan aims at maintaining and developing research relationships with various partners both internally and internationally.

Another priority objective that I am considering in my career development in the field of scientific research is my involvement in projects and research related to cogeneration, trigeneration, district heating, energy efficiency, the use of renewable energy sources, reducing environmental impact, etc.

Particular attention will be paid to the doctoral guidance activity. In this regard, I want to develop more cooperation with various companies, so that the doctoral theses elaborated under my guidance have a close connection with the industry and address topics of interest of companies. In this way, the transfer of knowledge and the results of the research to the economic environment are made easier and faster. In order to develop these links with companies I will use the existing contacts due to my involvement in the students' practice with companies such as Veolia Energie Prahova, LukOil Energy & Gas Romania SRL, Vinci Energies, RADET, Radox SRL, GDF SUEZ Energy Romania SA - ENGIE, Enet Focșani, RATB, etc.

The didactic plan involves the continuous improvement of the educational process, which includes the following aspects:

- Continuous improvement of the courses.
- Active involvement in the practice of students, supporting them in finding a place of practice, and maybe later on a job.
- Involvement in the development of existing master programs, and possibly in the development of new master studies.
- Involvement in various projects aimed at developing the material base, equipment and improvement of laboratories, creation of new laboratories, etc.

In addition to the teaching activities strictly related to the UPB education process, I also intend to support the development of various continuous training courses and e-learning.

I also propose maintaining and developing the didactic relations with other specialized universities both in the country and abroad.

The professional plan aims at developing collaboration links with various actors in the energy field in Romania and abroad.

A direction of development of the professional plan is the development of new professional relationships with the members of the scientific, academic and professional communities in various institutions, such as education, research, consultancy, design or industrial companies from the energy sector, both in the country and from abroad.

Another direction of professional development is membership as a member of various national and international organizations. In this regard, I would like to mention that since 2017 I am a member of the Working Group 3 "Eligible Generation" of the European Technology and Innovation Platform (ETIP-SNET) for the next 4 years.

In the same direction of international relations development, I would like to mention that I have applied for the position of expert in the European Platform for Research and Energy Education Universities (EUA-EPUE) and UNI-SET (universities under the SET-Plan program at the level of the European Union).

In conclusion I would like to say that I want to build my academic and professional career to ensure success and to bring me personal satisfaction and fulfillment, but also an increased visibility and recognition both in the country and abroad.