

**Research and Development in the field of
Energy Efficiency - experience and results
of the Serbian**

NATIONAL ENERGY EFFICIENCY PROGRAM

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Promoting financing eco-innovation
in CEE countries
27 April 2009, Zagreb, Croatia

Start-up and end of activity

NATIONAL ENERGY EFFICIENCY PROGRAM (NEEP) is research, development and demonstration (R&D&D) program

- **Allocated funds – about 2 millions Euros/year**
- **Founded by Ministry of Science and Technology** - **April 2001**
- **First Open invitation** - **January 2002**
- **Start of project financing** - **April 2002**
- **Last (7th) Open invitation** - **April 2006**
- **Closure of the NEEP** – **December 2008**
- **Last projects finished realization** – **April 2009**

Basic ideas

In undeveloped and developing countries, especially in small countries, transfer and implementation of the new technologies and energy management

IS POSSIBLE ONLY if it is based on:

- Strategy and priorities
- Research and development (pilot-plants)
- Demonstration, and
- Dissemination of best practice

Concept of the NEEP

- **To formulate** R&D strategies in EE and RES and to choose priorities
- **To demonstrate**, promote and implement new methods, new energy management and new efficient and environmentally acceptable technologies,
- **To unite** fundamental research and R&D&D with engineering activities and feasibility studies
- **To include** EE in all sub sectors of energy system,
- **To unite** activities of institutes, universities, engineering organizations and industry

Types of the projects

- **Demonstration projects (D)** – to demonstrate new technologies and equipment, engineering and managing methods using existing knowledge. Maximum 12 months.
- **Research, development and demonstration (R&D&D) projects** – to gain new knowledge, followed by demonstration and implementation of new technologies and equipment. Maximum 3 years
- **Main goal of every project** – pilot-plants and demonstration
- **Feasibility studies (S)** – to give a basis for policy formulation in EE, to make data base about energy potentials, natural recourses and recourses in energy efficiency. 3-12 months

Structure of the NEEP

NEEP included **EE&RES** in all sub sectors of energy system

- Energy efficiency in electric power production
- Energy efficiency in electric power transmission and distribution
- Energy efficiency in industry
- Energy efficiency in municipal systems
- Energy efficiency in households
- Development of domestic ovens and boilers burning solid fuels
- Use of alternative and renewable energy resources
- Energy efficiency in buildings
- Energy efficiency in traffic engineering

NEEP projects users

- **Public enterprises – utilities**
- **Local authorities**
- **Municipal public services**
- **Large agriculture farms**
- **Industry**
 - **Food industry**
 - **Paper and pulp industry**
 - **Small ovens and boilers production factories**
 - **Domestic production of equipment for small hydro power plants**

Projects financed in 2002-2008

- 7 open invitations for project proposals
- 231 projects (**both R&D&D and D**) and 44 strategic and/or feasibility studies
- 63 project + 7 studies of energy potentials in RES

EE and RES research has been continued in the frame of Technology development sector

- 30 project started in July 2008
- 35 project proposals are under consideration

Chosen results

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Energy efficiency in electric power production

- ***New method for management with wells for underground water draining at open pit mines – self energy consumption savings 5%, capacity increase 20%, investment costs less 20%***
- ***Implementation of standard procedures for defining optimal equipment repairation period***
- ***Implementation of process analysis of large thermal power plants – thermal efficiency increased 3-4%***
- ***Implementation of specific diagnostic procedure for boiler process analysis – increase of boiler thermal efficiency 1,5-2,5%***
- ***Methodology for analysis and increase of power of hydro-power plants in operation 5-10%***

**All results have been implemented in
Electric Power Company of Serbia**

Energy efficiency in electric power transmission and distribution

- ***Methods for analysis of energy losses in transmission and distributive network – cuts of losses for 5-10%***
- ***Development of measuring and regulation equipment (hardware and software) for exploitation control of transformers in distributive networks***
- ***“In situ” diagnostic for isolation control of energy and measuring transformers***
- ***Measuring equipment for “in situ” control of accuracy of metering transformers at high voltage – 110, 220 and 400 kV***
- ***Distant measurement of high voltage lines temperature***

**All results have been implemented in
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Energy efficiency in industry

- ***Reduction of energy consumption in sugar production in 3 sugar producing factories – from 1,5MJ/kg to 1,0MJ/kg***
- **Increase of energy efficiency of air distribution systems in industry – reduction of energy consumption achieved 17-30%**
- ***Reduction of energy consumption in paper and pulp industry for about 50%***
- **Increase of energy efficiency by wide range continual regulation of electric motors in industrial processes – energy savings 5 to 30%**
- **Computer based energy and fluid management in process industry**
- **Waste heat utilization in different companies in process industry**
- ***Development of fluidized bed combustion furnace for incineration of high density liquid waste deposit in oil reservoirs***

Energy efficiency in municipal systems

- **Concept and designs of the industrial size fluidized bed boilers and gasifiers for biomass and local coal have been developed**
- **Effects of implementation of distant control and heat measurement in district heating systems – in test buildings 20% less heat consumption, 30% less electricity consumption**
- **Introduction of combined heat and power production in gas fired district heating plants**
- ***Study of optimal layout of heat and gas distribution systems in large towns – possible 20% energy saving***
- ***Energy efficiency and optimal exploitation of water supplying systems in several towns – 15 – 20% of electricity savings,***
- ***Information system and data base of municipal waste management system***
- **Optimization of management and control of exploitation of district heating systems in small towns – 5 – 15 % energy savings**

Energy efficiency in households

- **Use of geothermal hot water heating in households**
- ***Use of heat of deep stones for two- and three-generation systems for households – experimental – testing device***
- **Influence of split conditioning systems on the electric energy distribution network**
- ***Development and design of the efficient equipment (hot water boilers) using gas burners with combustion in porous materials***
- **Use of heat-pumps with geothermal heat source for heating households**
- **PV solar systems for households lighting**
- **Analysis of the directives and technical standards in EU for appliances in households**
- **Systems for energy consumption management in households**
- **Education programs for pupils and students about EE and use of RES**
- **Advertising and education programs for general population – different education degrees – on EE and use of RES**

Development of small ovens, furnaces and boilers for households

- **Development of technology and equipment for making briquettes and pellets from local coal, agriculture and wood waste biomass,**
- ***Research and development of new technologies – cigarette combustion, fluidized bed combustion,***
- **Development, design and testing of household ovens with heat accumulation for coal combustion, and emission control**
- ***Development, design, testing and construction:***
 - **Small ovens and furnaces for households**
 - **Small boilers for central heating**
 - **Hot gas generators for industry and agriculture**
 - **Industrial boilers up to 100 MW_t, suitable for high volatile fuels – lignite and biomass**
- ***Development of boilers with cigarette type combustion of soya straw bales***

Possible and technically available energy potential of renewable energy sources

- ***Energy potential of waste biomass in Serbia***
- **Energy potential of geothermal waters for use to heat households and greenhouses**
- **Solar and wind energy potential in Serbia**
- **Energy potential of wood waste in forestry regions**
- ***Possible capacity of biodiesel production and necessary quantity of biodiesel to satisfy European standards***

Solar energy

- **Development of flat thermal solar collectors for domestic production**
- **Development of flat hybrid (thermal – PV) collectors for domestic production**
- **Development of systems for following up sun movement**
- **Testing of solar collectors**

Wind energy

- **Measurements of wind energy potential at several, chosen optimal locations**
- **Estimation of local wind energy potential**
- ***Implementation and development of modern numerical software for prediction of local wind energy potential and possible total power of farms of wind generators***
- ***Creation of micro, mezzo and macro wind energy potential maps of Serbia***
- **Synergetic use of solar and wind energy for melioration**
- **Use of wind energy for accumulation of hydro-energy**

Geothermal energy

- **Feasibility studies, design, construction, testing and implementation of:**
 - ***hydro geothermal systems in thermal spa, for households heating and vegetables growing in greenhouses***
 - **geothermal energy of earth, using heat pumps for heating and power generation in households**

Small hydro power plants

- ***Full domestic R&D&D and **production cycle** – development, experimental facilities for testing, design, construction, production and implementation of optimal turbines for specified locations and local conditions***
- **Construction and testing of mini and micro hydro power plant at specific locations – testing in situ and in real exploitation conditions**
- **Development, design, construction and testing of small turbine-pump systems for melioration**

Biomass

- **Energy and waste material balancing of medium and large agriculture companies**
- **Development of technology and equipment for biomass briquetting and pelleting**
- ***Research and development of new technologies – cigarette combustion, fluidized bed combustion,***
- ***Development, design, testing and construction of:***
 - ***Small ovens and furnaces for households***
 - ***Small boilers for central heating***
 - ***Hot gas generators for industry and agriculture***
 - ***Industrial boilers up to 100 MWt***
- **Use of bio-diesel and ethanol in internal combustion engines – equipment design, construction and testing**
- **Fast growing energy crops and wood**

Energy efficiency in buildings

- ***Determination of the new annual average design air temperature and humidity and determination of typical meteorological year— possible savings 12%***
- **Average design temperatures in urban cores – large towns**
- ***Energy saving homes constructed using natural materials, soil, non fired bricks – possible energy saving up to 40%***
- **Implementation of calculation methods for obtaining energy passports of buildings according to EU standards**
- ***Determination of energy consumption (energy efficiency) of typical school buildings in Serbia and suggestions for improvement of energy efficiency***
- **Development and production of energy efficient windows and construction of testing room according to EU standards**
- **Testing of typical buildings and determination of real heat consumption in several towns in Serbia**

Energy efficiency in traffic engineering

- ***Improvement of diesel and Otto engines to satisfy EU emission standards***
- ***Implementation of LNG combustion in existing internal combustion engines used in domestic car production***
- ***Management with hazardous materials in traffic, based on energy savings***
- **Implementation of natural gas in public city transport**
- **Analysis and implementation of EU standards of energy efficiency in different types of transport**
- **Implementation of biodiesel in city transport and transportation of goods and products**
- **Implementation of the methodology for energy efficiency control in transportation companies**

General observations

- **Utilities are best partners and used a lot of the results – have more money and qualified engineers**
- **Engineering organizations are not interested to be partners (buy equipment and do not need R&D&D)**
- **Industry mostly do not have money for implementation EE and RES project results (lack of legislation, obligatory technical standards, financial stimulations, fuel and energy prices)**
- **No friendly environment for implementation of EE and use of RES**
- **No money for pilot- and demonstration plants**
- **No money for measurement and experimental equipment**
- **Insufficient demonstrated and implemented results**
- **Weak impact on dissemination of the EE and RES**

Real situation in developing countries

- **Results of R&D&D projects were implemented only in:**
 - **state owned utilities**
 - **working industry – food industry, paper and pulp industry, agriculture**
- **Results of the projects realized for industry mostly were not implemented due to the lack of investment money**
- **In general – industry is not interested in energy efficiency and use of RES and waste fuels**
 - **Economic and financial environment is not favourable**
 - **There are no governmental measures and legislative stimulating energy efficient behaviour of industry**
 - **Electric energy prices are low**
 - **There is no Funds for support and stimulation EE and RES implementation**
 - **Investment from abroad has been small in this sector**

Conclusion

- **Energy reasonable behaviour is possible only in developed rich countries**
- **In developing countries there is no money for:**
 - **implementation of new, more efficient technologies**
 - **new energy efficient equipment**
 - **restructuring of industry to introduce low energy consuming production**
 - **For pilot- and demonstration plants**
 - **For eco-innovation financing**
- **Financial help of international fund and financial institutions is highly necessary**
- **Considering present crisis, investment in new technologies, new equipment and in RES will be in developing countries even decreasing**

Positive impact of NEEP projects

- **EE has been constituted as specific scientific topic**
- **Reorientation of scientific institutions and researchers to solve problems in EE and use of RES**
- **Choice of the priorities in planning research activity has been introduced**
- **Aim oriented fundamental and applied research is promoted followed by pilot- and D&D plants**
- **Large number of feasibility studies, pilot- demo-plant designs have been prepared for future investments**
- **RES energy potential studies change priorities in use of RES – biomass, wind, small hydro PP**
- **Usable project results and scientific papers are promoted as model**

Necessity of R&D&D

- **General and specific results of the NEEP and project financed justified its existence, and further continuation**
- **In developing countries science and R&D&D (including oriented fundamental research) are an **important and inevitable** part of the set of activities for:**
 - **Increase of energy efficiency**
 - **Increase of use of RES**
- **Those activities make excellent basement for all other activities in implementation of EE and RES**
- **Support from government and international institutions is necessary**
- **The same was in developed countries but they have done this task much earlier**

What is main task of R&D&D?

- **To follow cases of best practice in small countries as – Finland, Sweden, Denmark, Netherland, Austria are.**
- **To formulate strategies in EE and RES research and reorient scientific institutions considering local economic and energy conditions.**
 - **To direct R&D&D toward largest national potentials and resources.**
 - **To redirect R&D&D to solve problems in sectors where increase of EE and use of RES would give maximum effects**
 - **To direct R&D&D where largest intellectual and industrial potentials exist**
- **To prepare feasibility studies, designs, and, if possible, construction and testing of pilot- or demonstration plants, and prepare best practice dissemination**

Problems and barriers

In increasing EE and use of RES – R&D&D is important, necessary but not sufficient activity:

- Strategy of implementation followed by legal, financial and technical favorable condition
- Favorable legal, financial and technical environment is the most important
- Creating of market is necessary
- **Supporting governmental funds are unavoidable**, especially in poor economies, and if favorable environment and market are not developed
- To attract investments from international financial institutions and funds

Energy policy, based on general principles, has to be suited to specific conditions of every country!

R&D&D programs must be followed by:

- **Synergetic activity and participation of all responsible ministries and governmental institutions**
- **Favorable legal environment, and secondary legislation**
- **Favorable economic environment**
- **Activity of local authorities**
- **Activity of network of EE agencies**
- **Engineering activities and organizations**
- **Funds for supporting EE activities**
- **Advertizing and education of professionals and citizens**

Barriers

- **Lack of awareness in government, in local authorities and in management in industry of the importance of rational use of energy and environmental protection,**
- **Lack of knowledge about new energy technologies,**
- **Lack of investments for pilot- and demonstration plants, best practice cases**
- **Lack of investments for implementation of the new technologies, methods or organizational measures.**

Finally

- **Increase of funds for eco-innovation financing in CEE countries is necessary**
- **Promoting of eco-innovation is useful**
- **Foundation of special Funds for eco-innovation in CEE countries has to be discussed**