



# **NOVI KONCEPT ODRŽIVOG ENERGETSKOG RAZVOJA U PROCESNOJ INDUSTRIJI**

## **A NEW CONCEPT FOR SUSTAINABLE ENERGETIC DEVELOPMENT IN PROCESS INDUSTRY**

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# 1. INTRODUCTION

## ▪ SUBJECT OF THE PAPER

A new concept for sustainable development in process industry based on

- **dispersed production and consumption of electrical energy, heat energy** (steam, technological hot water etc.), **refrigeration and cooling energy** by implementing high energy efficient **poly – generation systems**, as well as on
- **thermo-transforming processes, maximum regeneration, recuperation and heat recovery systems, and material recycling systems.**

## ▪ RESEARCH METHODOLOGY

## ▪ SUMMARY OF PREVIOUS INVESTIGATION

## ▪ PURPOSE OF THE PAPER

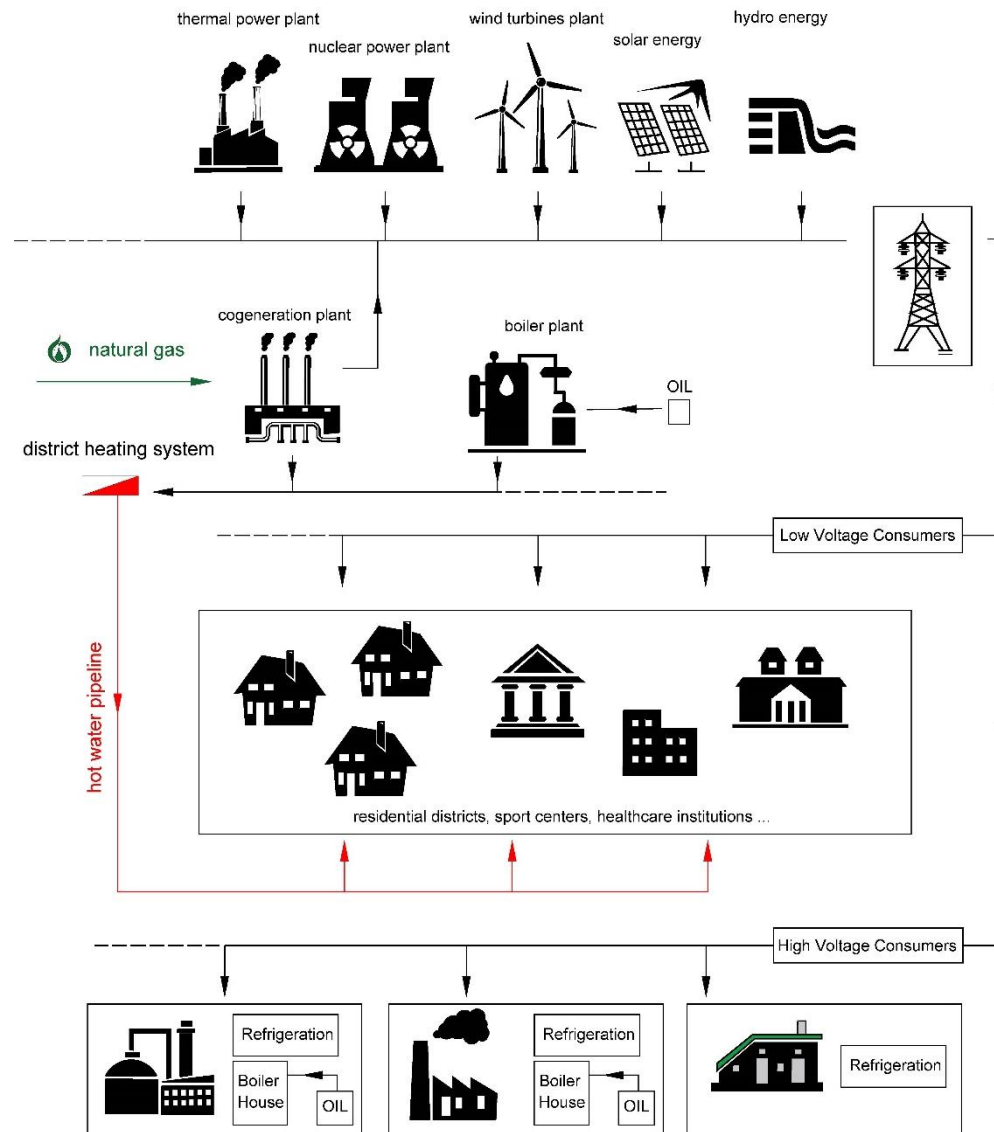
- **propose a new concept for sustainable development in process industry,**
- **describe the characteristics of the main components of the new concept and**
- **estimate the energetic, economic and environmental benefits of the implementation in various process industry sectors** (chemical and pharmaceutical industry, paper, food, dairy, meat, textile industries etc.).



## **2. A NEW CONCEPT OF SUSTAINABLE DEVELOPMENT IN THE GLOBAL ENERGETIC SECTOR**

### **2.1. Characteristics of traditional global energetic sector (Fig. 1)**

- **Centralized production of energy (electricity, heating, cooling, hot water, steam, etc.),**
- **Dispersed consumption of energy,**
- **Large electrical power plants (thermal power plants, hydro power plants, nuclear power plants),**
- **Large district heating systems,**
- **Central industrial steam boiler facilities,**
- **Central systems for heating, ventilation and air conditioning (HVAC systems) in residential, administrative, sport, cultural and educational objects, malls, etc,**
- **Low energy efficient thermal technologies applied in industry (chemical and pharmaceutical, paper, food, meat and dairy industries etc.),**
- **Vehicles, transport and traffic (internal combustion engines).**



*Figure 1 Traditional energetic sector*



## 2.2. Current research and development activities in the energetic sector

- Application of renewable energy sources (solar energy, geothermal energy, hydro energy, wind energy, etc.),
- Use of natural gas as the cleanest fossil fuel and one of the safest primary energy source as a replacement for traditionally used fossil fuels (coal, oil, etc.),
- Development of new concepts of energy efficient technologies of generation, distribution and utilization of energy,
- Development of new concepts of transport and traffic (hybrid vehicles and electric vehicles),
- Application of natural and environmentally friendly working fluids (refrigerants),
- Construction of energy efficient buildings and energy efficient building systems for heating, ventilation and air conditioning,
- Development of new concepts of energy efficient technology in process industry, chemical and pharmaceutical industry, paper industry, food industry,
- Development of cogeneration and tri-generation systems,
- Development and application of thermo-transforming technologies and utilization of low temperature waste heat,
- Development of new concepts for energy storage (battery storage, heating and cooling storage).



## 2.3. A new concept of sustainable development in the energetic sector (Fig. 2)

- Dispersed production of energy (electricity, heating, cooling, hot water, steam, etc.),
- Dispersed consumption of energy,
- Interconnection of the producers and consumers with the electrical system
- Dispersed generation of electricity using photovoltaic solar collectors and poly generation systems for simultaneous generation of electricity, heating and cooling;
- Utilization of high energy efficient thermal technologies in process industry, chemical and pharmaceutical industry, paper industry, food industry etc.;
- Application of thermo-transformation and utilization of low temperature waste heat;
- Implementation of electrical vehicles in transport and traffic.
- Development of poly generation systems with variable capacities and implementation in different buildings, residential objects, administrative, sport, cultural and educational objects, malls, etc. for heating, cooling, refrigeration and sanitary hot water generation and electricity generation.
- Development of poly generation systems with different capacities and implementation in different industrial systems for heating, cooling, refrigeration, steam generation, sanitary and technological hot water generation and electricity generation;
- Utilization of renewable energy sources.

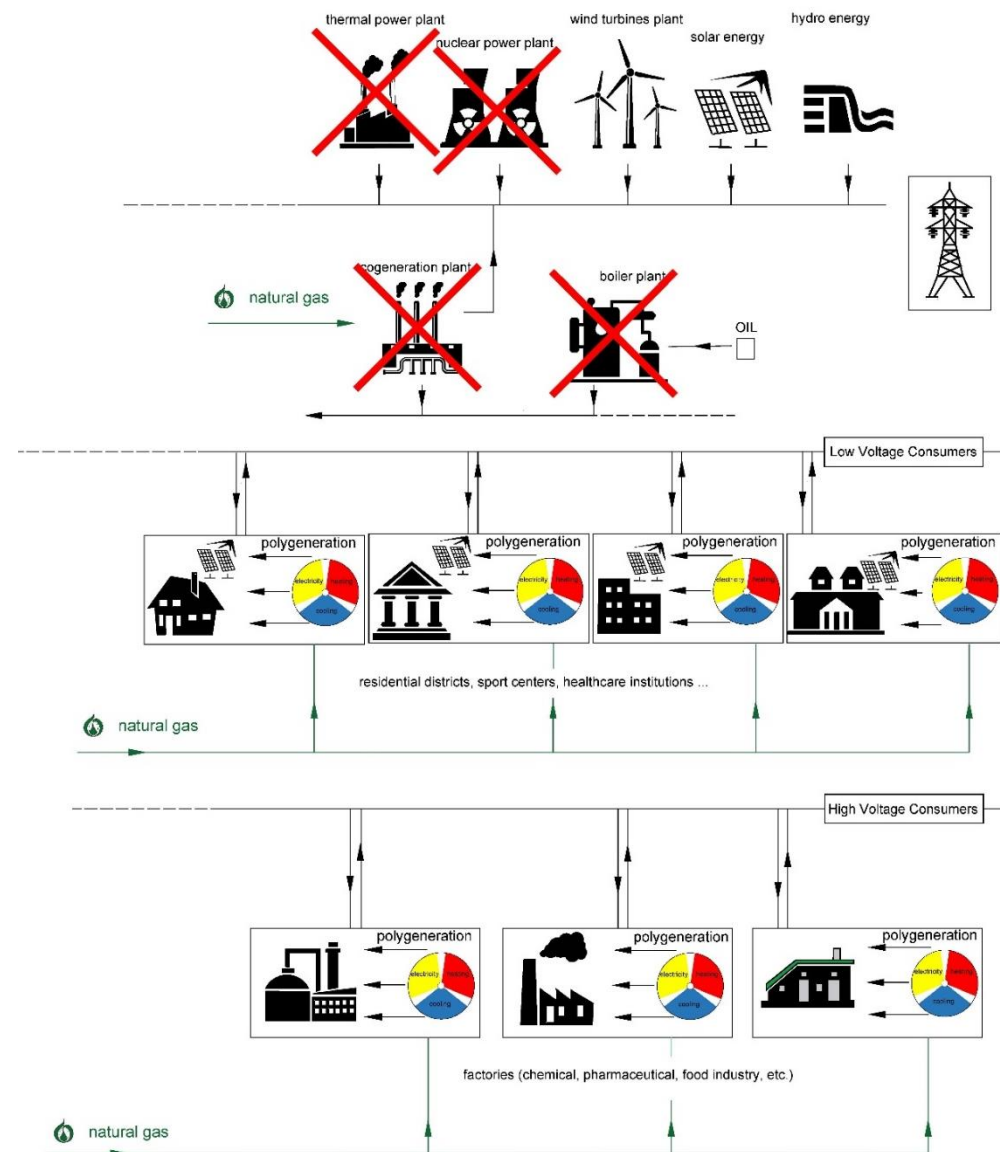


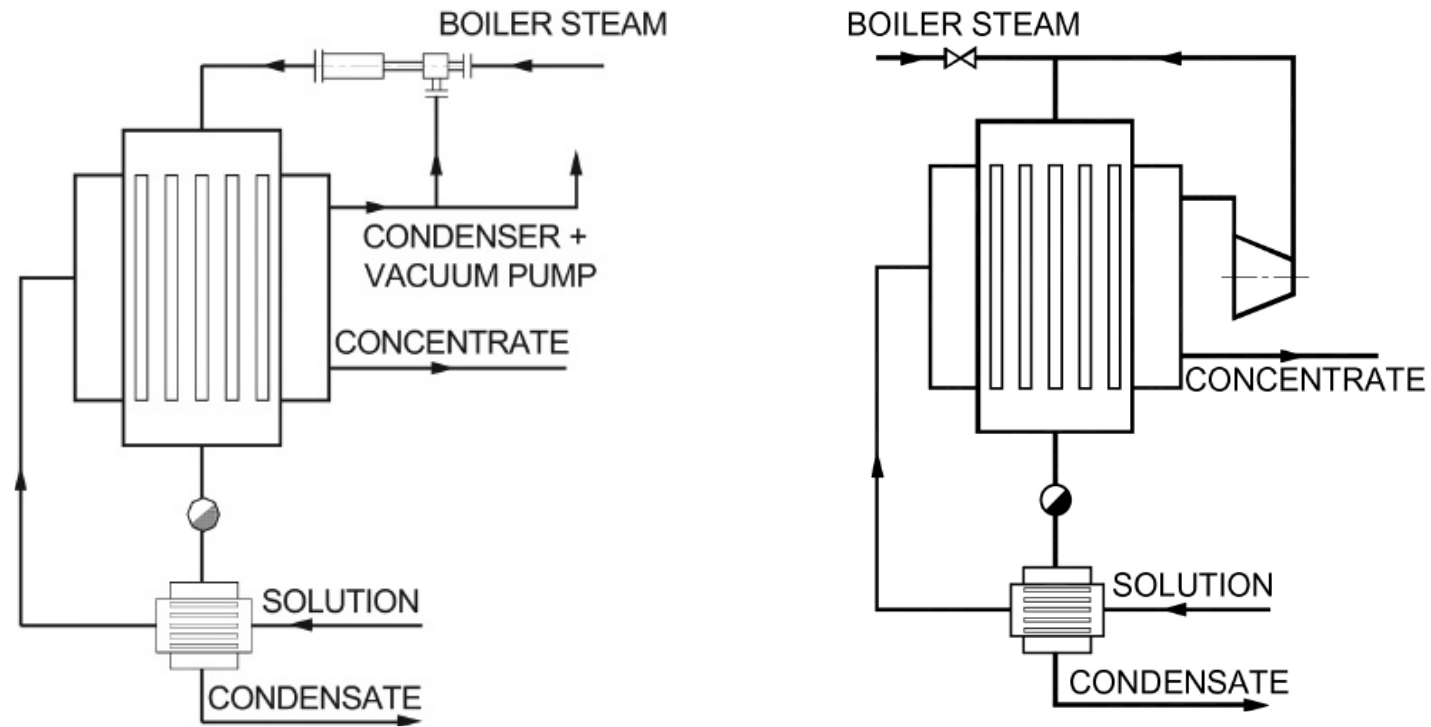
Figure 2 A new concept of sustainable development in the energetic sector



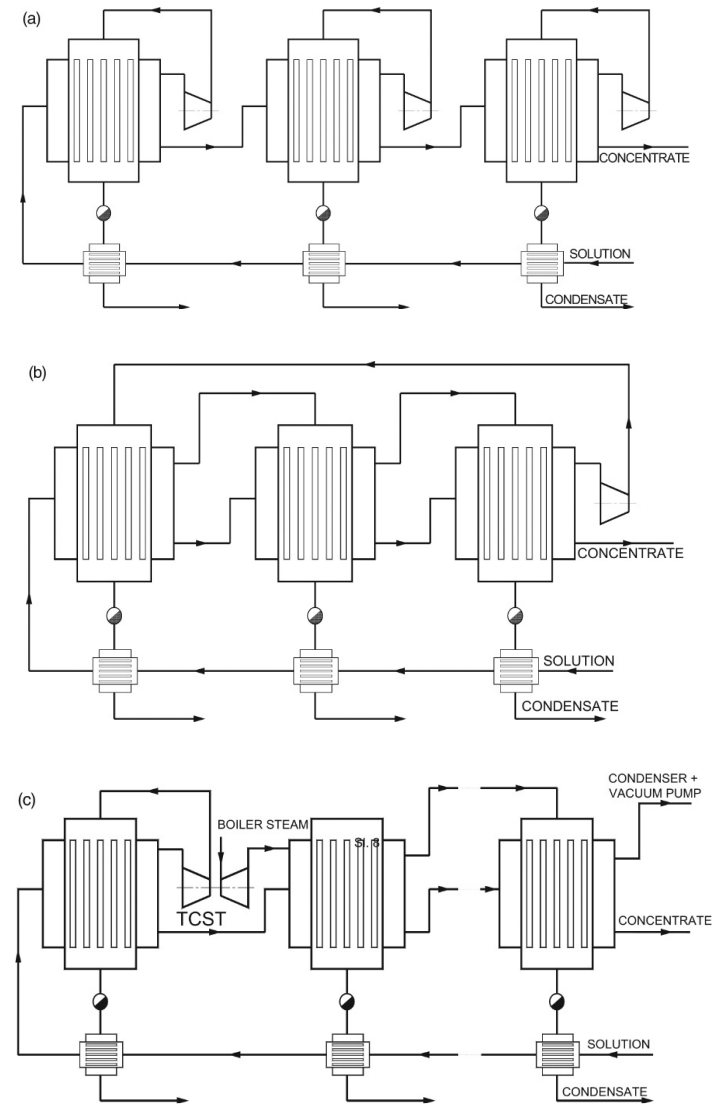
### 3. CHARACTERISTICS OF THE NEW CONCEPT OF SUSTAINABLE ENERGETIC DEVELOPMENT IN THE PROCESS INDUSTRY

- The new concept of sustainable development in the energy sector should be applied in the process industry energy sector (chemical and pharmaceutical industry, paper industry, food and canning industry, dairy industry, beer industry, meat industry, textile industry etc.)
- **INDUSTRIAL CONCENTRATORS:** Multistage concentrating and/or ejector and/or turbo compressor thermal vapor compression / recompression (Fig. 3, Fig. 4). High and extremely high COPs can be obtained using ejector thermal vapor recompression and using turbo compressor thermal vapor recompression depending on the operating temperature conditions.
- Introducing new closed steam-condensate systems with ejector thermal compression in various process industry thermal energy systems results in significant energy (fuel) saving and energy efficiency improvement.
- Application of new systems for vacuum and heat (steam) cogeneration in paper industry and other process industry sectors results in significant reduction of heat and electrical energy consumption.





*Figure 3 Evaporation / concentrating systems with ejector and turbo compressor thermal vapor recompression*



*Figure 4 Complex evaporation / concentrating plants with thermal vapor recompression*



## 4. CONCLUSIONS

- A new concept for sustainable development in the energetic sector in the process industry is proposed in this paper based on
  - **dispersed production and consumption of energy** (electricity, heating, cooling, hot water, steam, etc.),
  - **implementation of thermo-transforming systems and high temperature heat pumps for thermal vapor compression / recompression,**
  - **maximum regeneration, recuperation and heat recovery and material recycling systems, using the concept of cleaner production.**
- Comparison of the new and traditional energetic sector is presented and current research and development activities are discussed.
- The new concept for sustainable development of the energetic sector in the process industry is based on the concept for sustainable development in the global energetic sector.
- Implementation of the new concept in various process industry sectors (chemical and pharmaceutical industry, paper industry, food industry, dairy industry, meat industry, textile industry etc.) results in technical – energetic, economic and environmental benefits.