



RENEWABLE ENERGY SOURCES - biomass, hydro and solar -

UNIVERSITY OF BELGRADE

Faculty of Mechanical Engineering

Department for Engineering Materials

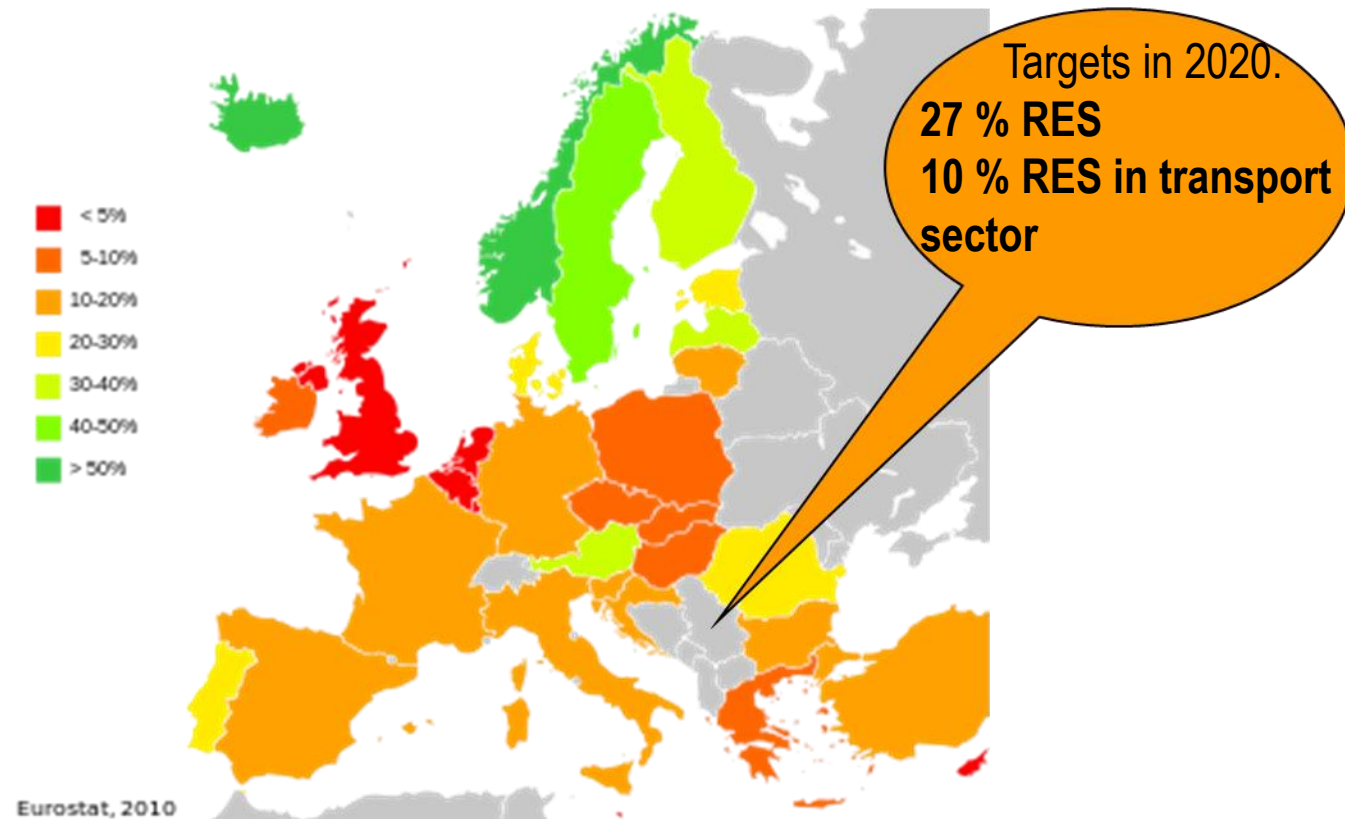
Fuel and Combustion Laboratory

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RES target for the Republic of Serbia

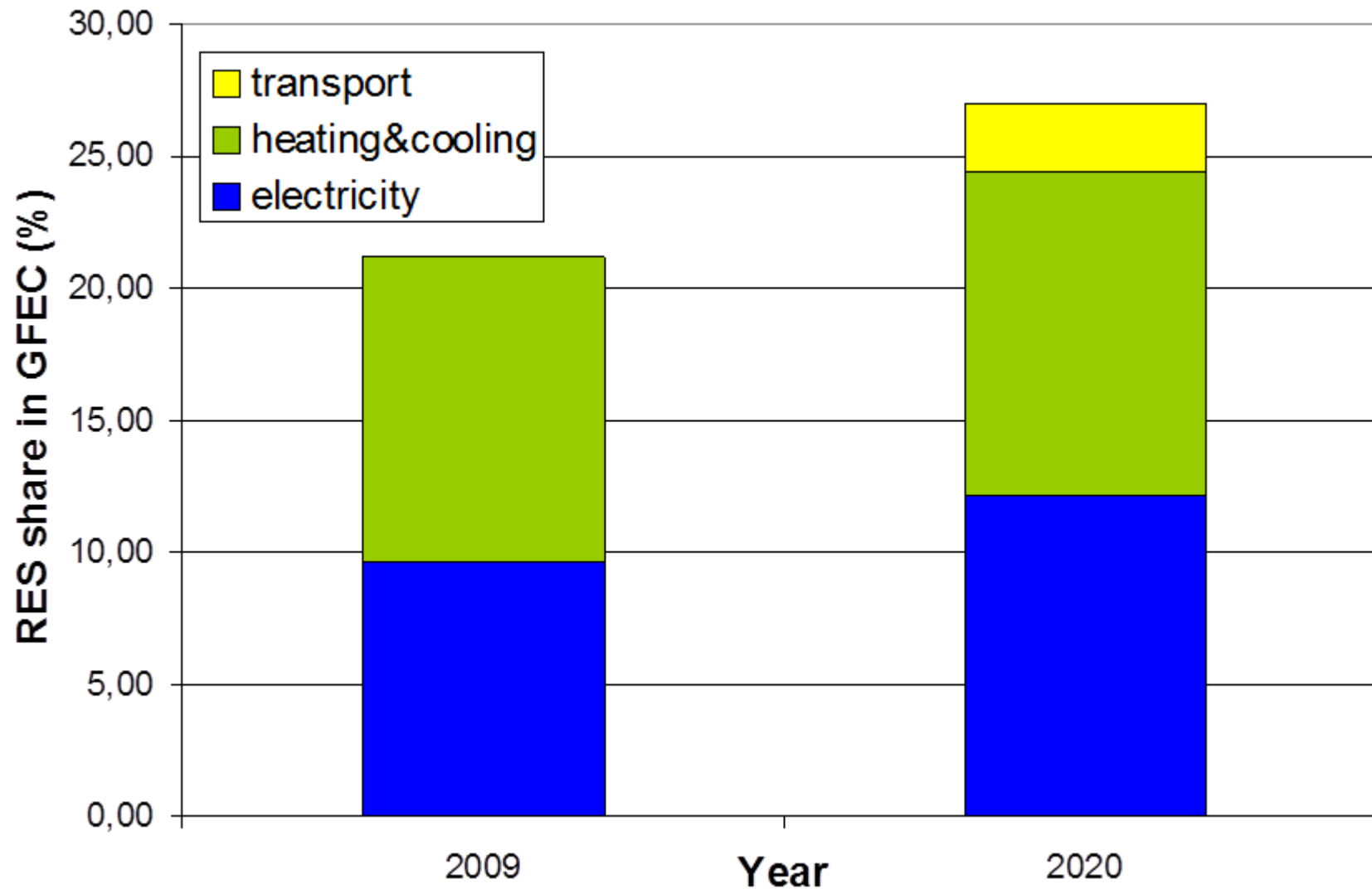




Utilization in 2009

- Out of the total available technical potential of renewable energy sources, the Republic of Serbia already uses 33%:
 - 0,9 Mtoe from hydro-potential
 - 1,06 Mtoe from biomass.
- Electricity sector
 - 884 ktoe – 28,7 % of energy consumption in electricity sector
- Heating&Cooling sector
 - 1.059 ktoe – 25,6 % of energy consumption in H&C sector
- Transport sector
 - biofuels were existent at the market only with 0,21 ktoe (this quantity has not been recorded in the national statistics).

Target for 2020



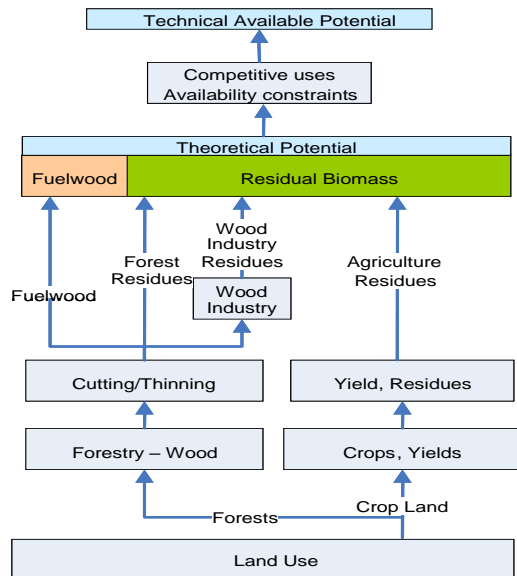


Studies and projects....

- Study "Biomass Consumption Survey for Energy Purposes in the Energy Community - Republic of Serbia" - Study on biomass consumption in 2009/10 and 2010/11, prepared for the calculation of binding share of RES for each member of the EnC prepared by the Centre for Renewable Energy Sources and Saving (CRES), 2011;
- Study "Emergency Oil Stocks in the Energy Community Level" – Study on mandatory reserves in compliance with the Directive 2009/119/EC, prepared by the Energy Institute Hrvoje Požar, 2011;
- "Strategic and Development Projects of the Electric Power Industry of Serbia" – review of planned structure of development of capacities in the electric power sector, Electric Power Industry of Serbia, 2011;
- Study "Identification and Assessment of Biomass Heating Applications in Serbia" – Study on the possibilities of use of biomass in the district heating system – improvement of energy efficiency and replacement of conventional fuels (lignite and heating oil) with biomass, prepared by USAID, 2010;
- Study "Building Capacities for the Use and Promotion of Solar Energy in the Republic of Serbia - Analysis of Existing Offer and Potential Demand for Solar Systems in Serbian Market", Mercados, 2010;
- Plans for development of capacities in the transport sector for the needs of production and distribution of biofuel, prepared on the basis of existing capacities and plans of the leading companies in that field
-



Renewable energy sources – biomass



Biomass source	Potential (toe)
Forest based biomass	755.086
Energy crops	594.134
<i>Agricultural biomass</i>	<i>1.717.928</i>
Field crop residue	1.411.786
Arboricultural residues	130.624
Liquid manure (for biogas production)	175.518
Municipal solid waste	199.876
Total Biomass	3.277.024

Renewable energy sources – biomass

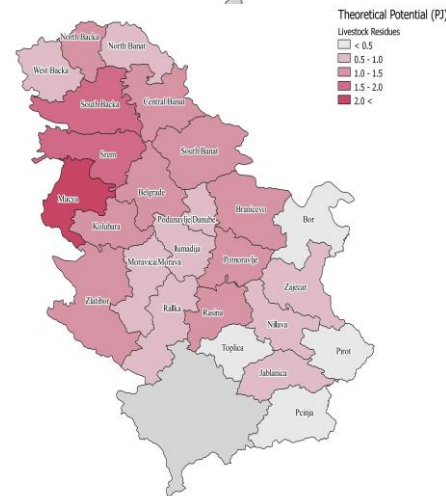
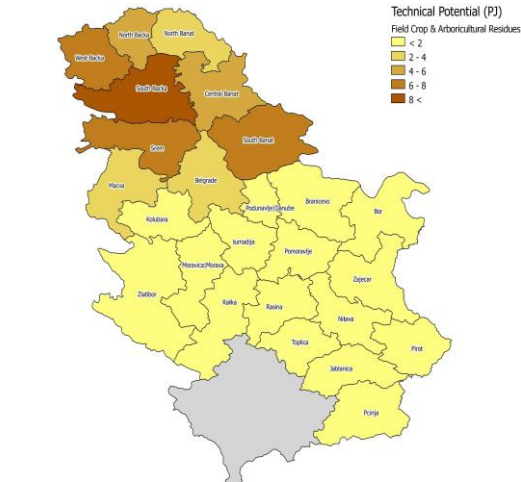


- The most promising options for biomass utilization in Serbia are:
 - Biomass – CHP plants (agriculture biomass and wood residues)
 - Biogas – CHP plants
 - District Heating Plants - total replacement of currently burn heavy oil or coal
 - Space heating in households and buildings using biomass pellets or briquettes
 - Co-firing with coal in Thermal Power Plants
 - Production of biofuels for transport.

Heat & electricity market opportunities



Crop and arboricultural residues

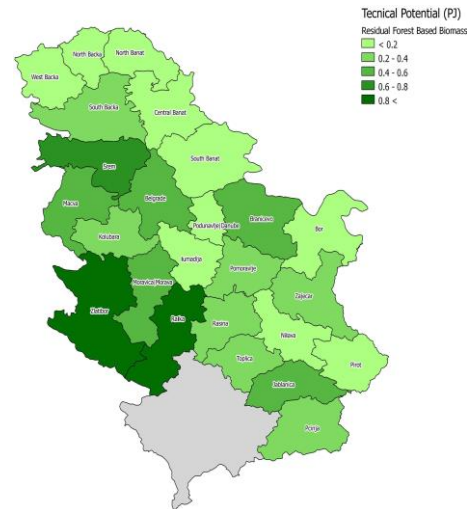


Livestock residues

If 37,5 PJ from the 104 PJ of technical potential is exploited

Electrical generation capacity 334 MW_e

Heat generation capacity 815 MW_{th}

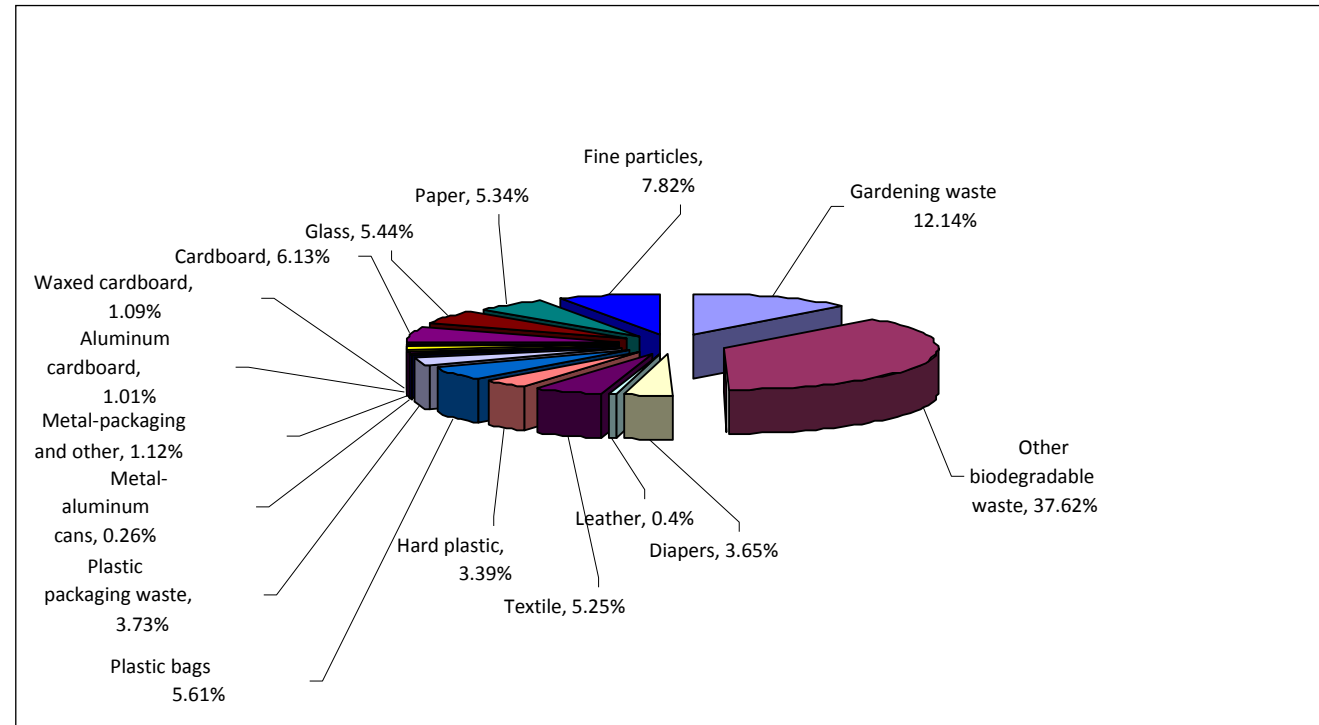


Forest based biomass

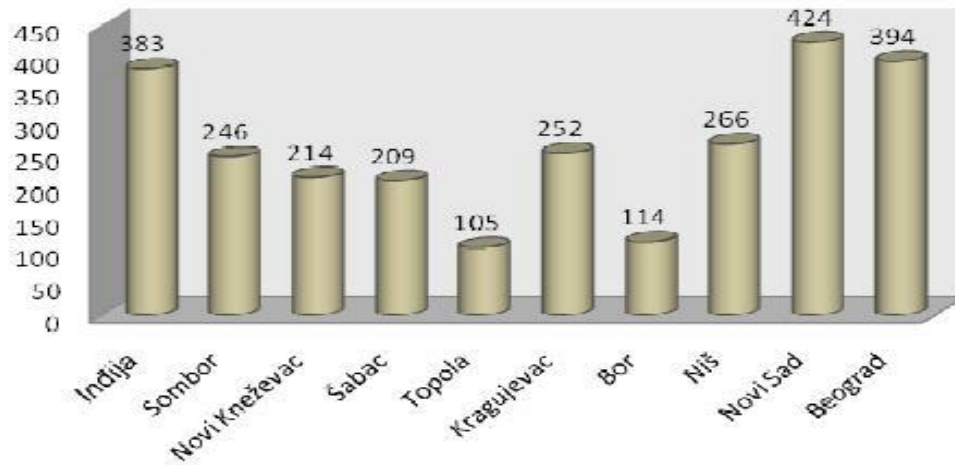
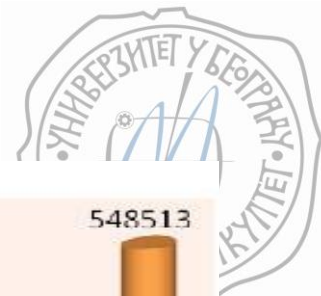
Waste Management in Serbia



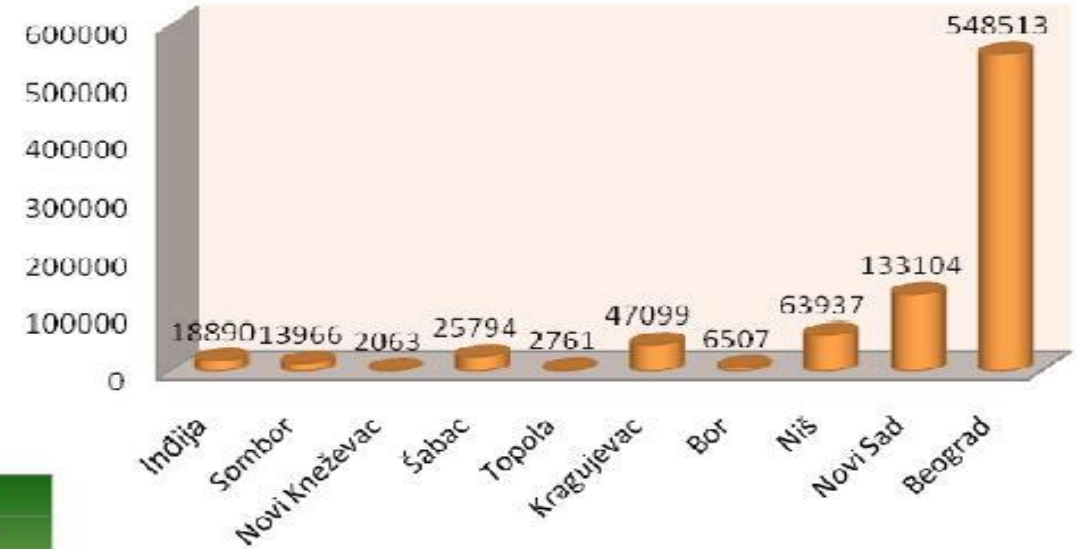
- Urban population generates 1 kg of MSW/cap./day
- Belgrade - 1,2 kg MSW/cap./day
- App. 0,87 kg MSW/cap./day (318 kgMSW/cap./a)
- 2.4 milion tons of MSW/a (2010.)
- 3.4 milion tons of MSW/a (2020.)



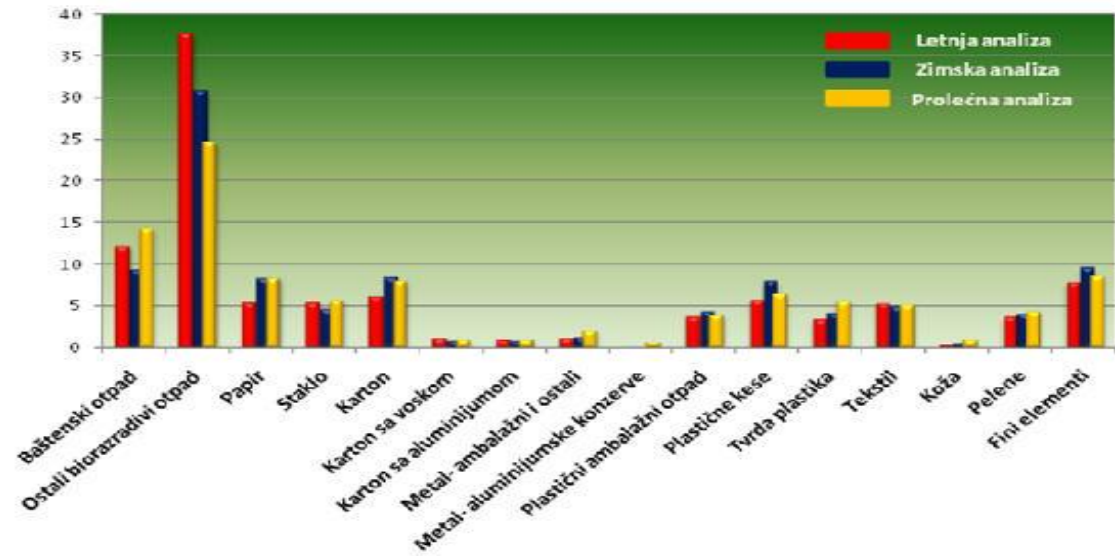
Waste Management in Serbia



Grafik 6.3 Generisane količine otpada po stanovniku godišnje (kg/st/god)



Grafik 6.2 Generisane količine otpada po opštinama (tona/godišnje)

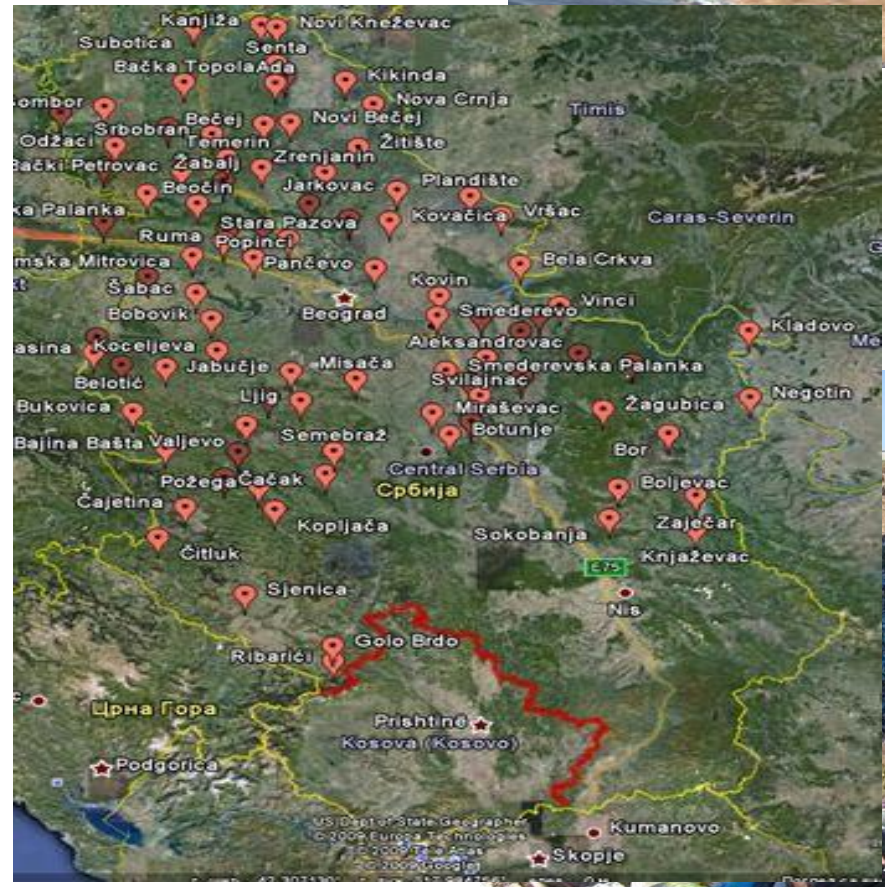


Grafik 6.1 Uporedni prikaz mofrološkog sastava otpada-letnja, zimska i prolećna analiza-Republika Srbija

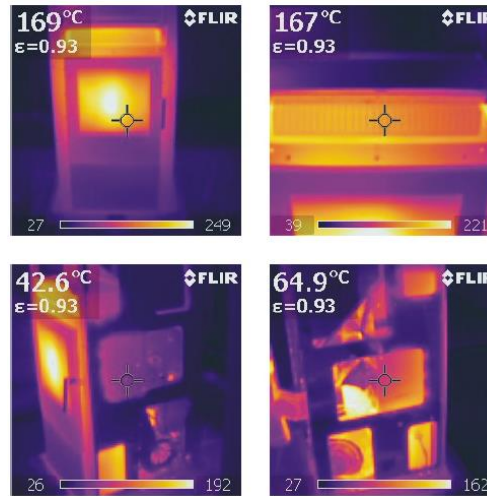
- Moisture content – high
- Heat value - low

Waste Management in Serbia

- Waste management in Serbia depends heavily on sanitary landfill sites
- In Serbia there are more than 1000 illegal dump sites
- In future – regional recycling centers (app. for min. 200000 inhabitants)



Experimental tests of pellet stove - according to EN 14785 -





Mathematical modeling

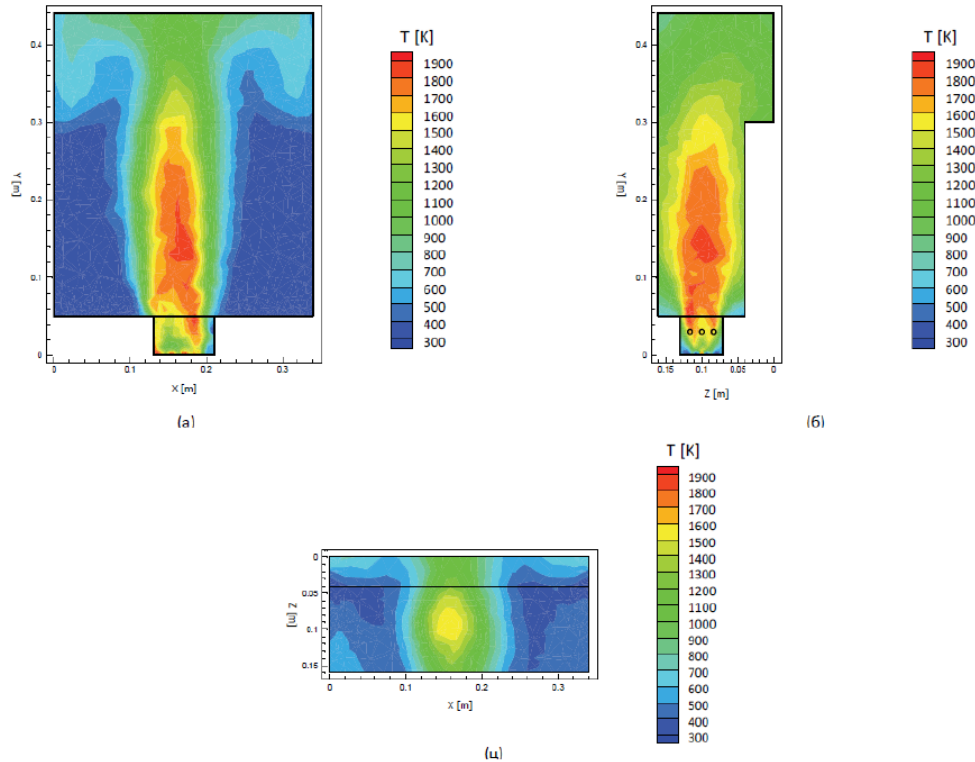
- Examples -

- **EXAMPLE 1 – Pellet stove**
 - Mathematical model for combustion process
 - Compare obtained results with experimental

- **EXAMPLE 2 – Pellet burner**
 - Mathematical model of fluid flow
 - Improve construction according to turbulence and high velocity criteria

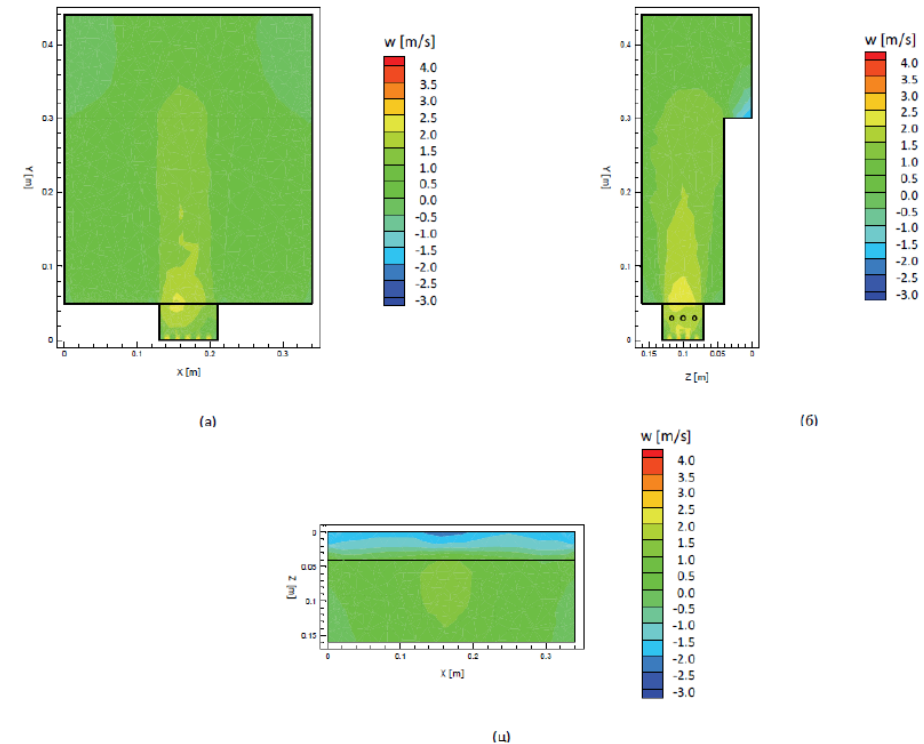
Mathematical modeling

- Example 1 - Model results -



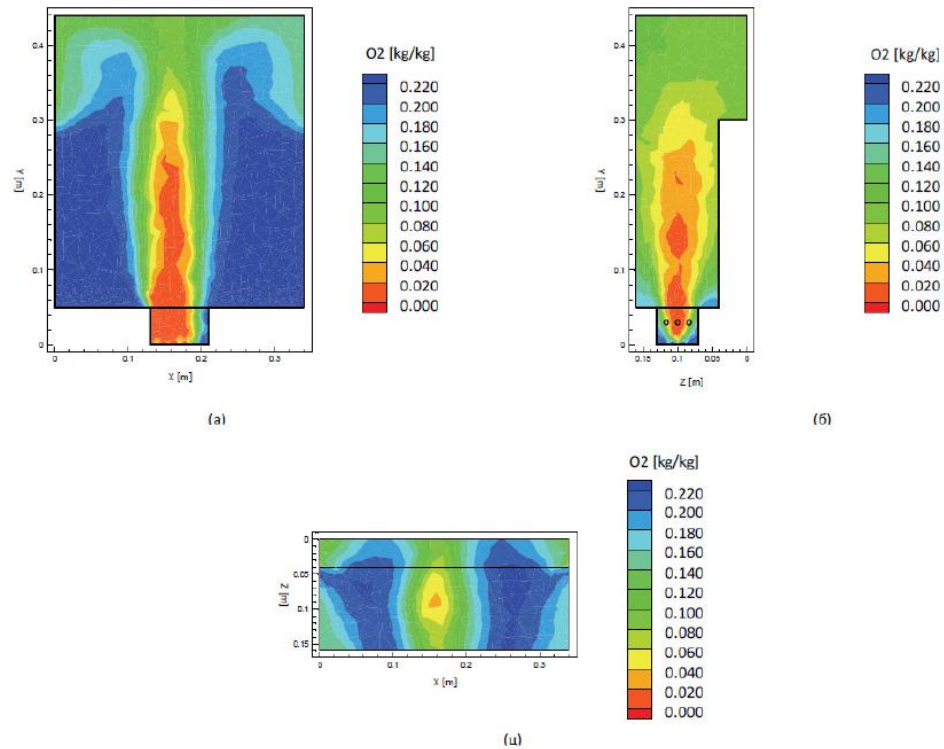
Temperature distribution for different cross sections

Velocity distribution for different cross sections



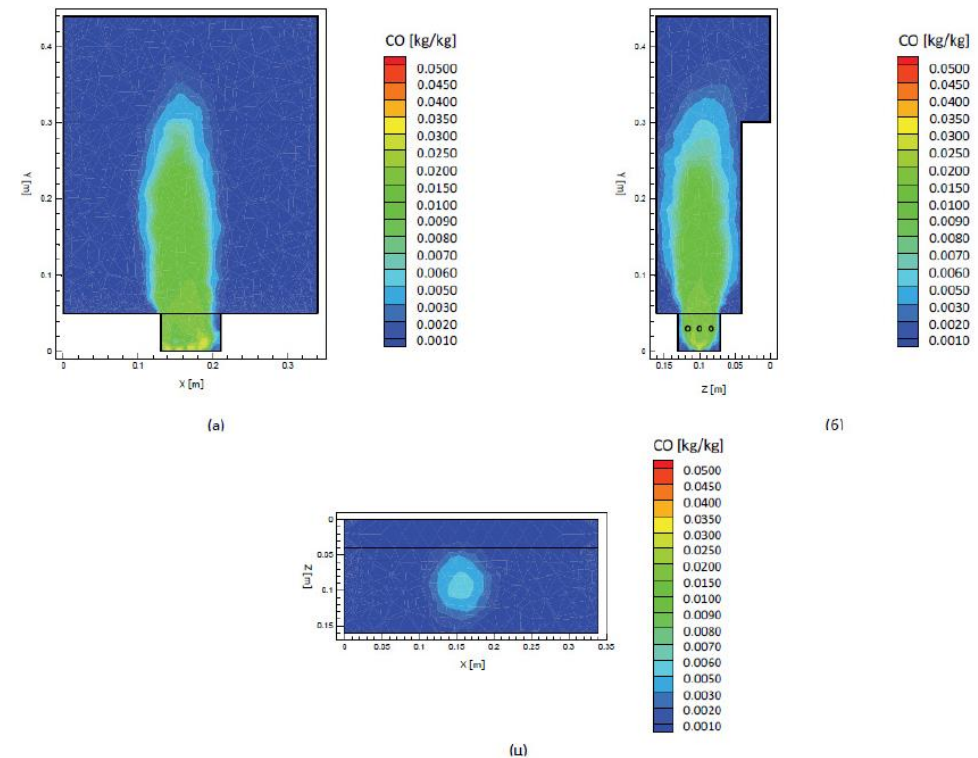
Mathematical modeling

- Example 1 - Model results -



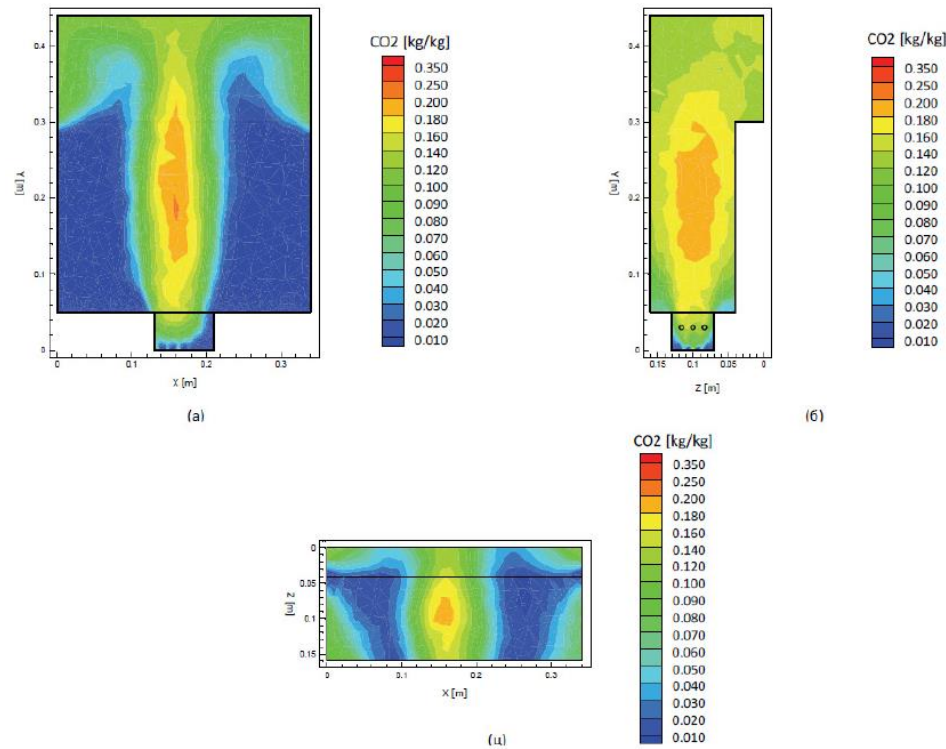
Oxygen (O₂) concentration for different cross sections

Carbonmonoxide (CO) concentration for different cross sections



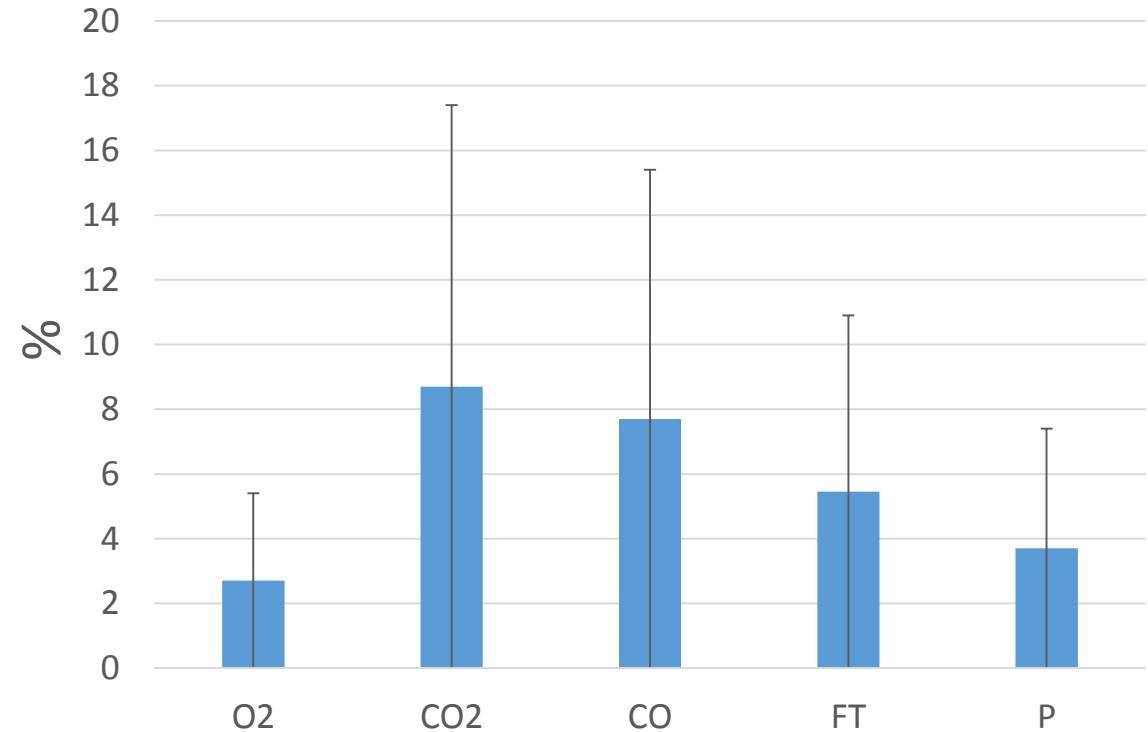
Mathematical modeling

- Example 1 - Model results -



Carbondioxide(CO₂) concentration for different cross sections

Differences between model and experimental results

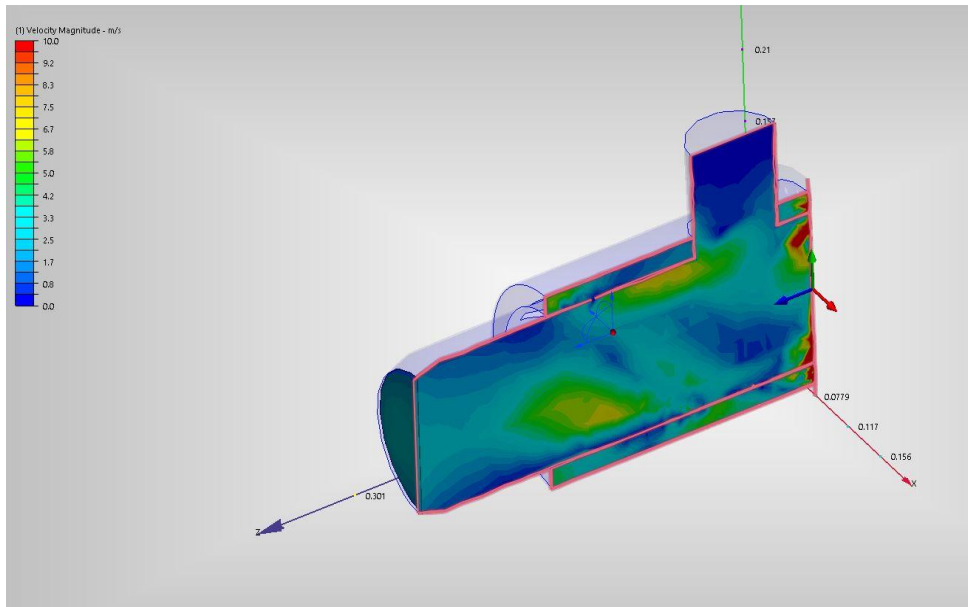


Mathematical modeling

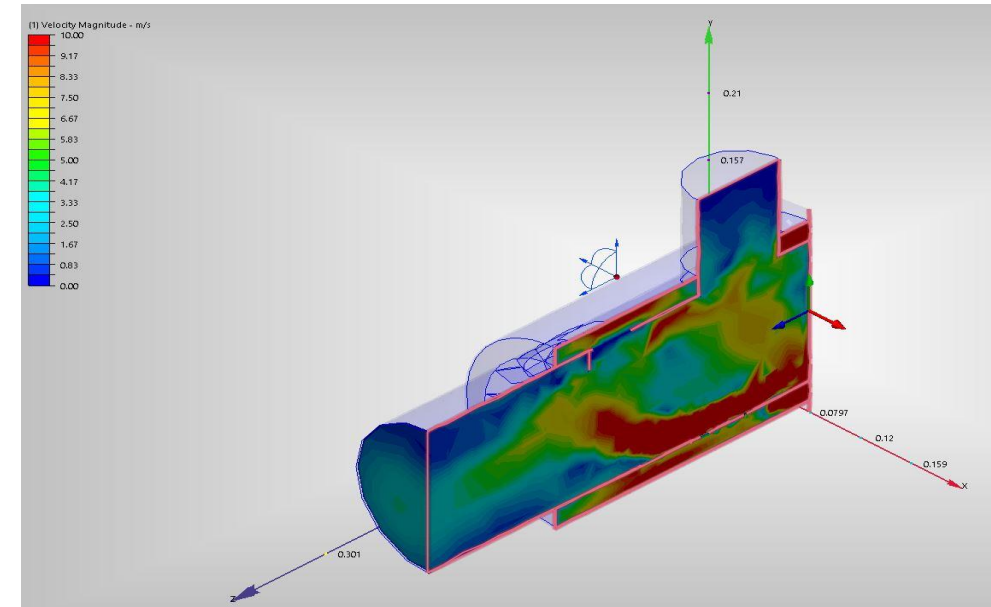
- Example 2 - Model results -



Improved construction



Base construction





Renewable energy sources – biofuel

BIOETHANOL	BIODIESEL
<ul style="list-style-type: none">Existing equipment and capacities cannot satisfy needs for the production of ethanol as fuelNew capacities need to be built, reconstructed (dehydration equipment is missing) and existing capacities increasedPossible concepts for the construction of new capacities<ul style="list-style-type: none">Construction of several large capacity facilitiesConstruction of a network of small facilities for the production of raw ethanol (65-70 % v/v) and processing in large facilitiesPossible ETBE production	<ul style="list-style-type: none">Raw materials relevant to this area<ul style="list-style-type: none">sunflowersoyarapeseedArea for raising oil-seed plants – 668.800 haArea for raising oil-seed plants intended for biodiesel processing - 350.000 haWaste edible oil – 10.000 tHVO - hydro treated vegetable oils





Research & development – biomass

- Demonstration projects for biomass utilization
 - Support the realization of demonstration projects through local, national and international funds.
 - Financing of biomass utilization projects and institutionalization of project funding.
 - Promote and support international cooperation.
 - Support establishing a network between the national and international research institutions.
 - Define the method for disseminating results not only among the researchers but all other stakeholders interested in biomass utilization.



Research & development – biomass

- Diversity and complexity of technologies
 - Organize the workshops and meetings with selected subjects
 - Generate a list of recommended alternatives of biomass utilization. Biomass utilization must be in accordance with BAT and BEP.
 - Promote the biomass utilization by disseminating the obtained results during the demonstration projects.
- Laboratories and equipment for R&D
 - Identify different laboratories for R&D.
 - Outline the programme of upgrading equipment and staff education in the laboratories.
 - Support the establishing a network and cooperation between the laboratories on the national and international level.

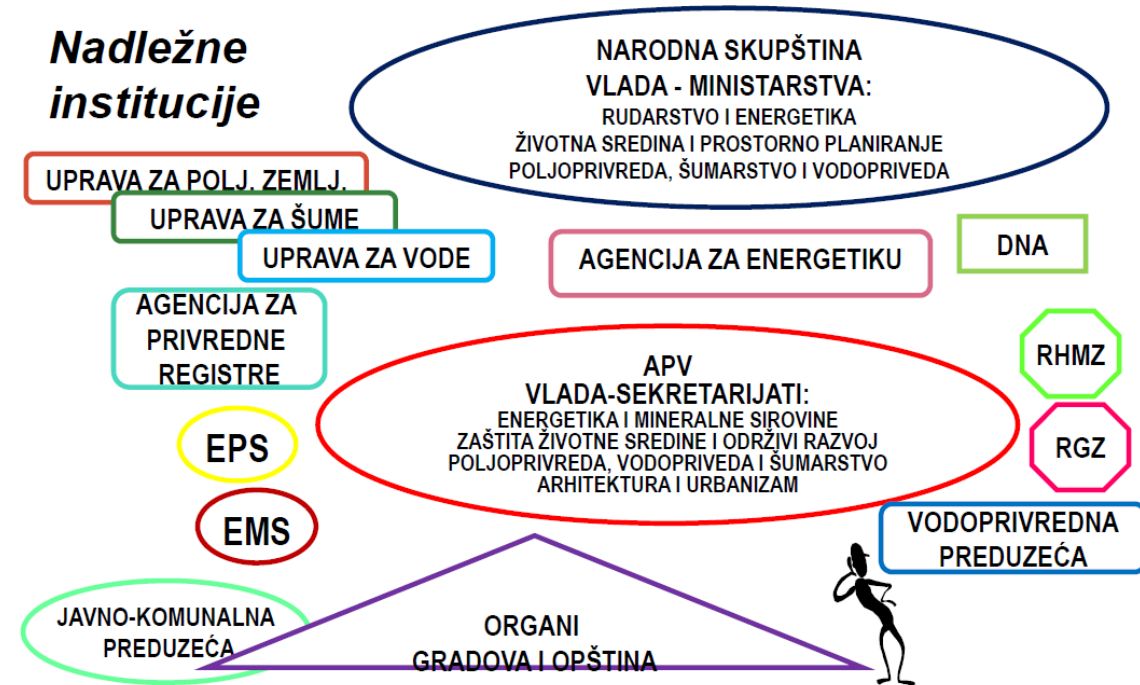
Renewable energy sources



Propisi za korišćenje



Nadležne institucije





Renewable energy sources – biomass

An important element for proper operation of the biomass plant is a long-term biomass supply contract

Straw and other non-hazardous agricultural or forest materials found in nature, and used in agriculture, forestry, or for energy production using such biomass or processes or methods that do not have a harmful effect on the environment and do not endanger health of people is not subject to the Law on Waste Management

Everything else... is subject to the Law on Waste Management

The right to construct - regulations governing the area of construction of the specific plant (from Location Permit, via Construction Permit, to Operating Permit)

The right to engage in the activity of electricity /heat generation
Electricity generation and combined heat-and-power production – market activities
Heat production – activity of public interest
Acquiring the right to engage in providing municipal services

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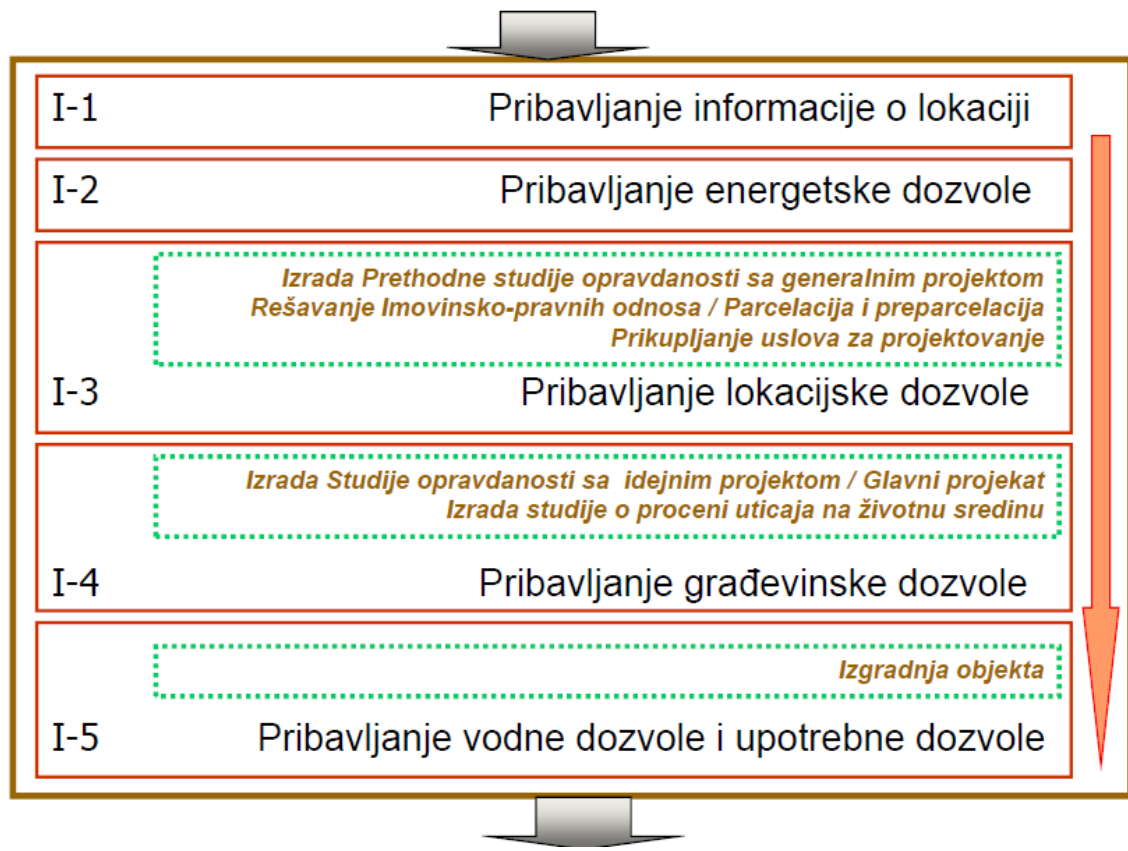
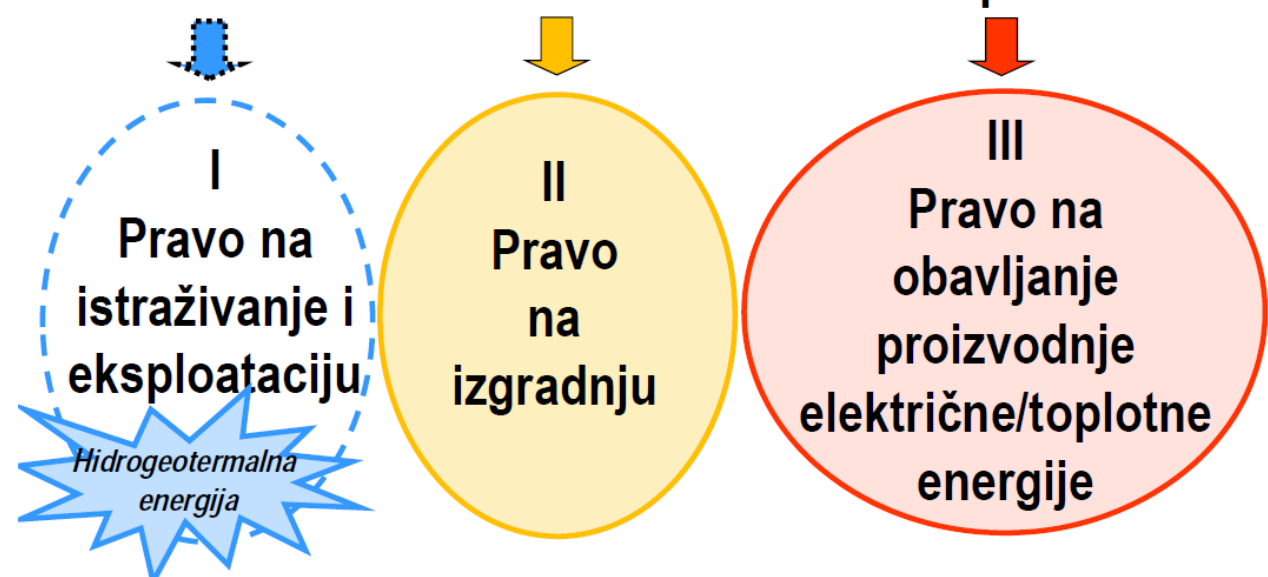
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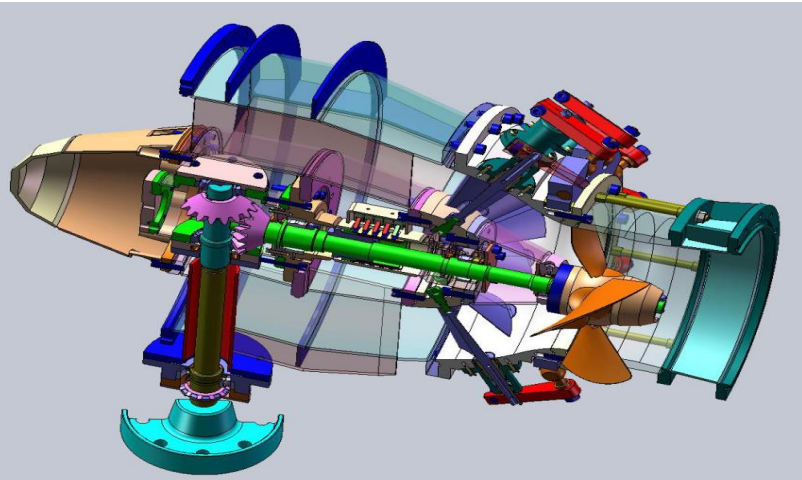


Renewable energy sources

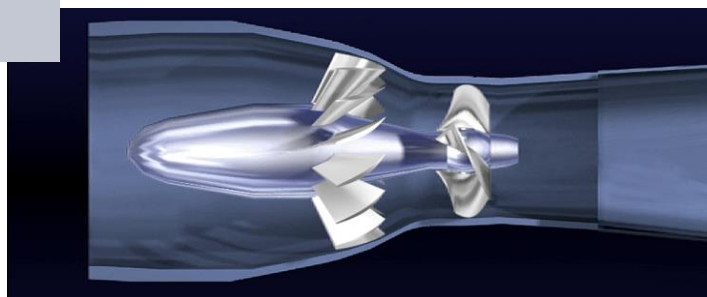
Investitor mora da stekne sledeća prava:



Research, development and mastering the production of tubular turbines

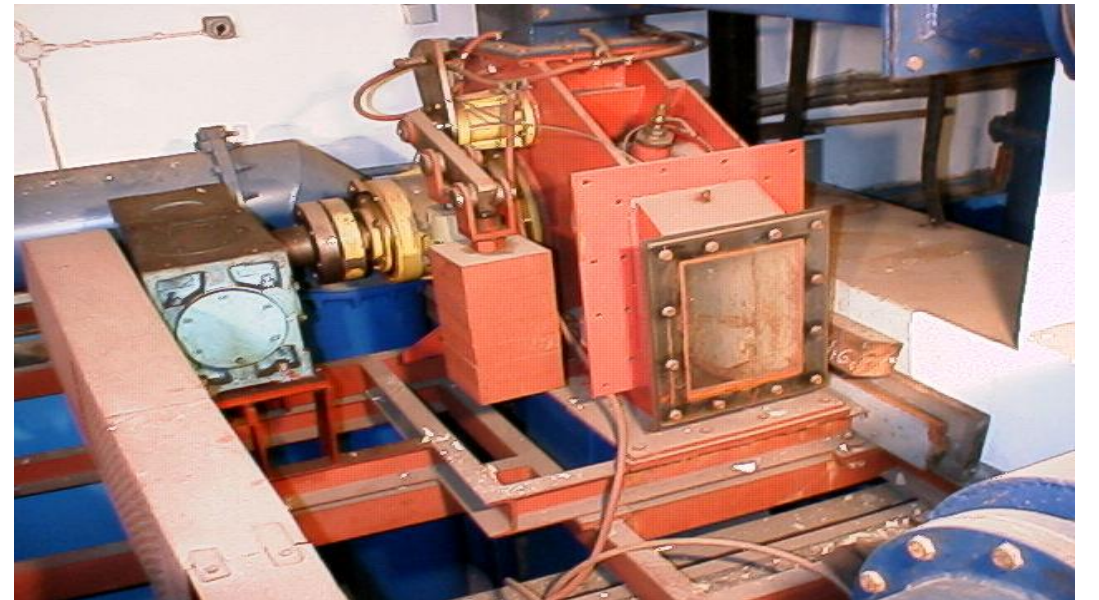
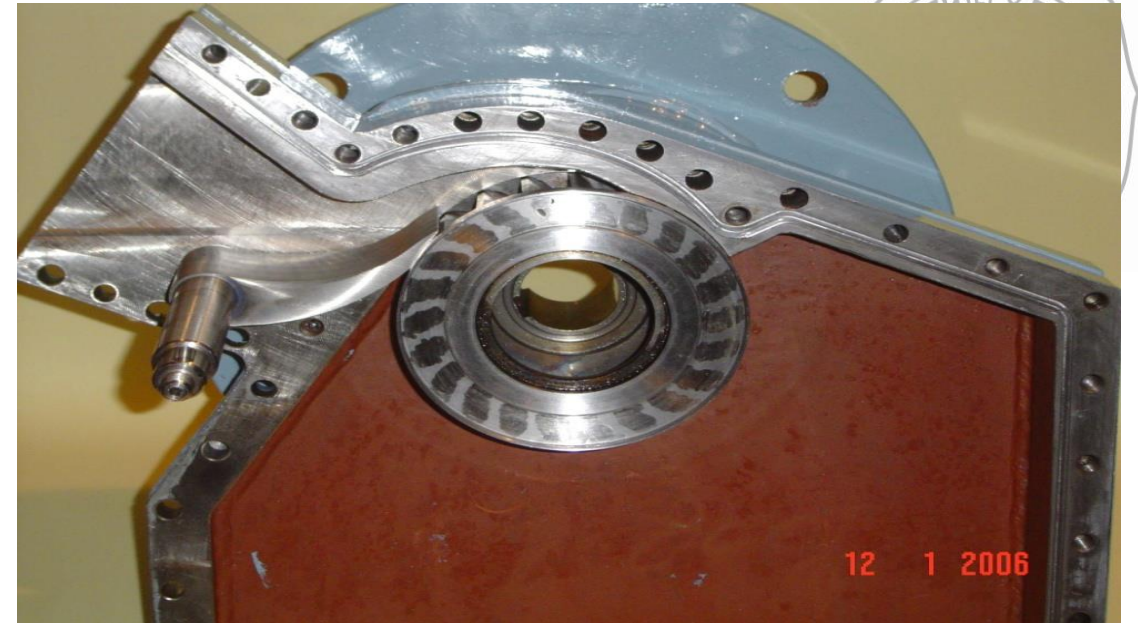
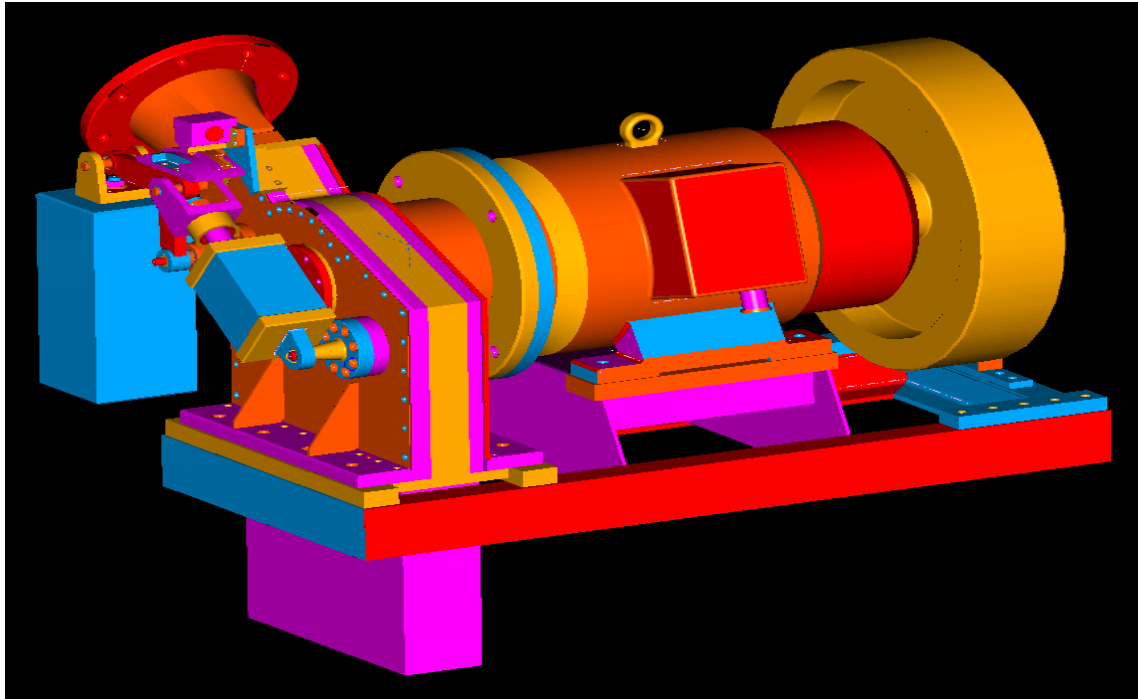


Model of 15 kW tubular turbine

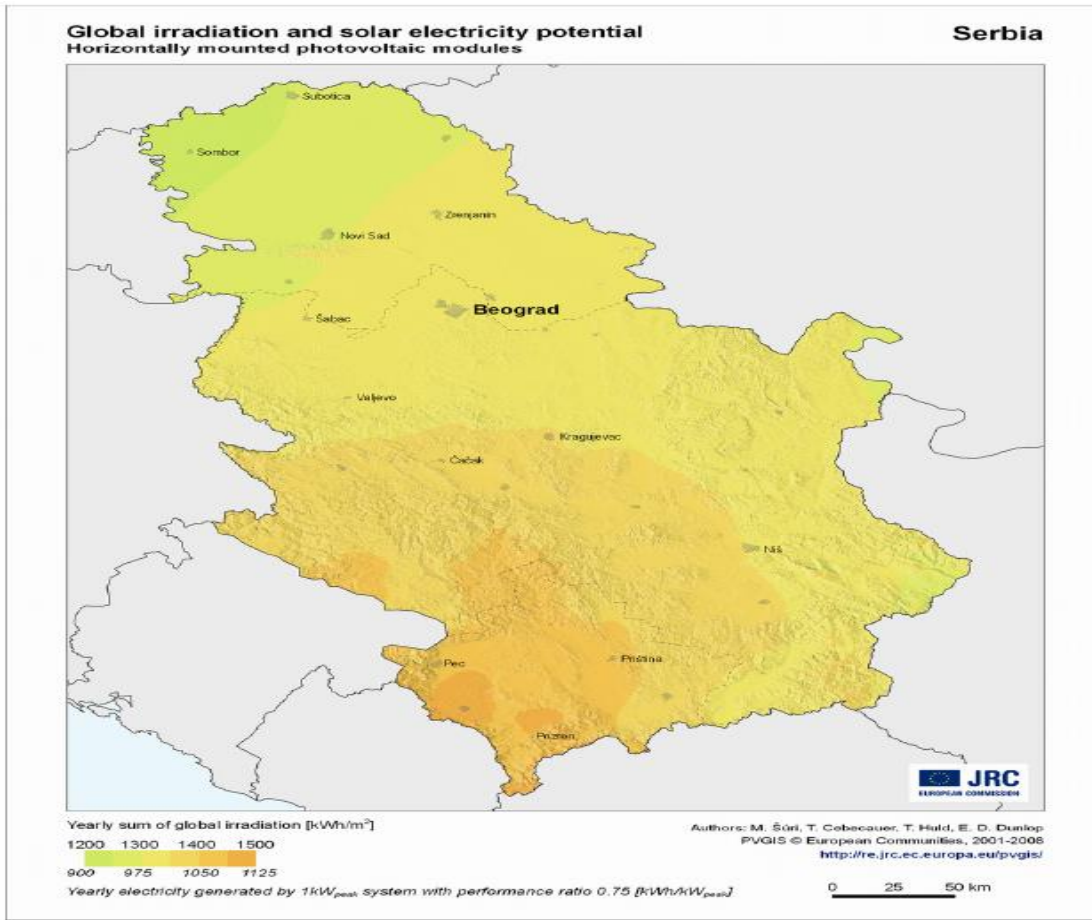


Model of 15 kW tubular turbine

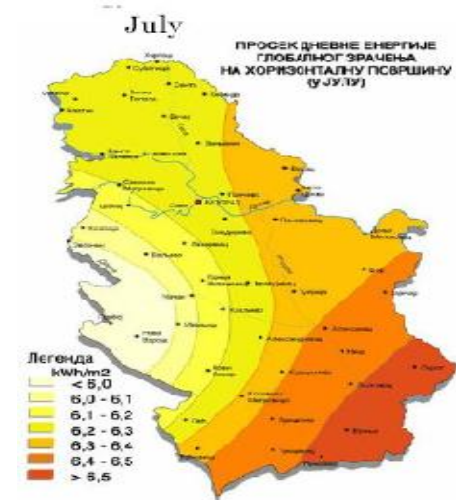
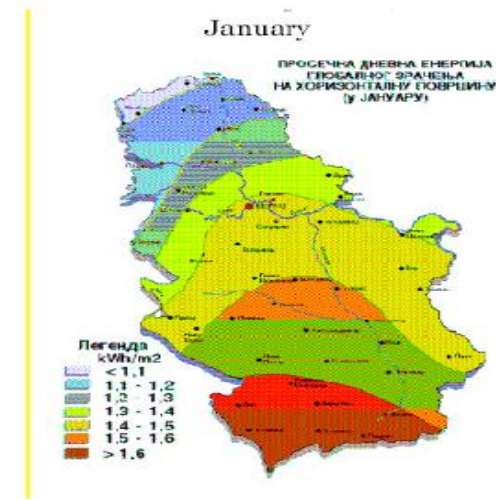
Model of the 25 kW Banki turbine



Renewable energy sources – solar power



- Average intensity of solar radiation
 - 1,1 kWh/m²/day at the north up to 1,7 kWh/m²/day at the south - during the month of January
 - 5,9 to 6,6 kWh/m²/day – during the month of July

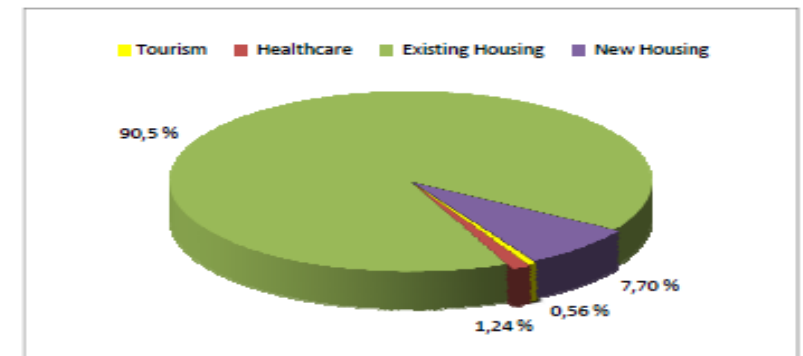




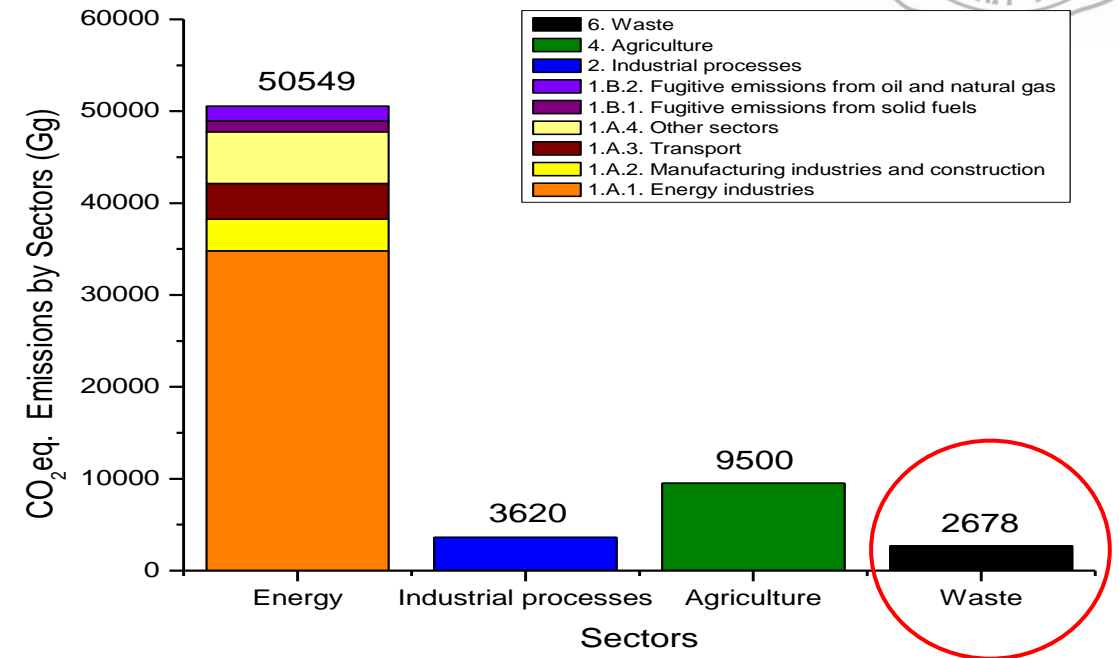
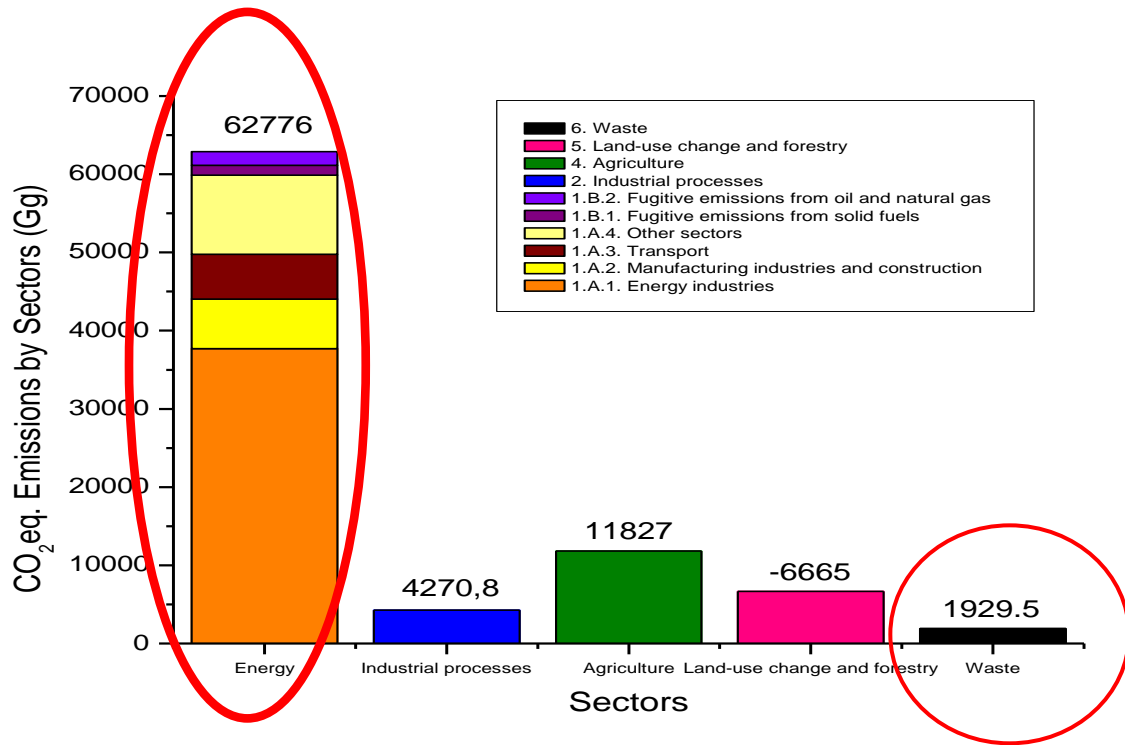
Renewable energy sources – solar power

- About 30 companies operate in the field of solar power
 - Manufactures and distributors of Thermal Solar Collectors and Photo Voltaic Collectors
 - Design and sale of solar equipment and installation
 - Institutions dedicated to promotion, research and training
- Study “Building Capacities for the Use and Promotion of Solar Energy in the Republic of Serbia - Analysis of Existing Offer and Potential Demand for Solar Systems in Serbian Market”, Mercados, 2010.

SECTOR	SHW (million l/year)	Collectors (m ²)
- Tourism	302,24	12.739,25
- Healthcare	666,84	28.106,85
- Existing Housing	48.632,45	2.049.840,00
- New Housing (2009-2018)	4.138,37	174.430,86
Total	53.739,90	2.265.116,96



Global warming – Climate Change/Serbia



GHG Emission CO₂eq, 1990. and 1998.

University of Belgrade

University of Belgrade is the oldest and most important institution of higher education in all of Serbia. Founded in 1808 as the Great Academy in revolutionary Serbia, by 1838 it merged with the Kragujevac based Lycee into a single university. Formally it was granted its university rights by a Royal Charter in 1905.



It is one of the largest universities in the Balkan region, counting over **89,000 students** and **4,200 members of teaching staff**. Students can choose from around **150 basic educational programs**. The University has **31 faculties**, **11 scientific research institutes** and a system of university libraries and information centres.

UNIVERSITY OF BELGRADE

Faculty of Mechanical Engineering



University of Belgrade - Faculty of Mechanical Engineering is the oldest and largest educational and scientific institution in the area of mechanical engineering in Balkan peninsula.

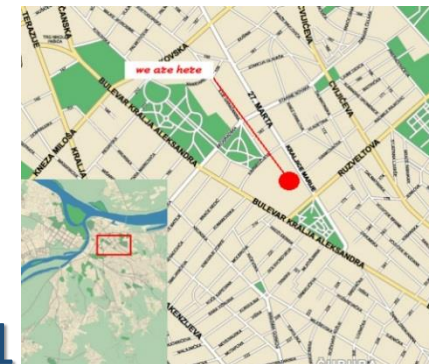
Basically deals with the area of mechanical engineering as well as with the other branches of technique.

STUDENTS

- Over 3.000 students on
- 22 different modules
- Three level of academic studies
- B.Sc, M.Sc and Ph.D studies

STAFF

- Full professors 79
- Associate professors 43
- Assistant professors 28
- Assistants 67
- Researchers 52
- Laboratory personnel 32
- Administrative personnel 131



UNIVERSITY OF BELGRADE

Faculty of Mechanical Engineering



CHAIRS AND DEPARTMENTS

1. Production Engineering
2. Material handling, constructions & logistics
3. Agricultural Machinery
4. Industrial Engineering
5. Mechanics
6. Theory of Mechanisms and Machines
7. Thermal Science Engineering
8. Thermal Power Engineering
- 9. Process Engineering & Environment Protection**
10. Thermal Mechanics
- 11. Hydro Power Engineering**
12. Mathematics
13. Aeronautical Engineering
14. Control Engineering
15. Physics and Electronics
16. Fluid Mechanics
17. Weapon Systems
18. Naval Architecture
19. Internal Combustion Engines
20. Motor Vehicles
21. Railway Mechanical Engineering
22. General Machine Constructions
- 23. Engineering Materials**
24. Strength of Structures

University of Belgrade

Faculty of Mechanical Engineering



Fuels and combustion laboratory

Fuels and Combustion Laboratory (FCL) is a part of the Department of Engineering materials.

Unique institution in Serbia, dedicated to education and research in the areas of:

- fuel characterization,
- combustion techniques,
- energy production and energy efficiency
- pollution control (from the combustion processes)
- Studies (pre-feasibility and feasibility, general, basic and main design), EIA study.

At the moment, FCL has staff of 4 Ph.D., 1 lab technician and several Ph.D. candidates.

University of Belgrade

Faculty of Mechanical Engineering



Fuels and combustion laboratory

Today, FCL is dominantly involved in projects related to:

- Characterization of biomass and waste,
- Production and utilisation of solid alternative fuels (briquettes and pellets produced from various raw materials)
- Testing and certification (in progress) of small scale stoves and boilers (up to 100kW)
- Mathematical modeling of combustion process
- Production (small scale plants) and utilisation of liquid biomass fuels (bio ethanol and biodiesel),
- Possibilities for low grade lignite combustion in existing thermal power stations (TPP),
- Environmental pollution control from coal fired TPPs,
- Studies, designs and EIA studies.



Conclusions

- For future development of RES sector, the following activities will be realized and support by Government:
 - adoption and enhancement of the legal framework which will stimulate a more energy efficient use of energy and more extensive use of RES,
 - economic incentive measures (through continuation of the already established support scheme for electricity generation from renewable energy sources and combined heat and electricity generation with a high process efficiency, as well as the preparation of a similar programme for heat at the local level), direct financial stimulations and corresponding taxation policy,
 - measures that will stimulate a sustainable biomass market,
 - enhancement of administrative procedures for investment in the field of RES and verification of their efficiency through demonstration projects,
 - systematic promotion of best practices applied in the EU countries (efficient use of energy and RES),
 - introduction of an organized system of energy management (energy management system) and
 - systematic project planning in the field of RES.

THANK YOU FOR YOUR ATTENTION!



Questions?

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