Chair of Renewable and Sustainable Energy Systems
TUM School of Engineering and Design
Technical University of Munich

Sustainable and profitable energy system development in Bosnia and Herzegovina

Anđelka Kerekeš[1], Vedran Perić[1], Elvisa Bećirović[2], Thomas Hamacher[1]

[1]Chair of Renewable and Sustainable Energy Systems, Technical University of Munich, Germany
[2]Public power utility Elektroprivreda BiH, Sarajevo, Bosnia and Herzegovina

Background

- Energy sector of Bosnia and Herzegovina (BiH) heavily relies on coal as a primary energy source [1]. Currently, about two third of the country's electrical energy is generated in coal power plants, while the remainder is coming from hydropower, and marginally wind and solar generation units [2].
- In contrast to most EU countries, governments across southeast Europe plan to build or renew lignite power plants during the next few years [3,4].

Study Objective

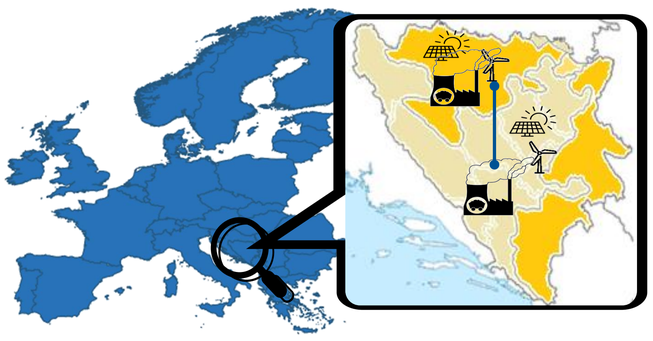
- The goal of this work is to investigate the cost-optimal solution for Bosnian electrical energy system development under different frameworks, to deduct which trends support a more sustainable energy sector as well as to provide a basis for deeper technical analysis of chances and constrains for integration of renewable energies in Bosnian system planning.

Methodology and Assumptions

Goal Cost optimal electrical energy system under different frameworks

Scope

- Geographic: Bosnia and Herzegovina as an isolated country. Two regions based on geo-political entities distiguished.
- Time: 2030



Model

- Software: urbs [5]
- Method: Linear optimisation for extension and operational planning of energy systems
- Time resolution: Hourly profiles for electricity demand and capacity factors of PV, wind and hydro power plants.

Assumptions Baseline:

Parameter	Subcategory	Value	Unit
Power plant investment cost [6,7,8,9]	Gas	815	€/kWh
	PV	722	
	Wind	1044	
	Lignite	1733	
	Biomass	1950	
	Geothermal	2072	
	Hydro	2718	
Power plant efficiency	Gas	55	%
	Lignite old	30	
	Lignite new	40	
	Biomass	41	
Energy carrier prices (without CO2) based on [6,7,10]	Gas	340	€/1000m³
	Coal	15	€/t
	Biomass	5	€/MWh
CO2	Costs till 2026	0	€/t
	Costs from 2026	100	€/t
	Limitation per year based on [11]	4.1	Mil. t
Renewables: full load hours per year [12,2]	PV	1535	h/a
	Wind	1660	
	Hydro	2300	
Renewables: capacity limitation	PV [12]	54,0	GW
	Wind [12]	32,4	
	Hydro	4,6	
Energy storage investment costs [6,7]	Batteries	146,000	€/MWh
	Batteries	168,000	€/MW
Demand	Electricity	15.2	TWh

Baseline Results

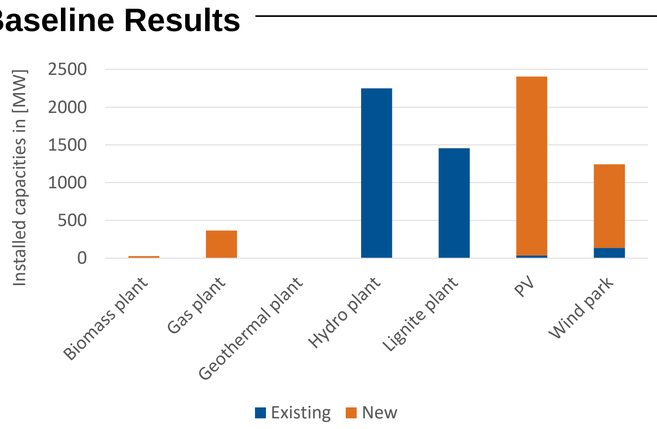


Figure 1: Installed generating capacities in 2030

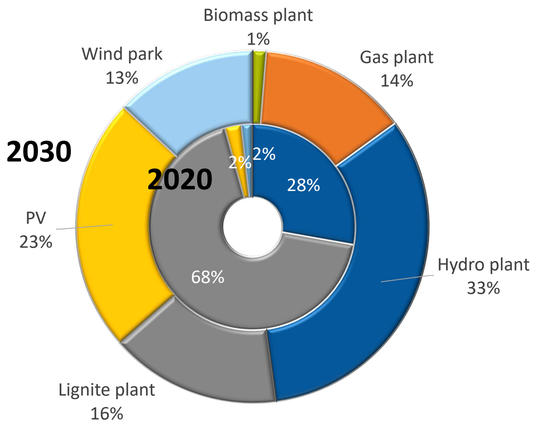


Figure 2: Energy mix in 2030 (outer race, own calculation) and 2020 (inner race) [4]

Sensitivity Analysis

Scenarios considering CO2 limitation

Scenario	Parameter	Value	Unit
CO2 price high	CO2 costs from 2026	300	€/t
CO2 price low	CO2 costs from 2026	67	€/t
Coal price high	Coal price	30	€/t
Coal price low	Coal price	7	€/t
PV, Wind price 125%	PV investment cost	903	€/kWh
	Wind investment cost	1305	
PV, Wind, Hydro 2020 prices [13]	PV investment cost	926	€/kWh
	Wind investment cost	1506	
	Hydro investment cost	2078	

Scenarios without considering CO2 limitation

Scenario	Parameter	Value	Unit
Baseline without CO2 limit *	CO2 limit	inf	t/a
PV price 150%	PV investment cost	1083	€/kWh
PV price 150%, CO2 price low	PV investment cost	1083	€/kWh
	CO2 costs from 2026	67	€/t
PV price 150%, CO2 price low, PV & Wind limit [14]	PV investment cost	1083	€/kWh
	CO2 costs from 2026	67	€/t
	PV potential limit	993	MW
	Wind potential limit	5,861	MW

* Base for all scenarios in this group

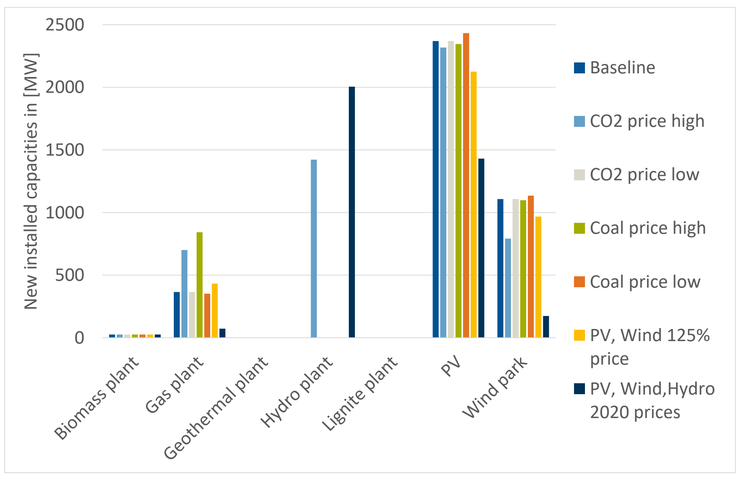


Figure 3: New installed capacities in scenarios, compared to baseline

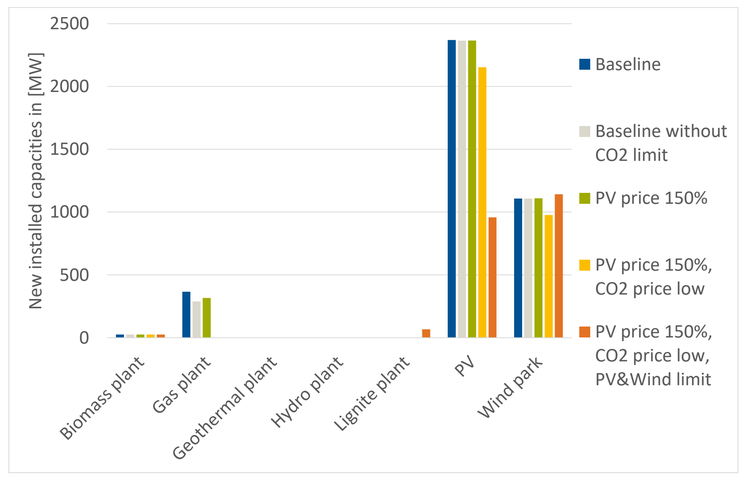


Figure 4: New installed capacities in scenarios without CO2 emission restriction, compared to baseline

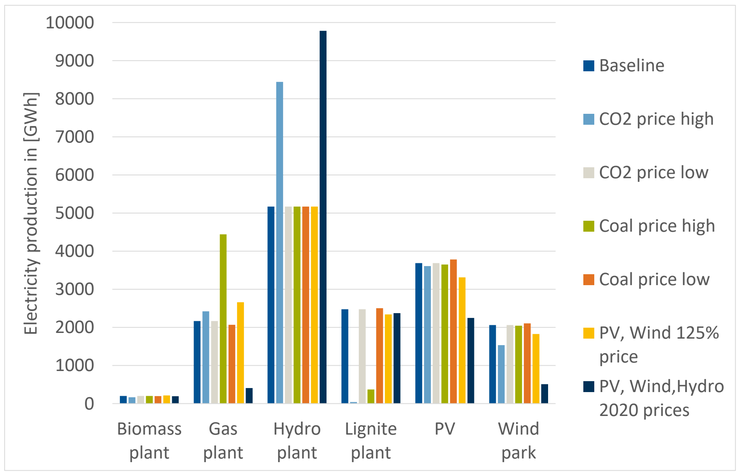


Figure 5: Electricity production in scenarios, compared to baseline

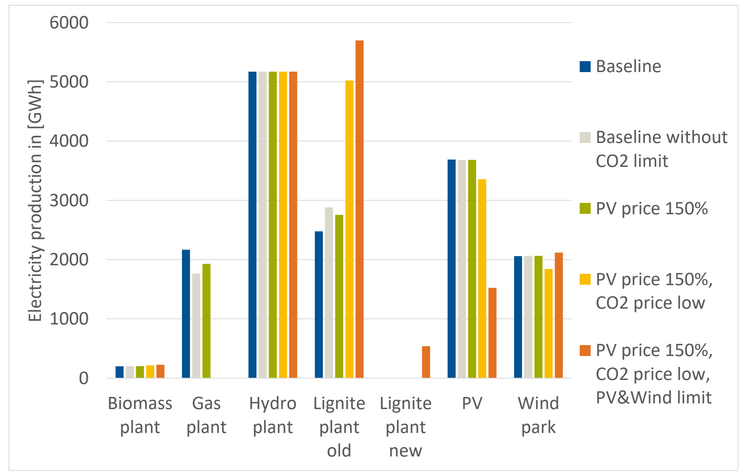


Figure 6: Electricity production in scenarios without CO2 emission restriction, compared to baseline

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