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Summary of the paper
OPTIMAL CONFIGURATION ASSESSMENT OF HYBRID ENERGY SYSTEM

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PROPOSED RESEARCH

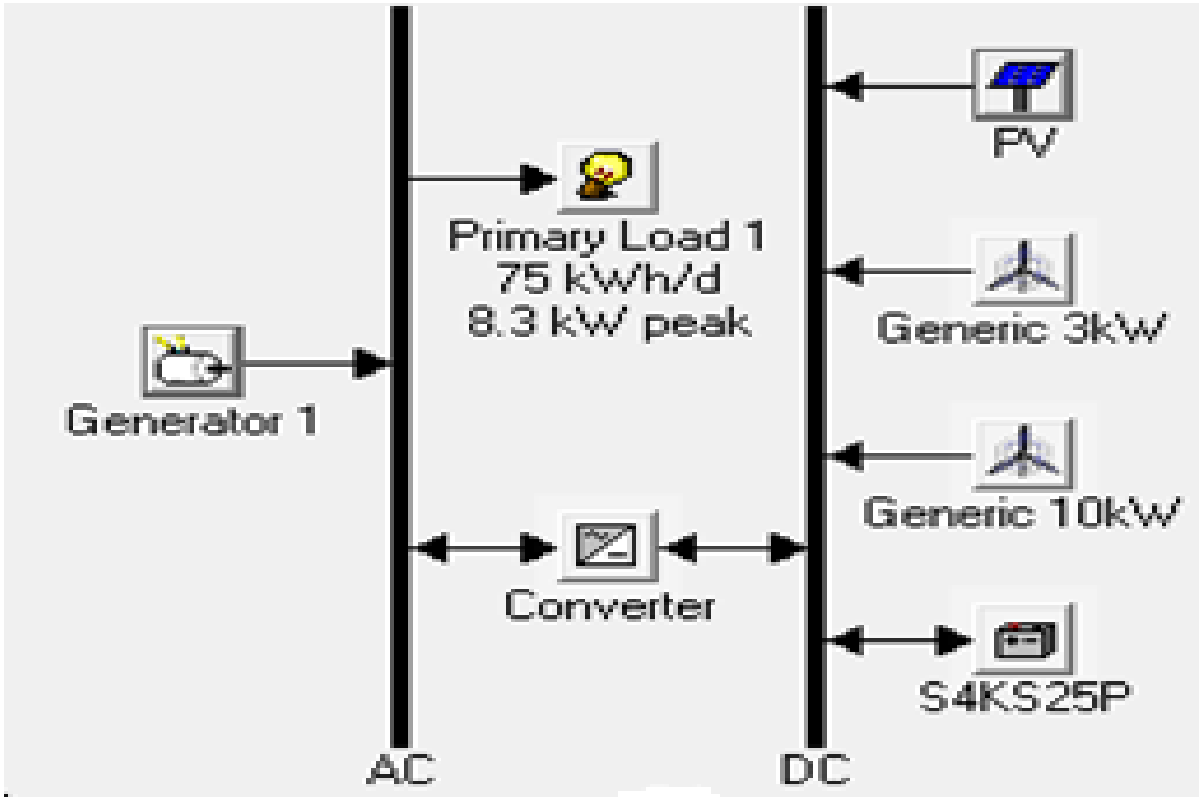
- An off-grid hybrid energy system consisting of photovoltaic system, wind turbines, diesel generator as a back-up power source, batteries and converters has been analyzed.

- The objective of the study – to determine the optimal configuration of the system, which will meet the electrical load, respecting the total net present costs.

- HOMER software was used to perform simulation, calculation and optimization.

- Sensitivity analysis has been also performed in order to examine how the average annual wind speed, average annual solar radiation and the fuel price will affect the configuration of the system.

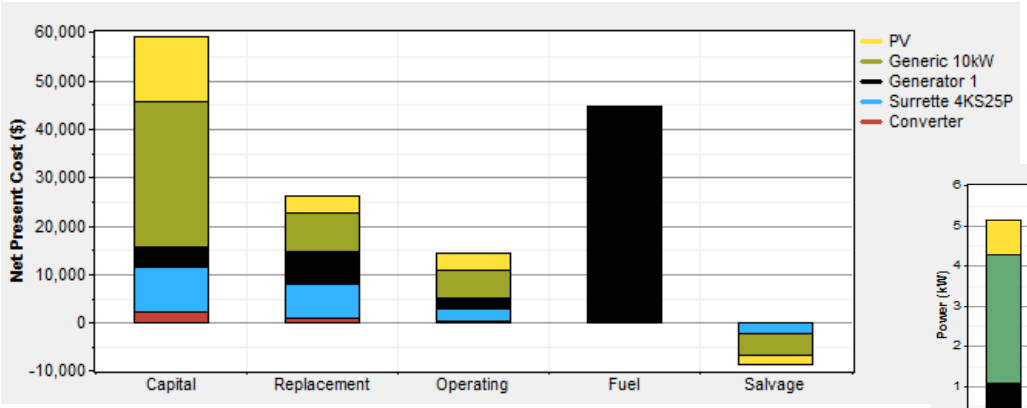
PROPOSED RESEARCH



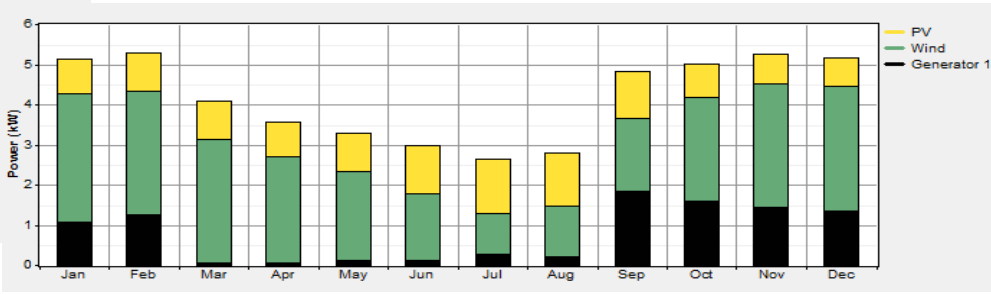
Schematic representation of the hybrid energy system under consideration

Results

- Basic electricity generation scenario, for an off-grid hybrid energy system:
  - 1 wind turbine Generic 10 kW (G10), 5 kW photovoltaic system, 8 kW diesel generator and 10 units of batteries.
- The net present cost for the whole hybrid system - 135,435 $
- The renewable fraction - 0.812
- Levelized Cost of Energy – 0.385 $/kWh



Net present cost by cost type



Monthly average electricity production

Results

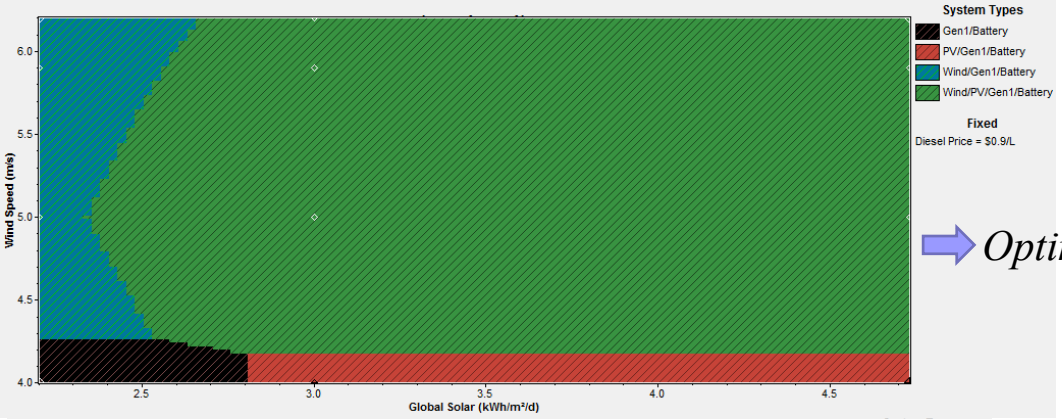
- Second case that is further analyzed is with the following inputs for the renewable components:
  - size of photovoltaic system: 5 kW, 6 kW, 7 kW, 8 kW, 9 kW, allow system with two types of wind turbines Generic 10 kW (1, 2) and Generic 3 kW (1, 2, 3), and system with the presence and absence of photovoltaics and wind turbines.
- The optimal system - system with 8 kW PV system, 1 wind turbine G10, 8 kW diesel generator and 10 storage batteries.

PV (kW)	G3	G10	Gen1 (kW)	S4KS25P	Conv. (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Capacity Shortage	Diesel (L)	Gen1 (hrs)
8		1	8	10	10	$ 67,180	5,054	$ 131,789	0.375	0.88	0.00	2,320	1,699
7		1	8	10	10	$ 64,470	5,287	$ 132,055	0.376	0.86	0.00	2,551	1,858
9		1	8	10	10	$ 69,890	4,868	$ 132,117	0.376	0.89	0.00	2,125	1,566
6		1	8	10	10	$ 61,760	5,570	$ 132,965	0.378	0.84	0.00	2,820	2,036
5		1	8	10	10	$ 59,050	5,975	$ 135,435	0.385	0.81	0.00	3,177	2,281
6	1	1	8	10	10	$ 71,760	5,087	$ 136,783	0.389	0.88	0.00	2,301	1,662
7	1	1	8	10	10	$ 74,470	4,882	$ 136,875	0.390	0.90	0.00	2,090	1,525
8	1	1	8	10	10	$ 77,180	4,706	$ 137,343	0.391	0.91	0.00	1,903	1,396
5	1	1	8	10	10	$ 69,050	5,380	$ 137,824	0.392	0.86	0.00	2,577	1,849
9	1	1	8	10	10	$ 79,890	4,545	$ 137,991	0.393	0.92	0.00	1,725	1,270
9	3		8	10	10	$ 69,890	5,333	$ 138,063	0.393	0.86	0.00	2,501	1,838
8	3		8	10	10	$ 67,180	5,561	$ 138,265	0.394	0.84	0.00	2,727	1,994
7	3		8	10	10	$ 64,470	5,817	$ 138,831	0.395	0.82	0.00	2,974	2,159
9	2		8	10	10	$ 59,890	6,316	$ 140,629	0.400	0.79	0.00	3,383	2,477
6	3		8	10	10	$ 61,760	6,193	$ 140,924	0.401	0.80	0.00	3,311	2,390
8	2		8	10	10	$ 57,180	6,606	$ 141,629	0.403	0.77	0.00	3,655	2,660

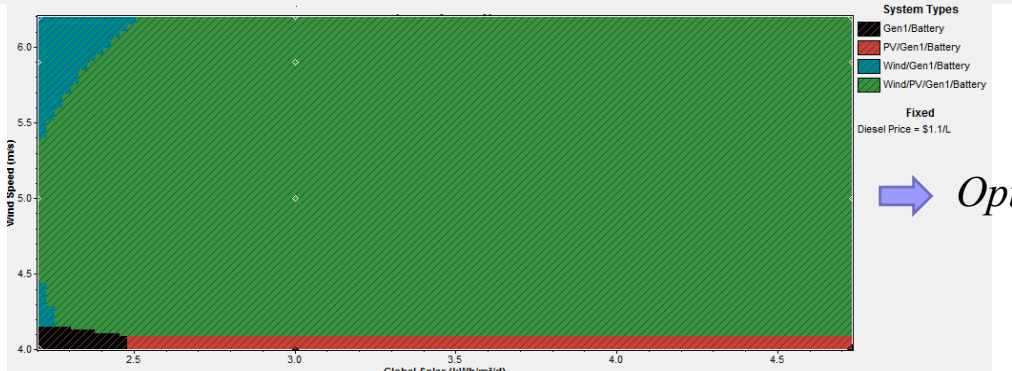
First 16 feasible solutions sorted by total net present cost for the second analyzed case

Results

- Sensitivity analysis
  - average annual wind speed: 4 m/s; 5 m/s; 5.9 m/s; 6.2 m/s
  - average annual solar radiation: 2.2 kWh/m²/d; 3 kWh/m²/d; 4.73 kWh/m²/d;
  - diesel price: 0.9 $/L; 1.1 $/L



Optimal system type graph when diesel price is 0.9 $/L



Optimal system type graph when diesel price is 1.1 $/L

CONCLUSION

- An off-grid hybrid energy system has been investigated.
- The software tool HOMER, that is used, allows the comparison of different combinations of components, their different quantities and performance. Feasible solutions are listed and sorted by total net present cost.
- In the program, the simulations are realized based on the input data for the components that are modeled, data for the electrical load, data of the energy resources availability (in this case for solar radiation and wind speed), fuel price as well as the economic parameters for the project.
- Sensitivity analysis is also performed.
- The conducted analyzes within the paper and the corresponding results and discussion are presented in section 4.4 in the paper.