Interreg
EUROPEAN UNION
Danube Transnational Programme
DanuP-2-Gas

DanuP-2-Gas

Studija predizvodljivosti P2G čvorišta za Hrvatsku

Nacionalna DanuP2Gas radionica za Hrvatsku, Zagreb, 24.11.2022.

Sveučilište u Zagrebu Fakultet elektrotehnike i računarstva, Laboratorij za sustave obnovljivih izvora energije

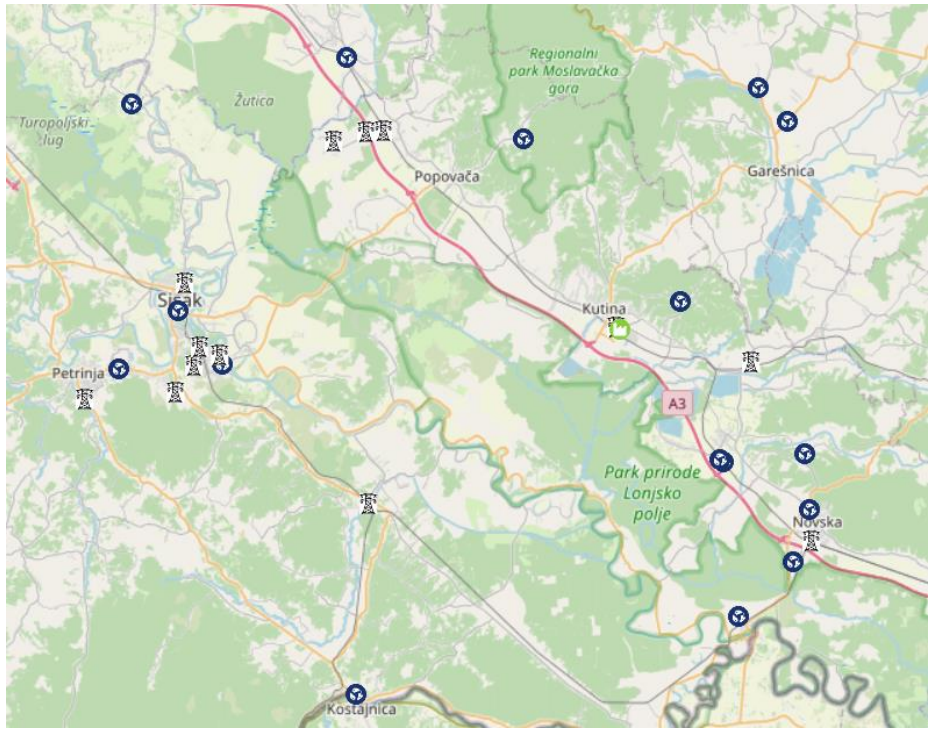
Antonio Karneluti, Prof. dr. sc. Mario Vašak, Dr. sc. Marijo Šundrica, Filip Rukavina

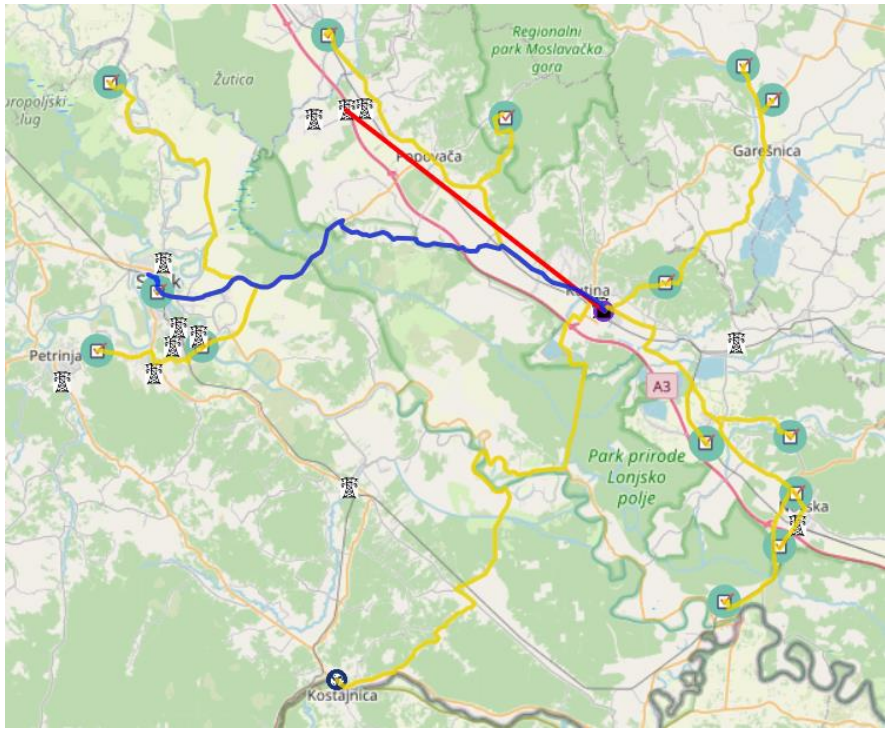
Studija predizvodljivosti P2G čvorišta za Hrvatsku

- 3 glavna slučaja:
  - P2G + IP – Petrokemija Kutina
  - P2G + REP – Tvornica Ulja Čepin
  - Samostalni P2G – Karlovac
- Varijacije cijene plina i iznosa subvencije

Subvencija [%] / Cijena plina	1x (trenutna)	10x uvećanje
0%	A	C
50%	B	D

Rezultati: P2G + IP – Petrokemija Kutina





Rezultati: P2G + IP – Petrokemija Kutina

RESULTS

Investment specifications

	Element	Cost		Size	
Processes	Dry anaerobic digestor	2.443.910,26	€	0,116377	kg/s
	Wet anaerobic digestor	2.443.910,26	€	0,116377	kg/s
	Dry biomass to biochar plant	0,00	€	0,000000	kg/s
	Wet biomass to biochar plant	0,00	€	0,000000	kg/s
	Combined heat and power (CHP)	0,00	€	0,00	kWe
	Carbon capture plant	0,00	€	0,000000	mol/s
	Gasification + water gas shift plant	14.028,80	€	0,014029	kg/s
	Methanation reactor	3.205.426,05	€	7,542179	mol/s
	Electrolyser	11.430.026,35	€	4.572,01	kW
	Demineralizer	1.156,05	€	11,560518	mol/s
	Precipitation collector	2.000,00	€	1.000,00	m^2
	Heat exchanger	227.944,10	€	2.279,44	kW
	Gas compressor station	202.112,95	€	252,6412	kWe
	Total for processes	**19.970.514,82**	**€**		
Storages	Dry biomass storage	100.000,00	€	10.000,00	kg
	Wet biomass storage	50.000,00	€	10.000,00	kg
	Biochar storage	15.000,00	€	1.000,00	kg
	Biogas storage	0,00	€	0,00	kg
	Hydrogen storage tank	0,00	€	0,00	kg
	Oxygen storage tank	0,00	€	0,00	kg
	Methane storage tank	0,00	€	0,00	kg
	Syngas storage tank	0,00	€	0,00	kg
	Carbon dioxide storage tank	0,00	€	0,00	kg
	Water storage tank	0,00	€	0,00	m^3
	Total for storages	**165.000,00**	**€**		
Connections enlargement	Electrical connection	0,00	€	0,00	MW
	Gas connection	0,00	€	0,00	MW
	Water connection	23,12	€	0,75	m^3/h
	Total for connections	**23,12**	**€**		
	Total investment	**20.135.537,94**	**€**		
	Payoff period	**7,10**	**years**		

Operational costs for selected period

		Cost		Amount	
Electrical energy	Produced by REP	0,00	€	0,00	MWh
	Consumed by IP	34.259.995,00	€	102.200,00	MWh
	Net consumption without investment	34.259.995,00	€	102.200,00	MWh
	Mean peak power without investment	490.000,00	€	11,67	MW
	Consumed by P2G	28.643.119,26	€	85.444,45	MWh
	Net consumption with investment	**62.903.114,26**	**€**	**187.644,46**	**MWh**
	Mean peak power with investment	**899.749,02**	**€**	**21,42**	**MW**
Heat	Produced by REP	0,00	€	0,00	MWh
	Produced IP	0,00	€	678.900,00	MWh
	Net production without investment	0,00	€	678.900,00	MWh
	Consumed by P2G	0,00	€	-17.298,91	MWh
	Net production with investment	**0,00**	**€**	**696.198,91**	**MWh**
Gas (methane) to/from the grid	Produced by REP	0,00	€	0,00	MWh
	Consumed by IP	4.916.743.244,83	€	6.057.529,54	MWh
	Net consumption without investment	4.916.743.244,83	€	6.057.529,54	MWh
	Produced by P2G	34.425.075,97	€	47.431,04	MWh
	Net consumption with investment	**4.877.092.883,32**	**€**	**6.010.098,50**	**MWh**
Water	Water from the grid consumed by P2G	648,02	€	5.445,57	m^3
	Collected precipitation consumed by P2G	n/a	€	867,19	m^3
Input materials	Dry biomass bought	24.839,02	€	3.650,00	t
	Wet biomass bought	27.995,44	€	2.962,00	t
	Biochar bought	0,00	€	0,00	t
	Total cost of input materials	**52.834,46**	**€**		
Additional sales	Hydrogen sold (in bottles)	0,00	€	0,00	t
	Oxygen sold (in bottles)	25.550,00	€	365,00	t
	Methane sold (in bottles)	0,00	€	0,00	t
	Biochar sold	21.960,00	€	183,00	t
	Total revenue from additional sales	**47.510,00**	**€**		
Residues	Residue from dry anaerobic digester	0,00	€	109,50	t
	Residue from wet anaerobic digester	0,00	€	444,30	t
	Tar from gasification + water gas shift plant	0,00	€	22,05	t
	CO2 emitted	0,00	€	0,00	t
	Total cost of residues	**0,00**	**€**		
	Total operational cost without investment	**4.951.493.239,83**	**€**		
	Total operational cost with investment	**4.940.901.719,08**	**€**		
	Savings with introduction of P2G	**10.591.520,75**	**€**		

RESULTS

Investment specifications

	Element	Cost		Size	
Processes	Dry anaerobic digestor	0,00	€	0,000000	kg/s
	Wet anaerobic digestor	0,00	€	0,000000	kg/s
	Dry biomass to biochar plant	0,00	€	0,000000	kg/s
	Wet biomass to biochar plant	0,00	€	0,000000	kg/s
	Combined heat and power (CHP)	30.000.000,00	€	10.000,00	kWe
	Carbon capture plant	0,00	€	0,000000	mol/s
	Gasification + water gas shift plant	0,00	€	0,000000	kg/s
	Methanation reactor	0,00	€	0,000000	mol/s
	Electrolyser	0,00	€	0,00	kW
	Demineralizer	0,00	€	0,000000	mol/s
	Precipitation collector	0,00	€	0,00	m^2
	Heat exchanger	1.250.000,00	€	12.500,00	kW
	Gas compressor station	0,00	€	0,0000	kWe
	Total for processes	**31.250.000,00**	**€**		
Storages	Dry biomass storage	0,00	€	0,00	kg
	Wet biomass storage	0,00	€	0,00	kg
	Biochar storage	0,00	€	0,00	kg
	Biogas storage	0,00	€	0,00	kg
	Hydrogen storage tank	0,00	€	0,00	kg
	Oxygen storage tank	0,00	€	0,00	kg
	Methane storage tank	0,00	€	0,00	kg
	Syngas storage tank	0,00	€	0,00	kg
	Carbon dioxide storage tank	0,00	€	0,00	kg
	Water storage tank	0,00	€	0,00	m^3
	Total for storages	**0,00**	**€**		
Connections enlargement	Electrical connection	0,00	€	0,00	MW
	Gas connection	0,00	€	0,00	MW
	Water connection	0,00	€	0,00	m^3/h
	Total for connections	**0,00**	**€**		
	Total investment	**31.250.000,00**	**€**		
	Payoff period	**10,44**	**years**		

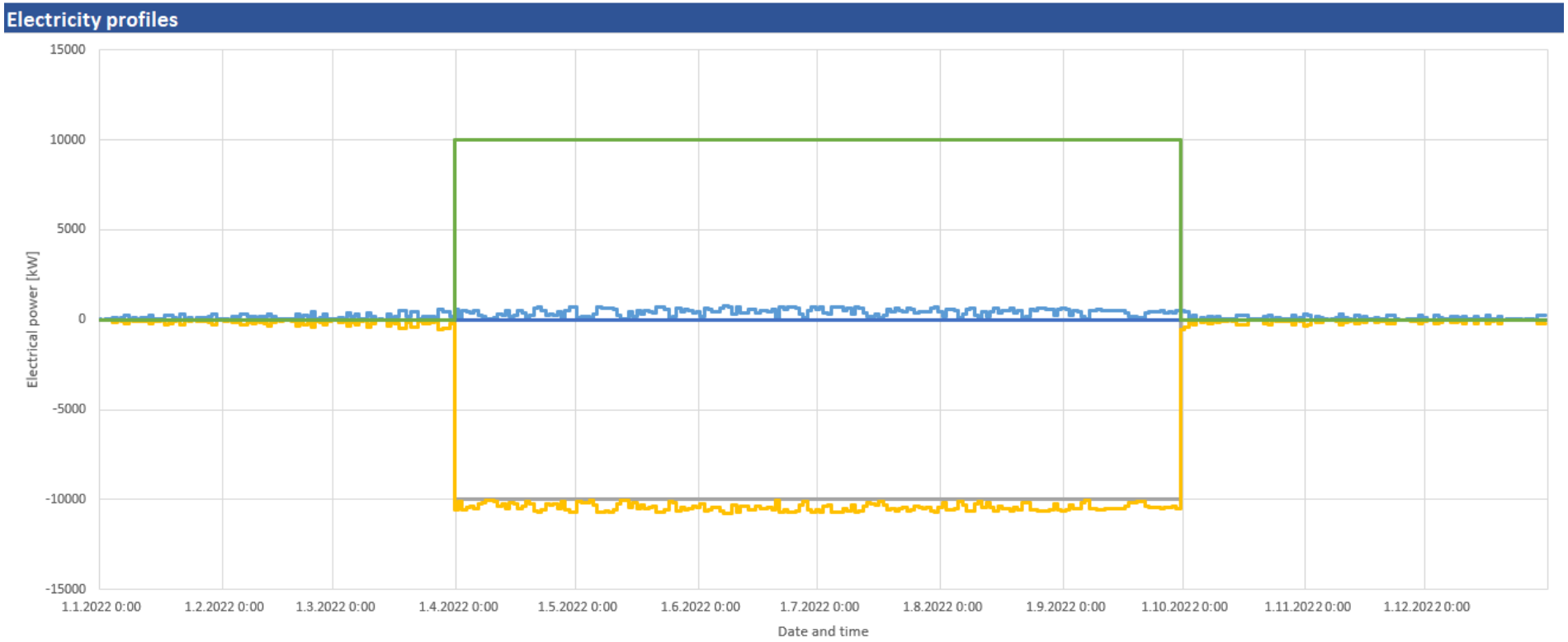
Operational costs for selected period

		Cost		Amount	
Electrical energy	Produced by REP	0,00	€	0,00	MWh
	Consumed by IP	34.259.995,00	€	102.200,00	MWh
	Net consumption without investment	34.259.995,00	€	102.200,00	MWh
	Mean peak power without investment	490.000,00	€	11,67	MW
	Consumed by P2G	-24.827.752,21	€	-87.600,00	MWh
	Net consumption with investment	**4.894.285,00**	**€**	**14.600,00**	**MWh**
	Mean peak power with investment	**70.000,00**	**€**	**1,67**	**MW**
Heat	Produced by REP	0,00	€	0,00	MWh
	Produced IP	0,00	€	678.900,00	MWh
	Net production without investment	0,00	€	678.900,00	MWh
	Consumed by P2G	0,00	€	-109.500,00	MWh
	Net production with investment	**0,00**	**€**	**788.400,00**	**MWh**
Gas (methane) to/from the grid	Produced by REP	0,00	€	0,00	MWh
	Consumed by IP	558.309.253,75	€	6.057.529,54	MWh
	Net consumption without investment	558.309.253,75	€	6.057.529,54	MWh
	Produced by P2G	-20.310.905,90	€	-220.368,75	MWh
	Net consumption with investment	**578.620.159,64**	**€**	**6.277.898,29**	**MWh**
Water	Water from the grid consumed by P2G	0,00	€	0,00	m^3
	Collected precipitation consumed by P2G	n/a	€	0,00	m^3
Input materials	Dry biomass bought	0,00	€	0,00	t
	Wet biomass bought	0,00	€	0,00	t
	Biochar bought	0,00	€	0,00	t
	Total cost of input materials	**0,00**	**€**		
Additional sales	Hydrogen sold (in bottles)	0,00	€	0,00	t
	Oxygen sold (in bottles)	0,00	€	0,00	t
	Methane sold (in bottles)	0,00	€	0,00	t
	Biochar sold	0,00	€	0,00	t
	Total revenue from additional sales	**0,00**	**€**		
Residues	Residue from dry anaerobic digester	0,00	€	0,00	t
	Residue from wet anaerobic digester	0,00	€	0,00	t
	Tar from gasification + water gas shift plant	0,00	€	0,00	t
	CO2 emitted	2.168.100,00	€	43.362,00	t
	Total cost of residues	**2.168.100,00**	**€**		
	Total operational cost without investment	**593.059.248,75**	**€**		
	Total operational cost with investment	**585.752.544,64**	**€**		
	Savings with introduction of P2G	**7.306.704,11**	**€**		

Rezultati: P2G + IP – Petrokemija Kutina

Subvencija [%] / Cijena plina	1x (trenutna)	10x uvećanje
0%	Investicija u CHP	Kontinuirana proizvodnja biometana
50%	Investicija u CHP	Kontinuirana proizvodnja biometana

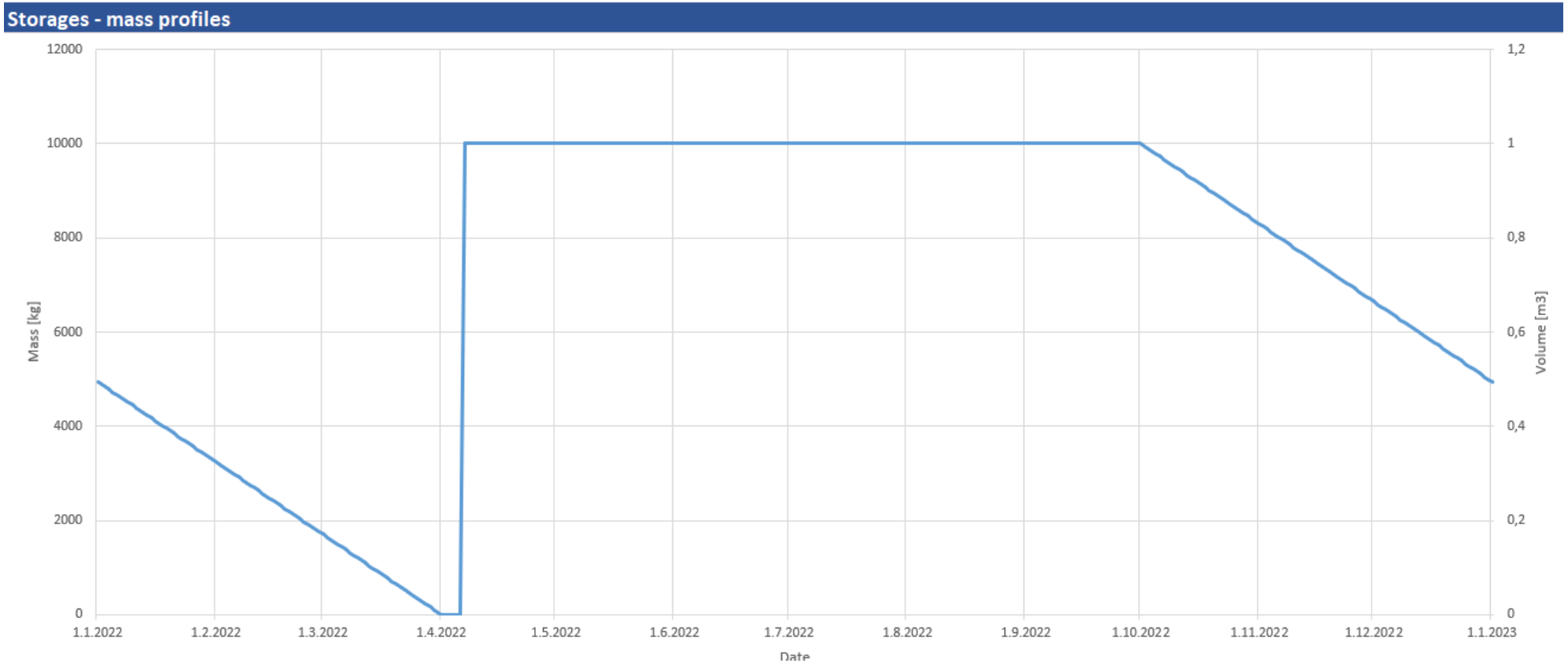
Rezultati: P2G + REP – Sunčana Elektrana TUČ



Rezultati: P2G + REP

Subvencija [%] / Cijena plina	1x (trenutna)	10x uvećanje
0%	Bez investicije	Periodička proizvodnja biometana (rad zimi)
50%	Investicija u CHP (rad ljeti)	Periodička proizvodnja biometana (rad zimi)

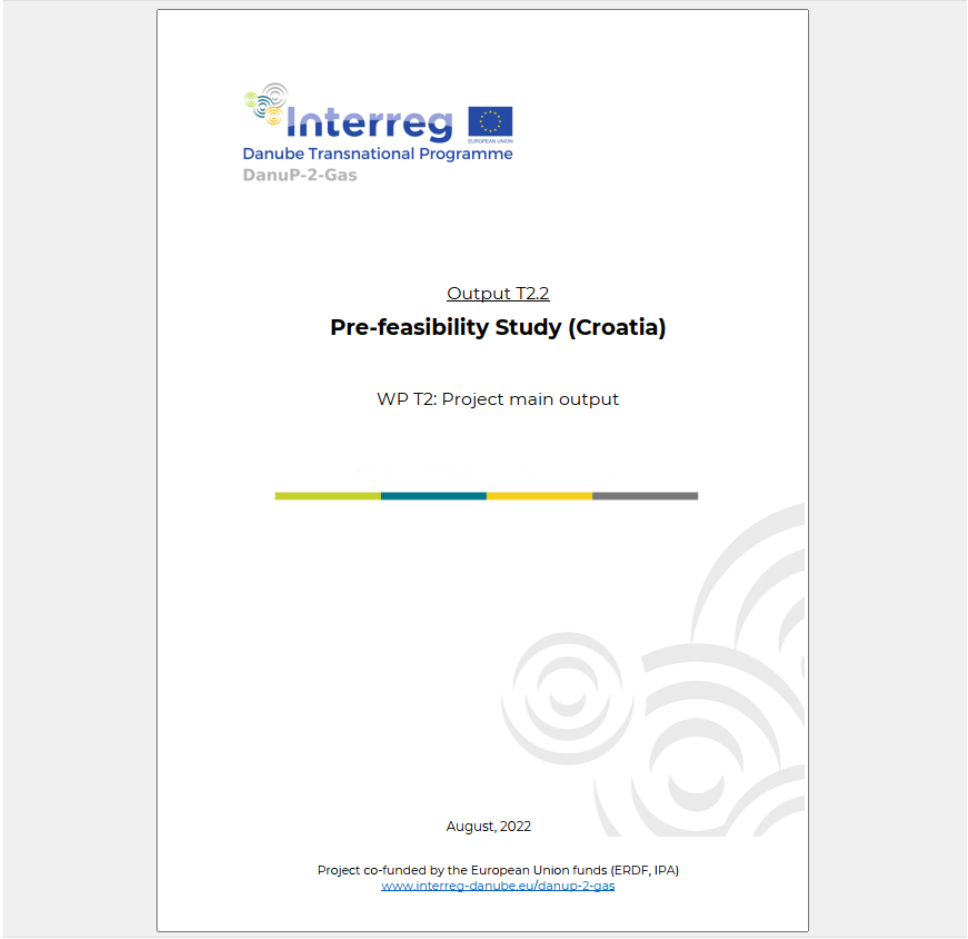
Rezultati: P2G - GF – Karlovac

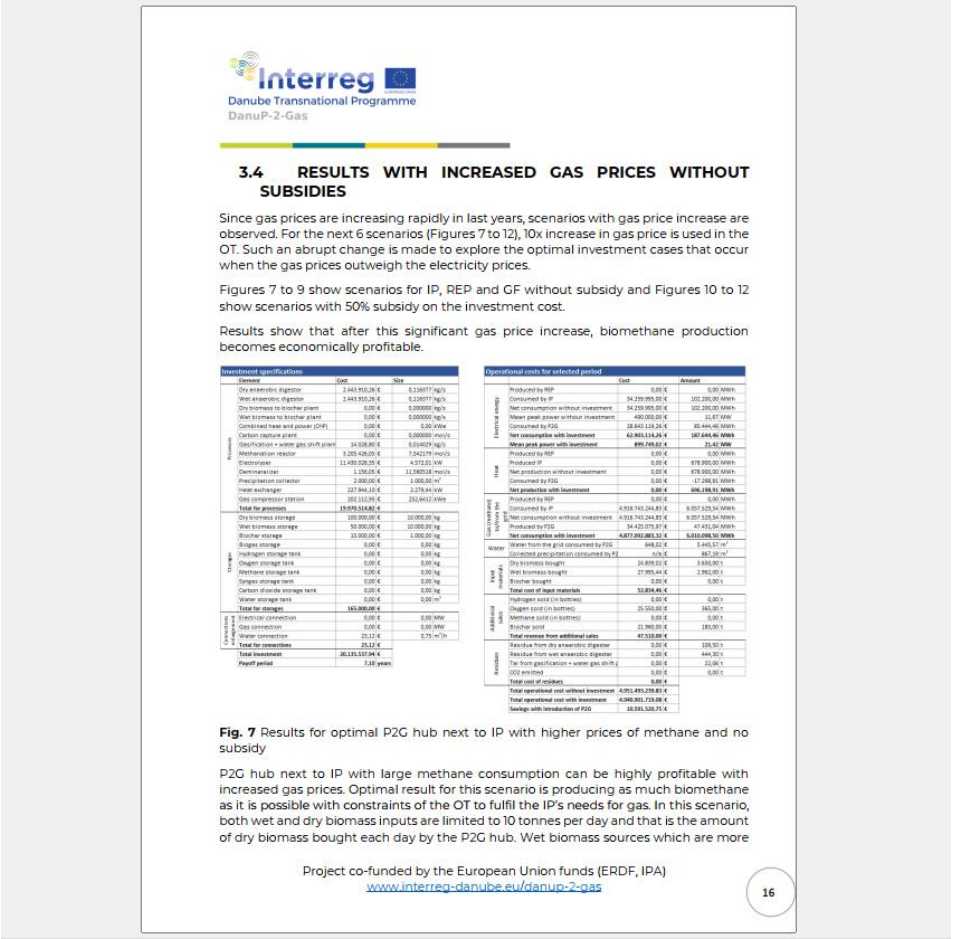


Rezultati: Samostalni P2G

Subvencija [%] / Cijena plina	1x (trenutna)	10x uvećanje
0%	Bez investicije	Periodička proizvodnja biometana (rad zimi)
50%	Investicija u CHP (rad ljeti)	Periodička proizvodnja biometana (rad zimi)

Studija predizvodljivosti





Interreg
EUROPEAN UNION
Danube Transnational Programme
DanuP-2-Gas

Hvala na pažnji

Mario Vašak, mario.vasak@fer.hr
Marijo Šundrica, marijo.sundrica@fer.hr
Filip Rukavina, filip.rukavina@fer.hr
Antonio Karneluti, antonio.karneluti@fer.hr

Smart City Technologies

FER LARES

https://www.interreg-danube.eu/danup-2-gas

https://www.lares.fer.hr