

<u>Output T2.2</u>

Pre-feasibility Study (Slovenia)

WP T2: Project main output

May, 2022

Project co-funded by the European Union funds (ERDF, IPA) www.interreg-danube.eu/danup-2-gas



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DOCUMENT CONTROL SHEET

Project reference	
Full title of the project	Innovative model to drive energy security and diversity in the Danube Region via combination of bioenergy with surplus renewable energy
Acronym	DanuP-2-Gas
Programme priority	Priority 3
Programme priority specific objective	SO 3.2 Improve energy security and energy efficiency
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Project coordinator	TZE

Short Description

The potential for exploitable organic residue for each participating country listing key aspects such as location, amount, transport options and costs.

Document Details	
Title of document	Pre-feasibility Report (Country)
Action	WP T2 Transnational Infrastructure and Biomass assessment & Pre-feasibility Studies
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VI	1.5.2022	lnes Ahmić, Matevž Šilc, Niko Natek	KSSENA	1 st version



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VF	30.08.2022	lnes Ahmić, Matevž Šilc, Niko Natek	KSSENA	Final Version of the OT – Version 1
VF – OT V2	20.10.2022	Hana Kolenc, Matevž Šilc, Niko Natek	KSSENA	Final Version, with the updated version 2 of the OT

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- LP Technology Centre Energy University of Applied Sciences Landshut (DE)
- ERDF PP1 Energy Agency of Savinjska, Koroška and Šaleška Region (SI)
- ERDF PP2 Tolna County Development Agency Nonprofit Public Ltd.(HU)
- ERDF PP3 Energy Institute at the Johannes Kepler University Linz (AT)
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- ERDF PP10 International Centre for Sustainable Development of Energy, Water and Environment Systems (HR)
- ERDF PP11 Energy Institute Hrvoje Požar (HR)
- ERDF PP12 University of Zagreb Faculty of Electrical Engineering and Computing (HR)
- IPA PP1 Regional Agency for Socio Economic Development Banat Ltd (RS)

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CONTENT

1.	METHODOLOGY	7
2.	Case Studies	8
	STUDY CASE 1 - RENEWABLE ENERGY PLANT - SE PRAPRETNO	8
	STUDY CASE 2 – INDUSTRIAL PLANT - TALUM D.D	11
	STUDY CASE 3 – P-2-G HUB AS GREEN FIELD PROJECT	13
3.	Results	14
	STUDY CASE 1 - RENEWABLE ENERGY PLANT SE PRAPRETNO	14
	STUDY CASE 2 – INDUSTRIAL PLANT TALUM D.D	20
	STUDY CASE 3 – P-2-G HUBS AS A GREEN FIELD PROJECT	26
4.	Conclusions	32



1. METHODOLOGY

As all the other partners of the consortium, we also used the data, which was investigated, archived, and shared for the biomass and the infrastructure databases development process. The regionally developed biomass and infrastructure databases will also be used for the further use in the Renewable energy Atlas, a part of the Danube energy platform, which will be automatically connected to the optimization tool. Thus, we felt that the use of the data from both databases was almost essential for the full understanding of the operation of the optimization tool. Other data, which was used strictly for the testing activities of the optimization tool, was used as publicly available data, accessible on the wide web. After the selection process, the data was selected and inserted in a shape of different parameters in the optimization tool. For the development of this updated pre-feasibility study version, the 2nd version of optimization tool was used, which was at the time available as the latest available version for the consortium of the DanuP-2-Gas project. The tool was used locally and offline.

The Optimization Tool (OT) V2 was used for all 18 cases, according to the work package.

The following cases were selected by predefining three scenarios:

- a) Implementation of P-2-G system on the location of existing renewable energy plant – SE Prapretno
- b) Implementation of P-2-G system on the location of existing industrial plant Industrial plant Talum d.d.
- c) Implementation of P-2-G hub as a green on-field project

For each of these three cases (IP, REP, and as green on-field project) the results include an investigation of:

- Natural gas price
 - o current price
 - o 5 times the current price
 - o 10 time the current price
- Context of the implementation of the P-2-G hub without the use of nonrefundable funds and with the use of a 50% subsidy

The results are described in the following chapters.



2. CASE STUDIES

As already described in the previous chapter, three locations for the potential P2G investment were considered.

The first case study is an already existing photovoltaic power plant – SE PRAPRETNO, which was constructed on the top of the debris from the coal industry, thus in the degraded area, which was not suitable for any other use. The second one is one of the biggest industrial plants in Slovenia - Talum d.d., which is one of the largest producers of primary aluminium and aluminium alloys in Slovenia. Finally, the third study case was only implemented as a green on-field project, which could be implemented anywhere, at any location, which would be preferably based near the used and available raw biomass sources, water sources, near various transport links, IP's, REP's, close to the end consumers, etc.

The first version of the optimization tool (OT VI) was updated in August of 2022, by its developers - University of Zagreb Faculty of Electrical Engineering and Computing. Thus, all the other partner's prefeasibility studies were also accordingly updated. This document was updated in the October of 2022, representing the last update of the deliverable by the end of the DanuP-2-Gas project.

STUDY CASE 1 - RENEWABLE ENERGY PLANT - SE PRAPRETNO

Solar power plant SE PRAPRETNO is currently the largest operating photovoltaic installation in Slovenia. It is located in the small town of Prapretno near Hrastnik, where it was built in a degraded area, where in the past years the coal ash and other waste materials related to the operation of the nearby thermal power plant and coal mine were layered. Thus, the area will not be useful for any other use (farm, housing etc.), for another few hundred years. In the light of this events, the biggest national energy holding – HSE Group, which is the largest producer and seller of electricity from domestic sources on the wholesale market in Slovenia and the largest Slovenian producer of electricity from renewable sources, constructed the photovoltaic power plant. With the nominal power of 3,036 MWp it is currently the biggest photovoltaic power plant in Slovenija.

The renewable energy plant SE PRAPRETNO has the following characteristics:

Nominal power: 3,036 MWp

Expected annual electricity production: 3,4 GWh

Number of installed panels: 6900

Nominal power of panel: 440 Wp

Average daily electricity production: 10 MWh

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Number of powered households: 800 The total installation capacity of the area: 15 MWp Estimated number of annual operating hours: 1100



Source: <u>https://www.hse.si/sl/</u>

As part of the DanuP-2-Gas project, the PRAPRETNO solar power plant was selected as STUDY CASE no. 1, in which we studied the possibility of establishing a P-2-G hub, next to the already existing power plant, which in theory turned out to be quite and effective, economical, and successful option, as the results were encouraging. The results of the study case are presented in the next chapter. Despite the fact that the studied renewable energy sources power plant was built and is intended for the production of electricity, which the mentioned power plant generates in a very remote area that is not close to water and biomass sources, and has very poor transport connections, the results of the OT theorised the savings in the amount of approxim

ately 97 million €, if the future market price would stays as it was by the time of investigation. In that case, the P2G hub would be paid off in just 5,4 years, which is relatively fast and the implementation of the P2G hub in line with the already established photovoltaic power plant, should present quite an effective solution or an advanced



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upgrade. Similar results with a high level of savings reduction were be observed in the context of gas price increases.



STUDY CASE 2 - INDUSTRIAL PLANT - TALUM D.D.

The second study case was based on the operation of one of the biggest Slovenian industrial plants company TALUM D.D., which is located in the eastern part of the country, near a town Kidričevo. The company is highly specialized in alumina and aluminium products with an annual production capacity of around 156.000 tonnes.

The company was founded in 1942 by the German company - Vereinigte Aluminium Werke, which built the first alumina factory in Slovenia in Strnišče (now Kidričevo). By the end of World War II, the factory was 70% completed, but the construction had to be halted. The factory was then finished in February 1954 and the first aluminium was produced in November the same year. The early capacity of the factory was 45.000 tonnes of alumina and 15.000 tonnes of aluminium per year.



Source: <u>https://www.talum.si/</u>

The first contract was established in 1957 with the French company – Pechiney, to supply a quantity of 80.000 tonnes of alumina. In 2004, a large-scale modernisation programme started at Talum d.d., which involved the construction of other new potlines for aluminium smelting. The total aluminium production from November 1954 to August 2004 amounted to around 2.560.069 tonnes, resulting in an annual production of around 51.000 tonnes of aluminium. Due to the long-term loss, several subsidiary companies



were closed in 2015: Talum Ulitki, Talum Livarna. In 2016, the company became the "best employer in the Podravje region", with Talum d.d. employing more than 1,300 workers.

The following characteristics of the company are presented:

Annual aluminium production: 150.000 tonnes

Electrical energy consumption per produced ton: 6,6 MWh/t

Natural gas consumption per produced ton: 160 Nm³/t

Aluminium production in 2020: 114.752 t

Natural gas consumption in 2020: 18.360.320 Nm³

Electrical energy consumption in 2020: 760 MWh

For the second study case, the same gas market, grid investment and electricity market prices were used, as for the first and the third study case, due to the fact that this was the situation in the country at the time. In the first version of the optimization tool the second study case proved to be the most successful of the three, as it is logical that there is a high energy consumption present for the whole year in the industrial areas, and not just seasonal. As it can be seen from the examples of the other partners, the operation of the P-2-G hub in the context of the operation of large industrial factories makes the most sense, since the production and consumption of energy can be additionally adapted to the operation of the factory and the production process.

Using the second version of the optimisation tool, we also got similar results to the first version. Interestingly, the implementation of the P-2-G hub makes the most sense when we also use grants in the investment, because then our investment costs are lower than if we would only invest in the hub by ourselves, which would highly increase the investment risk. As we can see in the results presented in the following sections and based on the optimization tool prediction, the implementation of a P-2-G hub at the industrial plant TALUM d.d. site would be beneficial and cost-effective, as we would save approximately 124 million € over a payback period of about 5 years, which makes sense, as the consumption of primary and secondary energy sources at the TALUM d.d. industrial plant is one of the highest among all business energy uses in Slovenia.

However, a drastic increase in the price of gas also drastically reduces the savings, as it can be seen in the examples where 5- and 10-times factors of the gas price are used.



STUDY CASE 3 – P-2-G HUB AS GREEN FIELD PROJECT

For the last (third) study case also, the same gas market, grid investment and electricity market prices were used, as before, and that was also due to the fact that this was the situation on the market in the country at the time. The results of the study case are presented in the next chapter. Given the fact that the use of the first version of the optimisation tool showed a rather pointless investment in P-2-G on-field, we can say differently for the second version of the optimisation tool, as the results show us some sensible solutions. It seems that the implementation of a P-2-G hub on field would be profitable, especially when the gas price is between the current price and five times the trend price. However, when the gas price reaches the ten times factor of the current price, the investment in an on-field P-2-H is not so sensible anymore.



Source: <u>https://siene.teces.si/projekt-reshub/</u>



3. RESULTS

STUDY CASE 1 - RENEWABLE ENERGY PLANT SE PRAPRETNO

Zero subsidy, market gas prices (May 2022)



RESULTS

	Element	Cost		Size	
	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	24.112,65	€	0,096451	kg/s
	Combined heat and power (CHP)	30.000.000,00	€	10.000,00	kWe
	Carbon capture plant	0,00	€	0,000000	mol/s
esse	Gasification + water gas shift plant	0,00	€	0,000000	kg/s
Proc	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	e	0,00	m²
	Heat exchanger	1.250.000,00	€	12.500,00	kW
	Gas compressor station	0,00	€	0,0000	kWe
	Total for processes	31.274.112,65	e		
	Dry biomass storage	0,00	€	0,00	kg
	Wet biomass storage	41.666,67	e	8.333,33	kg
	Biochar storage	15.000,00	€	1.000,00	kg
	Biogas storage	0,00	€	0,00	kg
5	Hydrogen storage tank	0,00	€	0,00	kg
orag	Oxygen storage tank	0,00	€	0,00	kg
5	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	m³
	Total for storages	56.666,67	e		
a ti	Electrical connection	1.653.981,13	€	8,57	MW
Served	Gas connection	4.855.156,25	€	25,16	MW
nlang	Water connection	0,00	€	0,00	m³/h
j ē	Total for connections	6.509.137,38	e		
	Total investment	37.839.916,70	€		
	Payoff period	5,40	years		

Operat	ional costs for selected period				
		Cost		Amount	
	Produced by REP	4.660.152,58	€	3.400,00	MWh
Â2	Consumed by IP	0,00	€	0,00	MWh
Electrical errer	Net consumption without investment	-4.660.152,58	€	-3.400,00	MWh
	Mean peak power without investment	0,00	€	0,00	MW
	Consumed by P2G	-119.935.678,51	€	-87.447,92	MWh
	Net consumption with investment	-124.595.831,08	€	-90.847,92	MWh
	Mean peak power with investment	0,00	€	0,00	MW
	Produced by REP	0,00	€	0,00	MWh
Heat	Produced by IP	0,00	€	0,00	MWh
	Net production without investment	0,00	€	0,00	MWh
	Consumed by P2G	0,00	€	-109.500,00	MWh
	Net production with investment	0,00	€	109.500,00	MWh
Gas (methane) to/from the grid	Produced by REP	0,00	€	0,00	MWh
	Consumed by IP	0,00	€	0,00	MWh
	Net consumption without investment	0,00	€	0,00	MWh
	Produced by P2G	-20.935.031,25	€	-220.368,75	MWh
	Net consumption with investment	20.935.031,25	€	220.368,75	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
20	Dry biomass bought	0,00	€	0,00	t
eria	Wet biomass bought	20.987,50	€	3.041,67	t
- 6	Biochar bought	0,00	€	0,00	t
	Total cost of input materials	20.987,50	€		
	Hydrogen sold (in bottles)	0,00	€	0,00	t
E .	Oxygen sold (in bottles)	0,00	€	0,00	t
ditic Sale	Methane sold (in bottles)	0,00	€	0,00	t
estitues Additional Input 줎 Gas (methane) 2	Biochar sold	547.500,00	€	365,00	t
	Total revenue from additional sales	547.500,00	€		
	Residue from dry anaerobic digester	0,00	€	0,00	t
Water Water from the grid consumed by P2G 0,00 ϵ Collected precipitation consumed by P2G n/a ϵ Dry biomass bought 0,00 ϵ Wet biomass bought 20.987,50 ϵ Biochar bought 0,00 ϵ Total cost of input materials 20.987,50 ϵ Hydrogen sold (in bottles) 0,00 ϵ Oxygen sold (in bottles) 0,00 ϵ Methane sold (in bottles) 0,00 ϵ Biochar sold 547.500,00 ϵ Residue from dry anaerobic digester 0,00 ϵ Residue from wet anaerobic digester 0,00 ϵ Tar from gasification + water gas shift plant 0,00 ϵ	0,00	t			
sidi	Tar from gasification + water gas shift plant	0,00	€	0,00	t
æ	CO2 emitted	2.168.100,00	€	43.362,00	t
	Total cost of residues	2.168.100,00	€		
	Total operational cost without investment	-4.660.152,58	€		
	Total operational cost with investment	-102.019.212,33	€]	
	Savings with introduction of B2C	07 350 050 76]	

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Optimization tool

Results

Charts (\pm)



Half subsidized, market gas prices (May 2022)



RESULTS

Inves	tment specifications				
	Element	Cost		Size	
	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	24.112,65	€	0,096451	kg/s
	Combined heat and power (CHP)	30.000.000,00	€	10.000,00	kWe
22	Carbon capture plant	0,00	€	0,000000	mol/s
esse	Gasification + water gas shift plant	0,00	€	0,000000	kg/s
Proc	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	m²
	Heat exchanger	1.250.000,00	€	12.500,00	kW
	Gas compressor station	0,00	€	0,0000	kWe
	Total for processes	31.274.112,65	€		
	Dry biomass storage	0,00	€	0,00	kg
	Wet biomass storage	41.666,67	€	8.333,33	kg
	Biochar storage	15.000,00	€	1.000,00	kg
	Biogas storage	0,00	€	0,00	kg
5	Hydrogen storage tank	0,00	€	0,00	kg
Sec.	Oxygen storage tank	0,00	€	0,00	kg
55	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	56.666,67	€		
a ti	Electrical connection	1.653.981,13	€	8,57	MW
eme	Gas connection	4.855.156,25	€	25,16	MW
anno Bagi	Water connection	0,00	€	0,00	m ³ /h
రే	Total for connections	6.509.137,38	€		
	Total investment	37.839.916,70	€		
	Payoff period	5,40	years		

Dperat	ional costs for selected period				
		Cost		Amount	
	Produced by REP	4.660.152,58	€	3.400,00	MWh
ŝ	Consumed by IP	0,00	€	0,00	MWh
Electricalene	Net consumption without investment	-4.660.152,58	€	-3.400,00	MWh
	Mean peak power without investment	0,00	€	0,00	MW
	Consumed by P2G	-119.935.678,51	€	-87.447,92	MWh
	Net consumption with investment	-124.595.831,08	€	-90.847,92	MWh
	Mean peak power with investment	0,00	€	0,00	MW
	Produced by REP	0,00	€	0,00	MWh
Heat	Produced by IP	0,00	€	0,00	MWh
	Net production without investment	0,00	€	0,00	MWh
	Consumed by P2G	0,00	€	-109.500,00	MWh
	Net production with investment	0,00	€	109.500,00	MWh
αĒ	Produced by REP	0,00	€	0,00	MWh
2 m	Consumed by IP	0,00	€	0,00	MWh
T T	Net consumption without investment	0,00	€	0,00	MWh
Gas (n to/froi	Produced by P2G	-20.935.031,25	€	-220.368,75	MWh
	Net consumption with investment	20.935.031,25	€	220.368,75	MWh
Water	Water from the grid consumed by P2G	0,00	€	0,00	m³
	Collected precipitation consumed by P2G	n/a	€	0,00	m³
10	Dry biomass bought	0,00	€	0,00	t
Ħ Ē	Wet biomass bought	20.987,50	€	3.041,67	t
Ē	Biochar bought	0,00	€	0,00	t
-	Total cost of input materials	20.987,50	€		
	Hydrogen sold (in bottles)	0,00	€	0,00	t
2	Oxygen sold (in bottles)	0,00	€	0,00	t
alitio ales	Methane sold (in bottles)	0,00	€	0,00	t
lues Additional Input em Gas (mette sales materials at to/from the	Biochar sold	547.500,00	€	365,00	t
	Total revenue from additional sales	547.500,00	€		
	Residue from dry anaerobic digester	0,00	€	0,00	t
8	Residue from wet anaerobic digester	0,00	€	0,00	t
sidu	production with investment0,00 ϵ duced by REP0,00 ϵ isumed by IP0,00 ϵ isumed by IP0,00 ϵ iconsumption without investment0,00 ϵ duced by P2G-20.935.031,25 ϵ iconsumption with investment20.935.031,25 ϵ ter from the grid consumed by P2G0,00 ϵ etced precipitation consumed by P2Gn/a ϵ biomass bought0,00 ϵ thar bought0,00 ϵ char bought0,00 ϵ drogen sold (in bottles)0,00 ϵ gen sold (in bottles)0,00 ϵ char sold547.500,00 ϵ diue from dry anaerobic digester0,00 ϵ idue from wet anaerobic digester0,00 ϵ idue form wet anaerobic digester0,00 ϵ al cost of residues2.168.100,00 ϵ al operational cost without investment-4.660.152,58 ϵ	0,00	t		
2	CO2 emitted	2.168.100,00	€	43.362,00	t
	Total cost of residues	2.168.100,00	€		
	Total operational cost without investment	-4.660.152,58	€		
	Total operational cost with investment	-102.019.212,33	€		
	Savings with introduction of P2G	97.359.059,76	€		

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Optimization tool Plants and sources P2G segments

Results

Charts

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Zero subsidy, five times the current price of gas



RESULTS

	Element	Cost		Size	
	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	24.112,65	€	0,096451	kg/s
	Combined heat and power (CHP)	30.000.000,00	€	10.000,00	kWe
*	Carbon capture plant	0,00	€	0,000000	mol/s
5556	Gasification + water gas shift plant	0,00	€	0,000000	kg/s
loco	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	m²
	Heat exchanger	1.250.000,00	€	12.500,00	kW
	Gas compressor station	0,00	€	0,0000	kWe
	Total for processes	31.274.112,65	€		
	Dry biomass storage	0,00	€	0,00	kg
	Wet biomass storage	41.666,67	€	8.333,33	kg
	Biochar storage	15.000,00	€	1.000,00	kg
	Biogas storage	0,00	€	0,00	kg
5	Hydrogen storage tank	0,00	€	0,00	kg
orag	Oxygen storage tank	0,00	€	0,00	kg
55	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	m³
	Total for storages	56.666,67	€		
ent a	Electrical connection	1.653.981,13	€	8,57	MW
e me	Gas connection	4.855.156,25	€	25,16	MW
ulan,	Water connection	0,00	€	0,00	m³/h
οe	Total for connections	6.509.137,38	€		
	Total investment	37.839.916,70	€		
	Payoff period	6,50	years		

Operat	ional costs for selected period				
		Cost		Amount	
	Produced by REP	4.660.152,58	€	3.400,00	MWh
â	Consumed by IP	0,00	€	0,00	MWh
ener	Net consumption without investment	-4.660.152,58	€	-3.400,00	MWh
icali	Mean peak power without investment	0,00	€	0,00	MW
ectr	Consumed by P2G	-119.935.678,51	e	-87.447,92	MWh
-	Net consumption with investment	-124.595.831,08	€	-90.847,92	MWh
	Mean peak power with investment	0,00	€	0,00	MW
	Produced by REP	0,00	€	0,00	MWh
-	Produced by IP	0,00	€	0,00	MWh
E C	Net production without investment	0,00	€	0,00	MWh
	Consumed by P2G	0,00	€	-109.500,00	MWh
	Net production with investment	0,00	e	109.500,00	MWh
⊕ E	Produced by REP	0,00	€	0,00	MWh
E 2	Consumed by IP	0,00	€	0,00	MWh
a t	Net consumption without investment	0,00	€	0,00	MWh
offic	Produced by P2G	-91.453.031,25	€	-220.368,75	MWh
0 8	Net consumption with investment	91.453.031,25	€	220.368,75	MWh
Water	Water from the grid consumed by P2G	0,00	€	0,00	m³
	Collected precipitation consumed by P2G	n/a	€	0,00	m³
مد	Dry biomass bought	0,00	€	0,00	t
era	Wet biomass bought	20.987,50	€	3.041,67	t
Ē	Biochar bought	0,00	€	0,00	t
	Total cost of input materials	20.987,50	€		
	Hydrogen sold (in bottles)	0,00	€	0,00	t
Ē,	Oxygen sold (in bottles)	0,00	€	0,00	t
ditic sale:	Methane sold (in bottles)	0,00	€	0,00	t
¥ .	Biochar sold	547.500,00	€	365,00	t
	Total revenue from additional sales	547.500,00	e		
	Residue from dry anaerobic digester	0,00	€	0,00	t
5	Residue from wet anaerobic digester	0,00	€	0,00	t
sidu	Tar from gasification + water gas shift plant	0,00	€	0,00	t
쮼	CO2 emitted	2.168.100,00	€	43.362,00	t
	Total cost of residues	2.168.100,00	€		
	Total operational cost without investment	-4.660.152,58	€]	
	Total operational cost with investment	-31.501.212,33	€]	
	Savings with introduction of P2G	26.841.059,76	€]	

+ \rightarrow

Optimization tool

Plants and sources P2G

P2G segments Results

Charts

+



Half subsidized, five times the current price of gas



RESULTS

nve	stment specifications				
	Element	Cost		Size	
	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	24.112,65	€	0,096451	kg/s
	Combined heat and power (CHP)	30.000.000,00	€	10.000,00	kWe
22	Carbon capture plant	0,00	€	0,000000	mol/s
esse	Gasification + water gas shift plant	0,00	€	0,000000	kg/s
Proc	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	m²
	Heat exchanger	1.250.000,00	€	12.500,00	kW
	Gas compressor station	0,00	€	0,0000	kWe
	Total for processes	31.274.112,65	€		
	Dry biomass storage	0,00	€	0,00	kg
	Wet biomass storage	41.666,67	€	8.333,33	kg
	Biochar storage	15.000,00	€	1.000,00	kg
	Biogas storage	0,00	€	0,00	kg
5	Hydrogen storage tank	0,00	€	0,00	kg
8	Oxygen storage tank	0,00	€	0,00	kg
5	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	m³
	Total for storages	56.666,67	€		
a ti	Electrical connection	1.653.981,13	€	8,57	MW
e ne	Gas connection	4.855.156,25	€	25,16	MW
onne nlang	Water connection	0,00	€	0,00	m ³ /h
రెత్	Total for connections	6.509.137,38	€		-
	Total investment	37.839.916,70	€		
	Payoff period	6,50	years	1	

Operat	ional costs for selected period				
		Cost		Amount	
	Produced by REP	4.660.152,58	€	3.400,00	MWh
Å2	Consumed by IP	0,00	€	0,00	MWh
E E	Net consumption without investment	-4.660.152,58	€	-3.400,00	MWh
	Mean peak power without investment	0,00	€	0,00	MW
ectr	Consumed by P2G	-119.935.678,51	€	-87.447,92	MWh
Ξ.	Net consumption with investment	-124.595.831,08	€	-90.847,92	MWh
	Mean peak power with investment	0,00	€	0,00	MW
	Produced by REP	0,00	€	0,00	MWh
+	Produced by IP	0,00	€	0,00	MWh
E ST	Net production without investment	0,00	€	0,00	MWh
_	Consumed by P2G	0,00	€	-109.500,00	MWh
	Net production with investment	0,00	€	109.500,00	MWh
œ₽	Produced by REP	0,00	€	0,00	MWh
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Consumed by IP	0,00	€	0,00	MWh
ta ta	Net consumption without investment	0,00	€	0,00	MWh
() se ()	Produced by P2G	-91.453.031,25	€	-220.368,75	MWh
σg	Net consumption with investment	91.453.031,25	€	220.368,75	MWh
Water	Water from the grid consumed by P2G	0,00	€	0,00	m ³
water	Collected precipitation consumed by P2G	n/a	€	0,00	m ³
	Dry biomass bought	0,00	€	0,00	t
ti in	Wet biomass bought	20.987,50	€	3.041,67	t
Ē	Biochar bought	0,00	€	0,00	t
_	Total cost of input materials	20.987,50	€		
	Hydrogen sold (in bottles)	0,00	€	0,00	t
8	Oxygen sold (in bottles)	0,00	€	0,00	t
ales ales	Methane sold (in bottles)	0,00	€	0,00	t
S Adr	Biochar sold	547.500,00	€	365,00	t
	Total revenue from additional sales	547.500,00	€		
	Residue from dry anaerobic digester	0,00	€	0,00	t
8	Residue from wet anaerobic digester	0,00	€	0,00	t
sidu	Tar from gasification + water gas shift plant	0,00	€	0,00	t
8	CO2 emitted	2.168.100,00	€	43.362,00	t
	Total cost of residues	2.168.100,00	€		
	Total operational cost without investment	-4.660.152,58	€		
	Total operational cost with investment	-31.501.212,33	€		
	Savings with introduction of P2G	26.841.059,76	€		



Zero subsidy, ten times the current price of gas

Danube Transnational Programme DanuP-2-Gas

RESULTS

	Element	Cost		Size	
	Dou anaerobic digestor	0.00	6	0.000000	ka/c
	Wet appendix digester	0,00	•	0,00000	kg/s
	Dev biomacs to biochar plant	0,00	۰ د	0,000000	kg/s
	bry biomass to biochar plant	0,00	•	0,000000	kg/s
	wet biomass to biochar plant	0,00	•	0,000000	Kg/S
	Combined neat and power (CHP)	0,00	•	0,00	kwe
ses	Carbon capture plant	0,00	•	0,00000	moi/s
See	Gasification + water gas shift plant	0,00	•	0,000000	Kg/S
Pro	Methanation reactor	0,00	•	0,000000	mol/s
	Electrolyser	0,00	•	0,00	KW
	Demineralizer	0,00	•	0,000000	moi/s
	Precipitation collector	0,00	€	0,00	m
	Heat exchanger	0,00	€	0,00	kW
	Gas compressor station	0,00	€	0,0000	kWe
	Total for processes	0,00	€		
	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
2	Hydrogen storage tank	0,00	€	0,00	kg
tora	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	m³
	Total for storages	0,00	€		
Ξ	Electrical connection	0,00	€	0,00	MW
E B	Gas connection	0,00	€	0,00	MW
n an	Water connection	0,00	€	0,00	m³/h
0.00	Total for connections	0,00	€		
	Total investment	0,00	€		
	Payoff period	n/a	years		

Operat	ional costs for selected period				
		Cost		Amount	
	Produced by REP	4.660.152,58	€	3.400,00	MWh
ŝ	Consumed by IP	0,00	€	0,00	MWh
E I	Net consumption without investment	-4.660.152,58	€	-3.400,00	MWh
car	Mean peak power without investment	0,00	€	0,00	MW
ectr	Consumed by P2G	0,00	€	0,00	MWh
-	Net consumption with investment	-4.660.152,58	e	-3.400,00	MWh
	Mean peak power with investment	0,00	€	0,00	MW
	Produced by REP	0,00	€	0,00	MWh
+	Produced by IP	0,00	€	0,00	MWh
E E	Net production without investment	0,00	e	0,00	MWh
	Consumed by P2G	0,00	€	0,00	MWh
	Net production with investment	0,00	€	0,00	MWh
÷ ₹	Produced by REP	0,00	€	0,00	MWh
트 월	Consumed by IP	0,00	€	0,00	MWh
a th	Net consumption without investment	0,00	€	0,00	MWh
) as (Produced by P2G	0,00	€	0,00	MWh
0 2	Net consumption with investment	0,00	€	0,00	MWh
Water	Water from the grid consumed by P2G	0,00	€	0,00	m ³
valer	Collected precipitation consumed by P2G	n/a	€	0,00	m ³
- 40	Dry biomass bought	0,00	€	0,00	t
ti di	Wet biomass bought	0,00	€	0,00	t
Ē	Biochar bought	0,00	€	0,00	t
_	Total cost of input materials	0,00	€		
	Hydrogen sold (in bottles)	0,00	€	0,00	t
2	Oxygen sold (in bottles)	0,00	€	0,00	t
ditio ales	Methane sold (in bottles)	0,00	€	0,00	t
Adv. 2	Biochar sold	0,00	€	0,00	t
	Total revenue from additional sales	0,00	€		
	Residue from dry anaerobic digester	0,00	€	0,00	t
S	Residue from wet anaerobic digester	0,00	€	0,00	t
sidu	Tar from gasification + water gas shift plant	0,00	€	0,00	t
2	CO2 emitted	0,00	€	0,00	t
	Total cost of residues	0,00	€		
	Total operational cost without investment	-4.660.152,58	€		
	Total operational cost with investment	-4.660.152,58	e		
	Savings with introduction of P2G	0,00	€		

Optimization tool

Plants and sources P2G segments

segments **Results**

Charts (+)



Half subsidized, ten times the current gas price

ube Transnational Programme nuP-2-Gas						
westment specifications			Oper	ational costs for salested period		
Element	Cost	Size	Oper	actional costs for selected period	Cost	Amount
Dry anaerobic digestor	0.00 €	0.000000 kg/s		Produced by REP	0.00 €	0.00
Wet anaerobic digestor	0.00 €	0.000000 kg/s		Consumed by IP	569.606.232.15 €	340.000.00
Dry biomass to biochar plant	0,00 €	0,000000 kg/s	1 2	Net consumption without investment	569.606.232,15 €	340.000,00
Wet biomass to biochar plant	12.056,33 €	0,096451 kg/s		Mean peak power without investment	887.227,76 €	49,29
Combined heat and power (CHP)	0,00 €	0,00 kWe		Consumed by P2G	254.787,10 €	152,08
" Carbon capture plant	0,00 €	0,000000 mol/s		Net consumption with investment	569.861.019,25 €	340.152,08
Gasification + water gas shift plant	0,00 €	0,000000 kg/s		Mean peak power with investment	887.540,26 €	49,31
Methanation reactor	0,00 €	0,000000 mol/s	1	Produced by REP	0,00 €	0,00
Electrolyser	0,00 €	0,00 kW	1	Produced by IP	0,00 €	400.000,00
Demineralizer	0,00 €	0,000000 mol/s	i i të	Net production without investment	0,00 €	400.000,00
Precipitation collector	0,00 €	0,00 m ²		Consumed by P2G	0,00 €	0,00
Heat exchanger	0,00 €	0,00 kW		Net production with investment	0,00 €	400.000,00
Gas compressor station	0,00 €	0,0000 kWe		Produced by REP	0,00 €	0,00
Total for processes	12.056,33 €		. ana	Consumed by IP	273.025.000,00 €	335.000,00
Dry biomass storage	0,00 €	0,00 kg		Net consumption without investment	273.025.000,00 €	335.000,00
Wet biomass storage	20.833,33 €	8.333,33 kg		Produced by P2G	0,00 €	0,00
Biochar storage	7.500,00 €	1.000,00 kg	1 69	Net consumption with investment	273.025.000,00 €	335.000,00
Biogas storage	0,00 €	0,00 kg		Water from the grid consumed by P2G	0,00 €	0,00
g Hydrogen storage tank	0,00 €	0,00 kg	- vvate	Collected precipitation consumed by P2G	n/a €	0,00
S Oxygen storage tank	0,00 €	0,00 kg		Dry biomass bought	0,00 €	0,00
Methane storage tank	0,00 €	0,00 kg	i ta i	Wet biomass bought	20.987,50 €	3.041,67
Syngas storage tank	0,00 €	0,00 kg	1 2 8	Biochar bought	0,00 €	0,00
Carbon dioxide storage tank	0,00 €	0,00 kg		Total cost of input materials	20.987,50 €	
Water storage tank	0,00 €	0,00 m ³		Hydrogen sold (in bottles)	0,00 €	0,00
Total for storages	28.333,33 €			Oxygen sold (in bottles)	0,00 €	0,00
Electrical connection	0,00 €	0,00 MW	ales ales	Methane sold (in bottles)	0,00 €	0,00
Gas connection	0,00 €	0,00 MW] ¥ °	Biochar sold	547.500,00 €	365,00
Water connection	0,00 €	0,00 m ³ /h	1	Total revenue from additional sales	547.500,00 €	
Total for connections	0,00 €			Residue from dry anaerobic digester	0,00 €	0,00
Total investment	40.389,66 €]	8	Residue from wet anaerobic digester	0,00 €	0,00
Payoff period	5,15 years		E I	Tar from gasification + water gas shift plant	0,00 €	0,00
		-	8	CO2 emitted	0,00 €	0,00
				Total cost of residues	0,00 €	
				Total operational cost without investment	843.518.459,90 €	
				Total operational cost with investment	843.247.047,01 €	
				Savings with introduction of P2G	271.412,90 €	



STUDY CASE 2 – INDUSTRIAL PLANT TALUM D.D.

Zero subsidy, market gas prices (May 2022)

ube	Transnational Programme					-					
IUP	-2-Gas										
ves	tment specifications					I I	Onerat	ional costs for selected period			
uc.	Element	Cost		Size		1 1	operat	ional costs for sciected period	Cost	Amount	
	Dry anaerobic digestor	0,00 €		0,000000	kg/s	1 1		Produced by REP	0,00 €	0,00	M
	Wet anaerobic digestor	0,00 €		0,000000	kg/s	1	ŝ	Consumed by IP	569.606.232,15 €	340.000,00	м
	Dry biomass to biochar plant	0,00 €		0,000000	kg/s	1	E.	Net consumption without investment	569.606.232,15 €	340.000,00	м
	Wet biomass to biochar plant	0,00 €	E	0,000000	kg/s	1	a la	Mean peak power without investment	887.227,76 €	49,29	м
	Combined heat and power (CHP)	0,00 €		0,00	kWe		ectr	Consumed by P2G	0,00 €	0,00	M
	Carbon capture plant	0,00 €		0,000000	mol/s		-	Net consumption with investment	569.606.232,15 €	340.000,00	м
2000	Gasification + water gas shift plant	0,00 €		0,000000	kg/s			Mean peak power with investment	887.227,76 €	49,29	M
į.	Methanation reactor	0,00 €		0,000000	mol/s	[Produced by REP	0,00 €	0,00	м
	Electrolyser	0,00 €		0,00	kW		+-	Produced by IP	0,00 €	400.000,00	N
	Demineralizer	0,00 €		0,000000	mol/s		E H	Net production without investment	0,00 €	400.000,00	N
	Precipitation collector	0,00 €		0,00	m²			Consumed by P2G	0,00 €	0,00	N
	Heat exchanger	0,00 €		0,00	kW			Net production with investment	0,00 €	400.000,00	N
	Gas compressor station	0,00 €		0,0000	kWe		⊕ ₽	Produced by REP	0,00 €	0,00	N
	Total for processes	0,00 €	ε			_	투월	Consumed by IP	31.825.000,00 €	335.000,00	N
	Dry biomass storage	0,00 €		0,00	kg		<u>a</u> ti	Net consumption without investment	31.825.000,00 €	335.000,00	N
	Wet biomass storage	0,00 €		0,00	kg		sa €	Produced by P2G	0,00 €	0,00	N
	Biochar storage	0,00 €		0,00	kg		9 8	Net consumption with investment	31.825.000,00 €	335.000,00	N
	Biogas storage	0,00 €		0,00	kg		Water	Water from the grid consumed by P2G	0,00 €	0,00	m
	Hydrogen storage tank	0,00 €		0,00	kg			Collected precipitation consumed by P2G	n/a €	0,00	m
	Oxygen storage tank	0,00 €		0,00	kg		مد	Dry biomass bought	0,00 €	0,00	t
	Methane storage tank	0,00 €		0,00	kg		eria	Wet biomass bought	0,00 €	0,00	t
	Syngas storage tank	0,00 €		0,00	kg		트	Biochar bought	0,00 €	0,00	t
	Carbon dioxide storage tank	0,00 €		0,00	kg			Total cost of input materials	0,00 €		_
	Water storage tank	0,00 €		0,00	m³			Hydrogen sold (in bottles)	0,00 €	0,00	t
	Total for storages	0,00 €	ε			.	E S	Oxygen sold (in bottles)	0,00 €	0,00	t
ent	Electrical connection	0,00 €		0,00	MW		iditic sale	Methane sold (in bottles)	0,00 €	0,00	t
Eas	Gas connection	0,00 €		0,00	MW		×	Biochar sold	0,00 €	0,00	t
	Water connection	0,00 €		0,00	m³/h			Total revenue from additional sales	0,00 €		_
9	Total for connections	0,00 €						Residue from dry anaerobic digester	0,00 €	0,00	t
	Total investment	0,00 €					San	Residue from wet anaerobic digester	0,00 €	0,00	t
	Payoff period	n/a y	ears				esid	Tar from gasification + water gas shift plant	0,00 €	0,00	t
							et.	CO2 emitted	0,00 €	0,00	t
								Total cost of residues	0,00 €	_	
								Total operational cost without investment	602.318.459,90 €	_	
								Total operational cost with investment	602.318.459,90 €	_	
								Savings with introduction of P2G	0,00 €		



Half subsidized, market gas prices (May 2022)

nve	stment specifications				Oper	ational costs for selected period		
	Element	Cost 5	ize				Cost	Amount
	Dry anaerobic digestor	0,00 €	0,000000	kg/s		Produced by REP	0,00 €	0,00
	Wet anaerobic digestor	0,00 €	0,000000	kg/s	è	Consumed by IP	569.606.232,15 €	340.000,00
	Dry biomass to biochar plant	0,00 €	0,000000	kg/s	. 2	Net consumption without investment	569.606.232,15 €	340.000,00
	Wet biomass to biochar plant	12.056,33 €	0,096451	kg/s		Mean peak power without investment	887.227,76 €	49,29
	Combined heat and power (CHP)	15.000.000,00 €	10.000,00	kWe	ect	Consumed by P2G	-119.935.678,51 €	-87.447,92
8	Carbon capture plant	0,00 €	0,000000	mol/s	. "	Net consumption with investment	423.103.648,85 €	252.552,08
Ses 2	Gasification + water gas shift plant	0,00 €	0,000000	kg/s		Mean peak power with investment	707.540,26 €	39,31
Proc	Methanation reactor	0,00 €	0,000000	mol/s		Produced by REP	0,00 €	0,00
	Electrolyser	0,00 €	0,00	kW		Produced by IP	0,00 €	400.000,00
	Demineralizer	0,00 €	0,000000	mol/s	_ <u><u></u></u>	Net production without investment	0,00 €	400.000,00
	Precipitation collector	0,00 €	0,00	m²	_	Consumed by P2G	0,00 €	-109.500,00
	Heat exchanger	625.000,00 €	12.500,00	kW		Net production with investment	0,00 €	509.500,00
	Gas compressor station	0,00 €	0,0000	kWe		Produced by REP	0,00 €	0,00
	Total for processes	15.637.056,33 €			. <u> </u>	Consumed by IP	31.825.000,00 €	335.000,00
	Dry biomass storage	0,00 €	0,00	kg	. 18	Net consumption without investment	31.825.000,00 €	335.000,00
	Wet biomass storage	20.833,33 €	8.333,33	kg	l l l l l l l l l l l l l l l l l l l	Produced by P2G	-20.935.031,25 €	-220.368,75
	Biochar storage	7.500,00 €	1.000,00	kg		Net consumption with investment	52.760.031,25 €	555.368,75
	Biogas storage	0,00 €	0,00	kg	Wate	Water from the grid consumed by P2G	0,00 €	0,00
Sec.	Hydrogen storage tank	0,00 €	0,00	kg		Collected precipitation consumed by P2G	n/a €	0,00
toral	Oxygen storage tank	0,00 €	0,00	kg	م ا	Dry biomass bought	0,00 €	0,00
S.	Methane storage tank	0,00 €	0,00	kg	i ta i	Wet biomass bought	20.987,50 €	3.041,67
	Syngas storage tank	0,00 €	0,00	kg	= fe	Biochar bought	0,00 €	0,00
	Carbon dioxide storage tank	0,00 €	0,00	kg		Total cost of input materials	20.987,50 €	
	Water storage tank	0,00 €	0,00	m ³		Hydrogen sold (in bottles)	0,00 €	0,00
	Total for storages	28.333,33 €				Oxygen sold (in bottles)	0,00 €	0,00
as to	Electrical connection	0,00 €	0,00	MW	a ditional di tional di tionad di tional di tionad di ti	Methane sold (in bottles)	0,00 €	0,00
ectio Yerne	Gas connection	0,00 €	0,00	MW	🤻 "	Biochar sold	547.500,00 €	365,00
Dung Dung	Water connection	0,00 €	0,00	m ³ /h		Total revenue from additional sales	547.500,00 €	
Qŝ	Total for connections	0,00 €				Residue from dry anaerobic digester	0,00 €	0,00
	Total investment	15.665.389,66 €			5	Residue from wet anaerobic digester	0,00 €	0,00
	Payoff period	5,13 years			side	Tar from gasification + water gas shift plant	0,00 €	0,00
					2 a	CO2 emitted	2.168.100,00 €	43.362,00
						Total cost of residues	2.168.100,00 €	
						Total operational cost without investment	602.318.459,90 €	
						Total operational cost with investment	478.212.807,86 €	
						Savings with introduction of P2G	124.105.652,05 €	



Zero subsidy, five times the current price of gas

anub anuP	e Transnational Programme P-2-Gas			RESU	JLIS			
								-
Inve	stment specifications			Oper	ational costs for selected period			
	Element	Cost	Size			Cost	Amount	
	Dry anaerobic digestor	0,00 €	0,000000 kg/s		Produced by REP	0,00 €	0,00	M
	Wet anaerobic digestor	0,00 €	0,000000 kg/s	<u>a</u>	Consumed by IP	569.606.232,15 €	340.000,00	M
	Dry biomass to biochar plant	0,00 €	0,000000 kg/s		Net consumption without investment	569.606.232,15 €	340.000,00	M
	Wet biomass to biochar plant	0,00 €	0,000000 kg/s	icale	Mean peak power without investment	887.227,76 €	49,29	м
	Combined heat and power (CHP)	0,00 €	0,00 kWe	ectr	Consumed by P2G	0,00 €	0,00	м
**	Carbon capture plant	0,00 €	0,000000 mol/s	=	Net consumption with investment	569.606.232,15 €	340.000,00	M
esse	Gasification + water gas shift plant	0,00 €	0,000000 kg/s		Mean peak power with investment	887.227,76 €	49,29	м
Proc	Methanation reactor	0,00 €	0,000000 mol/s		Produced by REP	0,00 €	0,00	M
	Electrolyser	0,00 €	0,00 kW		Produced by IP	0,00 €	400.000,00	M
	Demineralizer	0,00 €	0,000000 mol/s	<u> </u>	Net production without investment	0,00 €	400.000,00	M
	Precipitation collector	0,00 €	0,00 m ²		Consumed by P2G	0,00 €	0,00	M
	Heat exchanger	0,00 €	0,00 kW		Net production with investment	0,00 €	400.000,00	M
	Gas compressor station	0,00 €	0,0000 kWe	~ E	Produced by REP	0,00 €	0,00	N
	Total for processes	0,00 €		28	Consumed by IP	139.025.000,00 €	335.000,00	N
	Dry biomass storage	0,00 €	0,00 kg	t a t	Net consumption without investment	139.025.000,00 €	335.000,00	N
	Wet biomass storage	0,00 €	0,00 kg	as (Produced by P2G	0,00 €	0,00	N
	Biochar storage	0,00 €	0,00 kg	60	Net consumption with investment	139.025.000,00 €	335.000,00	M
	Biogas storage	0,00 €	0,00 kg		Water from the grid consumed by P2G	0,00 €	0,00) m
5	Hydrogen storage tank	0,00 €	0,00 kg	vvate	Collected precipitation consumed by P2G	n/a €	0,00) m
orag	Oxygen storage tank	0,00 €	0,00 kg		Dry biomass bought	0,00 €	0,00	t
S	Methane storage tank	0,00 €	0,00 kg	t is is	Wet biomass bought	0,00 €	0,00	t
	Syngas storage tank	0,00 €	0,00 kg	<u>É</u>	Biochar bought	0,00 €	0,00	t
	Carbon dioxide storage tank	0,00 €	0,00 kg] '	Total cost of input materials	0,00 €		
	Water storage tank	0,00 €	0,00 m ³		Hydrogen sold (in bottles)	0,00 €	0,00	t
	Total for storages	0,00 €			Oxygen sold (in bottles)	0,00 €	0,00	t
u t	Electrical connection	0,00 €	0,00 MW		Methane sold (in bottles)	0,00 €	0,00	t
eme	Gas connection	0,00 €	0,00 MW] Ÿ	Biochar sold	0,00 €	0,00	t
anne	Water connection	0,00 €	0,00 m ³ /h]	Total revenue from additional sales	0,00 €		
ပီခံ	Total for connections	0,00 €			Residue from dry anaerobic digester	0,00 €	0,00	t
	Total investment	0,00 €		8	Residue from wet anaerobic digester	0,00 €	0,00	t
	Payoff period	n/a yea	rs	ido la	Tar from gasification + water gas shift plant	0,00 €	0,00	t
				l a	CO2 emitted	0,00 €	0,00	t
					Total cost of residues	0,00 €		
					Total operational cost without investment	709.518.459,90 €		
					Total operational cost with investment	709.518.459,90 €		
					Savings with introduction of P2G	0,00 €		



Half subsidized, five times the current price of gas

nuP-2-Gas						
vestment specifications	Cast	Cine .	Oper	ational costs for selected period	Cart	
Dev apporchis digostor	C051	5/2e		Dradwood by DED	0.00 5	Amount
Wet anaerobic digestor	0,00 €	0,000000 kg/s		Consumed by IP	560 606 232 15 6	340,000,00
Dry biomass to biochar plant	0,00 €	0.000000 kg/s	- 2	Net consumption without investment	569 606 232 15 €	340.000.00
Wet biomass to biochar plant	12.056.33 €	0.096451 kg/s		Mean peak power without investment	887.227.76 €	49.29
Combined heat and power (CHP)	15.000.000.00 €	10.000.00 kWe		Consumed by P2G	-119.935.678.51 €	-87,447,92
	0,00 €	0.000000 mol/s	- 2	Net consumption with investment	423.103.648.85 €	252,552,08
Gasification + water gas shift plant	0,00 €	0,000000 kg/s		Mean peak power with investment	707.540.26 €	39,31
Methanation reactor	0,00 €	0,000000 mol/s	1	Produced by REP	0.00 €	0.00
e. Electrolyser	0,00 €	0,00 kW	1	Produced by IP	0,00 €	400.000,00
Demineralizer	0,00 €	0,000000 mol/s	Fat	Net production without investment	0,00 €	400.000,00
Precipitation collector	0,00 €	0,00 m ²		Consumed by P2G	0,00 €	-109.500,00
Heat exchanger	625.000,00 €	12.500,00 kW		Net production with investment	0,00 €	509.500,00
Gas compressor station	0,00 €	0,0000 kWe		Produced by REP	0,00 €	0,00
Total for processes	15.637.056,33 €		 	Consumed by IP	139.025.000,00 €	335.000,00
Dry biomass storage	0,00 €	0,00 kg	a a a	Net consumption without investment	139.025.000,00 €	335.000,00
Wet biomass storage	20.833,33 €	8.333,33 kg	as (Produced by P2G	-91.453.031,25 €	-220.368,75
Biochar storage	7.500,00 €	1.000,00 kg	60	Net consumption with investment	230.478.031,25 €	555.368,75
Biogas storage	0,00 €	0,00 kg	Wate	Water from the grid consumed by P2G	0,00 €	0,00
Hydrogen storage tank	0,00 €	0,00 kg	vvate	Collected precipitation consumed by P2G	n/a €	0,00
Oxygen storage tank	0,00 €	0,00 kg	هد ا	Dry biomass bought	0,00 €	0,00
Methane storage tank	0,00 €	0,00 kg	eria put	Wet biomass bought	20.987,50 €	3.041,67
Syngas storage tank	0,00 €	0,00 kg	_ = Ē	Biochar bought	0,00 €	0,00
Carbon dioxide storage tank	0,00 €	0,00 kg		Total cost of input materials	20.987,50 €	
Water storage tank	0,00 €	0,00 m ³		Hydrogen sold (in bottles)	0,00 €	0,00
Total for storages	28.333,33 €		- 10,00	Oxygen sold (in bottles)	0,00 €	0,00
Electrical connection	0,00 €	0,00 MW	al titi	Methane sold (in bottles)	0,00 €	0,00
Gas connection	0,00 €	0,00 MW	×	Biochar sold	547.500,00 €	365,00
Water connection	0,00 €	0,00 m³/h		Total revenue from additional sales	547.500,00 €	
Total for connections	0,00 €	_		Residue from dry anaerobic digester	0,00 €	0,00
Total investment	15.665.389,66 €	_	<u></u>	Residue from wet anaerobic digester	0,00 €	0,00
Payoff period	5,30 years	i	isa İ	Tar from gasification + water gas shift plant	0,00 €	0,00
				CO2 emitted	2.168.100,00 €	43.362,00
				Total cost of residues	2.168.100,00 €	_
				Total operational cost without investment	709.518.459,90 €	_
				Total operational cost with investment	655.930.807,86 €	_
				Savings with introduction of P2G	53.587.652,05 €	



Zero subsidy, ten times the current price of gas

anuP-	2-Gas								
nvest	tment specifications					Onerat	tional costs for selected period		
	Element	Cost	Size			opera	infiniteosts for selected period	Cost	Amount
	Dry anaerobic digestor	0.00 €	0.000000	kg/s			Produced by REP	0.00 €	. 0.0
	Wet anaerobic digestor	0.00 €	0.000000	kg/s		2	Consumed by IP	569.606.232.15 €	340.000.0
	Dry biomass to biochar plant	0.00 €	0.000000	kg/s		La la	Net consumption without investment	569.606.232.15 €	340.000.0
	Wet biomass to biochar plant	0,00 €	0,000000	kg/s		ale	Mean peak power without investment	887.227.76 €	I 49.:
	Combined heat and power (CHP)	0,00 €	0,00	kWe		ectri	Consumed by P2G	0,00 €	i 0,1
	Carbon capture plant	0,00 €	0,000000	mol/s		8	Net consumption with investment	569.606.232,15 €	E 340.000,/
sse	Gasification + water gas shift plant	0,00 €	0,000000	kg/s			Mean peak power with investment	887.227,76 €	E 49,7
roce	Methanation reactor	0,00 €	0,000000	mol/s			Produced by REP	0,00 €	E 0,0
-	Electrolyser	0,00 €	0,00	kW			Produced by IP	0,00 €	400.000,0
	Demineralizer	0,00 €	0,000000	mol/s		Heat	Net production without investment	0,00 €	£ 400.000,0
	Precipitation collector	0,00 €	0,00	m ²		-	Consumed by P2G	0,00 €	i 0,(
	Heat exchanger	0,00 €	0,00	kW			Net production with investment	0,00 €	400.000,0
	Gas compressor station	0,00 €	0,0000	kWe		πĒ	Produced by REP	0,00 €	£ 0,(
·	Total for processes	0,00 €				E 2	Consumed by IP	273.025.000,00 €	335.000,0
	Dry biomass storage	0,00 €	0,00	kg		a t	Net consumption without investment	273.025.000,00 €	335.000,0
	Wet biomass storage	0,00 €	0,00	kg) as (Produced by P2G	0,00 €	i 0,0
	Biochar storage	0,00 €	0,00	kg		оg	Net consumption with investment	273.025.000,00 €	335.000,0
	Biogas storage	0,00 €	0,00	kg		Water	Water from the grid consumed by P2G	0,00 €	£ 0,0
5	Hydrogen storage tank	0,00 €	0,00	kg		water	Collected precipitation consumed by P2G	n/a €	i 0,0
orage	Oxygen storage tank	0,00 €	0,00	kg		مد	Dry biomass bought	0,00 €	i 0,0
8	Methane storage tank	0,00 €	0,00	kg		E E	Wet biomass bought	0,00 €	i 0,0
	Syngas storage tank	0,00 €	0,00	kg		- 6	Biochar bought	0,00 €	i 0,0
	Carbon dioxide storage tank	0,00 €	0,00	kg			Total cost of input materials	0,00 €	i i
	Water storage tank	0,00 €	0,00	m ³			Hydrogen sold (in bottles)	0,00 €	i 0,0
	Total for storages	0,00 €				E s	Oxygen sold (in bottles)	0,00 €	i 0,0
a t	Electrical connection	0,00 €	0,00	MW		ld itic sa le	Methane sold (in bottles)	0,00 €	i 0,0
gen ecti	Gas connection	0,00 €	0,00	MW		N.	Biochar sold	0,00 €	I 0,0
an lar	Water connection	0,00 €	0,00	m³/h			Total revenue from additional sales	0,00 €	<u>i</u>
~ ~	Total for connections	0,00 €	1				Residue from dry anaerobic digester	0,00 €	i 0,(
ŀ	Total investment	0,00 €				S	Residue from wet anaerobic digester	0,00 €	i 0,(
	Payoff period	n/a years				besid	Tar from gasification + water gas shift plant	0,00 €	(0, (
						œ	CO2 emitted	0,00 €	i 0, 0
					l		Total cost of residues	0,00 €	<u>t</u>
							Total operational cost without investment	843.518.459,90 €	<u>t</u>
							Total operational cost with investment	843.518.459,90 €	<u>t</u>
							Savings with introduction of P2G	0,00 €	<u>(</u>



Half subsidized, ten times the current gas price

nube							RESU	LTS			
nuP	-2-Gas										
		_									
nves	tment specifications						Opera	tional costs for selected period			
	Element	Cost		Size					Cost	A	mount
	Dry anaerobic digestor	0,00	€	0,000000	kg/s			Produced by REP	0,00	€	0,00
	Wet anaerobic digestor	0,00	€	0,000000	kg/s]	Å.	Consumed by IP	569.606.232,15	€	340.000,00
	Dry biomass to biochar plant	0,00	€	0,000000	kg/s]	E E	Net consumption without investment	569.606.232,15	€	340.000,00
	Wet biomass to biochar plant	12.056,33	€	0,096451	kg/s			Mean peak power without investment	887.227,76	€	49,29
	Combined heat and power (CHP)	0,00	€	0,00	kWe		ectr	Consumed by P2G	254.787,10	€	152,08
	Carbon capture plant	0,00	€	0,000000	mol/s		-	Net consumption with investment	569.861.019,25	€	340.152,08
sess	Gasification + water gas shift plant	0,00	€	0,000000	kg/s			Mean peak power with investment	887.540,26	€	49,31
Proc	Methanation reactor	0,00	€	0,000000	mol/s			Produced by REP	0,00	€	0,00
	Electrolyser	0,00	€	0,00	kW		=	Produced by IP	0,00	€	400.000,00
	Demineralizer	0,00	€	0,000000	mol/s		Hea H	Net production without investment	0,00	€	400.000,00
	Precipitation collector	0,00	€	0,00	m²			Consumed by P2G	0,00	€	0,00
	Heat exchanger	0,00	€	0,00	kW			Net production with investment	0,00	€	400.000,00
	Gas compressor station	0,00	€	0,0000	kWe		@ E	Produced by REP	0,00	€	0,00
	Total for processes	12.056,33	€			,	불불	Consumed by IP	273.025.000,00	€	335.000,00
	Dry biomass storage	0,00	€	0,00	kg		ĒĒ	Net consumption without investment	273.025.000,00	€	335.000,00
	Wet biomass storage	20.833,33	€	8.333,33	kg		Sas 4	Produced by P2G	0,00	€	0,00
	Biochar storage	7.500,00	€	1.000,00	kg		_ ¥	Net consumption with investment	273.025.000,00	€	335.000,00
	Biogas storage	0,00	€	0,00	kg		Water	Water from the grid consumed by P2G	0,00	€	0,00
ñ,	Hydrogen storage tank	0,00	€	0,00	kg			Collected precipitation consumed by P2G	n/a	€	0,00
toral	Oxygen storage tank	0,00	€	0,00	kg		<u>a</u>	Dry biomass bought	0,00	€	0,00
°	Methane storage tank	0,00	€	0,00	kg		era put	Wet biomass bought	20.987,50	€	3.041,67
	Syngas storage tank	0,00	€	0,00	kg		트	Biochar bought	0,00	€	0,00
	Carbon dioxide storage tank	0,00	€	0,00	kg			Total cost of input materials	20.987,50	€	
	Water storage tank	0,00	€	0,00	m³			Hydrogen sold (in bottles)	0,00	€	0,00
	Total for storages	28.333,33	€			,	E .	Oxygen sold (in bottles)	0,00	€	0,00
t t	Electrical connection	0,00	€	0,00	MW		lditic sale	Methane sold (in bottles)	0,00	€	0,00
E ag	Gas connection	0,00	€	0,00	MW		N N	Biochar sold	547.500,00	€	365,00
na la	Water connection	0,00	€	0,00	m³/h			Total revenue from additional sales	547.500,00	€	
· •	Total for connections	0,00	€					Residue from dry anaerobic digester	0,00	€	0,00
	Total investment	40.389,66	e				San	Residue from wet anaerobic digester	0,00	€	0,00
	Payoff period	5,15	years				pi sa	Tar from gasification + water gas shift plant	0,00	€	0,00
							"	CO2 emitted	0,00	€	0,00
								Total cost of residues	0,00	€	
								Total operational cost without investment	843.518.459,90	€	
								Total operational cost with investment	843.247.047,01	€	
								Savings with introduction of P2G	271.412,90	€	



STUDY CASE 3 – P-2-G HUB AS A GREEN ON-FIELD PROJECT

Zero subsidy, market gas prices (May 2022)

vest										
vest E										
vest E										
E	ment specifications				C	Operat	tional costs for selected period			
	Element	Cost	Size					Cost	Amo	unt
0	Dry anaerobic digestor	0,00 €	0,000000	kg/s			Produced by REP	0,00	e 📃	0,00
v	Net anaerobic digestor	0,00 €	0,000000	kg/s		ŝ	Consumed by IP	0,00	e 🛛	0,00
0	Dry biomass to biochar plant	0,00 €	0,000000	kg/s		8	Net consumption without investment	0,00	e 📃	0,00
V	Wet biomass to biochar plant	24.112,65 €	0,096451	kg/s		12	Mean peak power without investment	0,00	e 📃	0,00
c	Combined heat and power (CHP)	30.000.000,00 €	10.000,00	kWe		EC	Consumed by P2G	-119.935.678,51	e 📃	-87.447,92
, <u>c</u>	Carbon capture plant	0,00 €	0,000000	mol/s		-	Net consumption with investment	-119.935.678,51	e 📃	-87.447,92
G	Sasification + water gas shift plant	0,00 €	0,000000	kg/s			Mean peak power with investment	0,00	e	0,00
2	Methanation reactor	0,00 €	0,000000	mol/s			Produced by REP	0,00	e 📃	0,00
E	Electrolyser	0,00 €	0,00	kW		Ħ	Produced by IP	0,00	e	0,00
0	Demineralizer	0,00 €	0,000000	mol/s		Ŧ	Net production without investment	0,00	e	0,00
P	Precipitation collector	0,00 €	0,00	m²			Consumed by P2G	0,00	e -	109.500,00
H	Heat exchanger	1.250.000,00 €	12.500,00	kW			Net production with investment	0,00	e :	109.500,00
G	Sas compressor station	0,00 €	0,0000	kWe		œ ۲	Produced by REP	0,00	e	0,00
T	Total for processes	31.274.112,65 €			,	Ē Ē	Consumed by IP	0,00	e	0,00
0	Dry biomass storage	0,00 €	0,00	kg		Gas (me to/from1	Net consumption without investment	0,00	e	0,00
V	Net biomass storage	41.666,67 €	8.333,33	kg			Produced by P2G	-20.935.031,25	€ ∹	220.368,75
B	Biochar storage	15.000,00 €	1.000,00	kg	Water	Net consumption with investment	20.935.031,25	e :	220.368,75	
B	Biogas storage	0,00 €	0,00	kg		Water from the grid consumed by P2G	0,00	e 📃	0,00	
<u>ا</u> ا	Hydrogen storage tank	0,00 €	0,00	kg			Collected precipitation consumed by P2G	n/a	e 📃	0,00
	Dxygen storage tank	0,00 €	0,00	kg		<u>a</u>	Dry biomass bought	0,00	e 📃	0,00
° N	Methane storage tank	0,00 €	0,00	kg		put beriat	Wet biomass bought	20.987,50	e 🛛	3.041,67
s	Syngas storage tank	0,00 €	0,00	kg		- 6	Biochar bought	0,00	e 🛛	0,00
C	Carbon dioxide storage tank	0,00 €	0,00	kg			Total cost of input materials	20.987,50	e 🛛	
v	Water storage tank	0,00 €	0,00	m³			Hydrogen sold (in bottles)	0,00	e 🛛	0,00
T	Fotal for storages	56.666,67 €			,	E s	Oxygen sold (in bottles)	0,00	e 📃	0,00
Ę	Electrical connection	2.060.000,00 €	10,00	MW		iditi sale	Methane sold (in bottles)	0,00	e 📃	0,00
5	Gas connection	4.855.156,25 €	25,16	MW		×	Biochar sold	547.500,00	e 📃	365,00
al A	Water connection	0,00 €	0,00	m³/h			Total revenue from additional sales	547.500,00	e 📃	
Ĩ	Total for connections	6.915.156,25 €	4				Residue from dry anaerobic digester	0,00	E	0,00
Т	Total investment	38.245.935,57 €	-			ŝ	Residue from wet anaerobic digester	0,00	E	0,00
P	Payoff period	5,40 years				besid	Tar from gasification + water gas shift plant	0,00	E	0,00
						<u>e</u> 2	CO2 emitted	2.168.100,00	E	43.362,00
					L		Total cost of residues	2.168.100,00	E	
							Total operational cost without investment	0,00	E	
							Total operational cost with investment	-97.359.059,76	E	
							Savings with introduction of P2G	97.359.059,76	E	



AB

Half subsidized, market gas prices (May 2022)

D E F G H

anuP	·2-Gas							
nves	tment specifications				Opera	tional costs for selected period		
	Element	Cost	Size	4 4			Cost	Amount
	Dry anaerobic digestor	0,00 €	0,000000 kg/s			Produced by REP	0,00 €	0,00
	Wet anaerobic digestor	0,00 €	0,000000 kg/s		Age .	Consumed by IP	0,00 €	0,00
	Dry biomass to biochar plant	0,00 €	0,000000 kg/s	-	5	Net consumption without investment	0,00 €	0,00
	Wet biomass to biochar plant	12.056,33 €	0,096451 kg/s	-	Lig.	Mean peak power without investment	0,00 €	0,00
	Combined heat and power (CHP)	15.000.000,00 €	10.000,00 kWe	-	E.	Consumed by P2G	-119.935.678,51 €	-87.447,92
ses	Carbon capture plant	0,00 €	0,000000 mol/s	-	-	Net consumption with investment	-119.935.678,51 €	-87.447,92
Ses	Gasification + water gas shift plant	0,00 €	0,000000 kg/s	-		Mean peak power with investment	0,00 €	0,00
Pro	Methanation reactor	0,00 €	0,000000 mol/s	-		Produced by REP	0,00 €	0,00
	Electrolyser	0,00 €	0,00 kW	-	ŧ	Produced by IP	0,00 €	0,00
	Demineralizer	0,00 €	0,000000 mol/s	-	£	Net production without investment	0,00 €	0,00
	Precipitation collector	0,00 €	0,00 m*	-		Consumed by P2G	0,00 €	-109.500,00
	Heat exchanger	625.000,00 €	12.500,00 kW	-		Net production with investment	0,00 €	109.500,00
	Gas compressor station	0,00 €	0,0000 kWe		(e 12	Produced by REP	0,00 €	0,00
	Total for processes	15.637.056,33 €		, I	륲륲	Consumed by IP	0,00 €	0,00
	Dry biomass storage	0,00 €	0,00 kg	-	Gas (m to/from	Net consumption without investment	0,00 €	0,00
	Wet biomass storage	20.833,33 €	8.333,33 kg	-		Produced by P2G	-20.935.031,25 €	-220.368,75
	Biochar storage	7.500,00 €	1.000,00 kg	-		Net consumption with investment	20.935.031,25 €	220.368,75
	Biogas storage	0,00 €	0,00 kg	-	Water	Water from the grid consumed by P2G	0,00 €	0,00
1962	Hydrogen storage tank	0,00 €	0,00 kg	-		Collected precipitation consumed by P2G	n/a €	0,00
Stor	Oxygen storage tank	0,00 €	0,00 kg	-	Input aterials	Dry biomass bought	0,00 €	0,00
	Methane storage tank	0,00 €	0,00 kg	-		Wet biomass bought	20.987,50 €	3.041,67
	Syngas storage tank	0,00 €	0,00 kg	-	- E	Biochar bought	0,00 €	0,00
	Carbon dioxide storage tank	0,00 €	0,00 kg	-		Total cost of input materials	20.987,50 €	
	Water storage tank	0,00 €	0,00 m		-	Hydrogen sold (in bottles)	0,00 €	0,00
	Total for storages	28.333,33 €		, I	les les	Oxygen sold (in bottles)	0,00 €	0,00
ment	Electrical connection	2.060.000,00 €	10,00 MW	-	vddh sa	Piecharceld	0,00 €	0,00
neci Mger	Gas connection	4.855.156,25 €	25,16 MW	-	~	Biochar sold	547.500,00 €	365,00
enli	water connection	0,00 €	0,00 m /h	J		notal revenue from additional sales	547,500,00 €	
	Total for connections	0.915.156,25 €	-			Residue from an aerobic digester	0,00 €	0,00
	rotar investment	22.380.343,91 €	-		anp	Residue from wet anaerooic digester	0,00 €	0,00
	кауоп репод	5,24 years	1		Sage 1	CO2 emitted	0,00 €	0,00
						Total cost of raciduar	2.108.100,00 €	45.562,00
				L		Total approximational cost without investment	2.165.100,00 €	-
						Total operational cost without investment	0,00 €	\neg
						Savings with introduction of DDC	-97.359.059,76 €	\neg
						Savings with Introduction of P2G	97.359.059,76 €	

M N O



Zero subsidy, five times the current price of gas

anub anuP	• Transnational Programme -2-Gas							
_								
Inves	tment specifications	for the	tion.	Ор	perat	ional costs for selected period	2 1	
	Element	Cost	Size			Produced by PEP	Cost	Amount
	Dry anaerobic digestor	0,00 €	0,00000 kg/s	- .	~	Produced by REP	0,00 €	0,00
	Wet anaerobic digestor	0,00 €	0,00000 kg/s	-	20	Consumed by IP	0,00 €	0,00
	Dry biomass to biochar plant	0,00 €	0,000000 kg/s	- -	aler	Net consumption without investment	0,00 €	0,00
	Combined best and newer (CHP)	24.112,05 €	0,096451 kg/s	- -	10	Consumed by P3C	110 025 579 51 5	87.447.03
	Combined heat and power (CHP)	50.000.000,00 €	10.000,00 kwe	- -	ě.	Consumed by P2G	-119.935.678,51 €	-87.447,92
ses	Carbon capture plant	0,00 €	0,00000 mol/s	-		Net consumption with investment	-119.955.678,51 €	-87.447,92
DCes	Gasincation + water gas shirt plant	0,00 €	0,000000 kg/s			Predward by DSD	0,00 €	0,00
Ри	Floctrohysor	0,00 €	0,00000 mol/s			Produced by REP	0,00 €	0,00
	Dominoralizor	0,00 €	0,00 KW		eat	Not production without investment	0,00 €	0,00
	Demineralizer	0,00 €	0,00000 mol/s	- :	Ť	Net production without investment	0,00 €	0,00
	Precipitation collector	0,00 €	0,00 m	-		Consumed by P2G	0,00 €	-109.500,00
	Heat exchanger	1.250.000,00 €	12.500,00 kW		-	Net production with investment	0,00 €	109.500,00
	Gas compressor station	0,00 €	0,0000 kwe	- I 🗑	Ë.	Produced by REP	0,00 €	0,00
	Total for processes	51.2/4.112,65 €	0.00 he	ר ∰	Ę	Consumed by IP	0,00 €	0,00
	Dry biomass storage	0,00 €	0,00 kg	- 5	to t	Net consumption without investment	0,00 €	0,00
	viet biomass storage	41.666,67 €	8.555,55 Kg	Water	Produced by P2G	-91.453.031,25	-220.368,75	
	Biochar storage	15.000,00 €	1.000,00 kg		Net consumption with investment	91.453.031,25	220.368,75	
	biogas storage	0,00 €	0,00 kg		water from the grid consumed by P2G	0,00 €	0,00	
1	Hydrogen storage tank	0,00 €	0,00 kg		Collected precipitation consumed by P2G	n/a •	0,00	
Stor	Oxygen storage tank	0,00 €	0,00 kg		Dry biomass bought	0,00 €	0,00	
	rvietnane storage tank	0,00 €	0,00 kg	- 1	Input	viet biomass bought	20.987,50 €	5.041,67
	Syngas storage tank	0,00 €	0,00 kg			Biochar bought	0,00 €	0,00
	Carbon dioxide storage tank	0,00 €	0,00 kg	-		Total cost of input materials	20.987,50 €	
	vvater storage tank	0,00 €	0,00 m	· _		Ryurogen sold (in bottles)	0,00 €	0,00
	Flortrical connection	2 060 000 00 C	10.00 1494	ן <u>פ</u>	8	Acthono cold (in bottles)	0,00 €	0,00
tion:	Cas connection	2.000.000,00 €	10,00 MW	- ip	8	Piochar cold	0,00 €	0,00
arget	Water connection	4.655.156,25 €	25,16 MW	- 1		Total revenue from additional cales	547.500,00 €	305,00
er C	Total for connections	6 015 156 25 F	0,00 m /h	-		Peridue from dou anaerobic director	547.500,00 €	
	Total investment	39 345 035 57 5	+		5	Pesidue from wet anaerobic digester	0,00 €	0,00
	Payoff pariod	56,245,955,57 C	-		in the second se	Tar from gasification + water gas shift alant	0,00 €	0,00
	Payon period	0,51 years]		Se la	CO2 emitted	2 168 100 00 6	43 363 00
						Total cost of residues	2.100.100,00 €	45.502,00
						Total operational cost without investment	2.108.100,00 €	-
						Total operational cost with investment	-26 841 050 75 6	-
						Savings with introduction of DDC	-2010411039,70 €	-
						savings with introduction of P2G	20.841.059,76 €	



Half subsidized, five times the current price of gas

nub	e Transnational Programme -2-Gas			RESU	JLTS		
nve	stment specifications			Oper	ational costs for selected period		
	Element	Cost	Size			Cost	Amount
	Dry anaerobic digestor	0,00 €	0,000000 kg/s		Produced by REP	0,00 €	0,00
	Wet anaerobic digestor	0,00 €	0,000000 kg/s	è	Consumed by IP	0,00 €	0,00
	Dry biomass to biochar plant	0,00 €	0,000000 kg/s		Net consumption without investment	0,00 €	0,00
	Wet biomass to biochar plant	12.056,33 €	0,096451 kg/s		Mean peak power without investment	0,00 €	0,00
	Combined heat and power (CHP)	15.000.000,00 €	10.000,00 kWe	ectr	Consumed by P2G	-119.935.678,51 €	-87.447,92
5	Carbon capture plant	0,00 €	0,000000 mol/s		Net consumption with investment	-119.935.678,51 €	-87.447,97
cesse	Gasification + water gas shift plant	0,00 €	0,000000 kg/s		Mean peak power with investment	0,00 €	0,00
Proc	Methanation reactor	0,00 €	0,000000 mol/s		Produced by REP	0,00 €	0,00
	Electrolyser	0,00 €	0,00 kW		Produced by IP	0,00 €	0,00
	Demineralizer	0,00 €	0,000000 mol/s	. 2	Net production without investment	0,00 €	0,00
	Precipitation collector	0,00 €	0,00 m ²		Consumed by P2G	0,00 €	-109.500,00
	Heat exchanger	625.000,00 €	12.500,00 kW		Net production with investment	0,00 €	109.500,00
	Gas compressor station	0,00 €	0,0000 kWe		Produced by REP	0,00 €	0,00
	Total for processes	15.637.056,33 €		. <u>Ē</u>	Consumed by IP	0,00 €	0,00
	Dry biomass storage	0,00 €	0,00 kg	. 18	Net consumption without investment	0,00 €	0,00
	Wet biomass storage	20.833,33 €	8.333,33 kg	se +5	Produced by P2G	-91.453.031,25 €	-220.368,75
	Biochar storage	7.500,00 €	1.000,00 kg	40	Net consumption with investment	91.453.031,25 €	220.368,75
	Biogas storage	0,00 €	0,00 kg	Wate	Water from the grid consumed by P2G	0,00 €	0,00
55	Hydrogen storage tank	0,00 €	0,00 kg		Collected precipitation consumed by P2G	n/a €	0,00
tora	Oxygen storage tank	0,00 €	0,00 kg	م	Dry biomass bought	0,00 €	0,00
\$	Methane storage tank	0,00 €	0,00 kg		Wet biomass bought	20.987,50 €	3.041,67
	Syngas storage tank	0,00 €	0,00 kg	. <u> </u>	Biochar bought	0,00 €	0,00
	Carbon dioxide storage tank	0,00 €	0,00 kg		Total cost of input materials	20.987,50 €	
	Water storage tank	0,00 €	0,00 m ³		Hydrogen sold (in bottles)	0,00 €	0,00
	Total for storages	28.333,33 €		, Ē,	Oxygen sold (in bottles)	0,00 €	0,00
ent	Electrical connection	2.050.000,00 €	10,00 MW	sa ditio	Methane sold (in bottles)	0,00 €	0,00
ection Series	Gas connection	4.855.156,25 €	25,16 MW	. P	Biochar sold	547.500,00 €	365,00
in lan	Water connection	0,00 €	0,00 m ³ /h		Total revenue from additional sales	547.500,00 €	
0.0	Total for connections	6.915.156,25 €			Residue from dry anaerobic digester	0,00 €	0,00
	Total investment	22.580.545,91 €		5	Residue from wet anaerobic digester	0,00 €	0,00
	Payoff period	5,89 years		22	Tar from gasification + water gas shift plant	0,00 €	0,00
				č –	CO2 emitted	2.168.100,00 €	43.362,00
					Total cost of residues	2.168.100,00 €	_
					Total operational cost without investment	0,00 €	_
					Total operational cost with investment	-26.841.059,76 €	
					Savings with introduction of P2G	26.841.059,76 €	



Zero subsidy, ten times the current price of gas

Luvest Unvest V V V V V V V V V V V V V V V V V V V	tment specifications Element Dry anaerobic digestor Wet anaerobic digestor Dry biomass to biochar plant Wet biomass to biochar plant Combined heat and power (CHP) Carbon capture plant Gasification + water gas shift plant Methanation reactor	Cost 0,00 € 0,00 € 0,00 € 0,00 € 24.112,65 € 0,00 € 0,00 €	Size 0,000000 0,000000 0,000000	kg/s	Opera	tional costs for selected period	Cost	Amount	
Loccesses D D D D D D D D D D D D D D D D D	tment specifications Element Dry anaerobic digestor Wet anaerobic digestor Dry biomass to biochar plant Wet biomass to biochar plant Combined heat and power (CHP) Carbon capture plant Gasification + water gas shift plant Methanation reactor	Cost 0,00 € 0,00 € 0,00 € 24.112,65 € 0,00 €	Size 0,000000 0,000000 0,000000	kg/s	Opera	tional costs for selected period	Cost	Amount	
Luccesses Lucces	tment specifications Element Dry anaerobic digestor Wet anaerobic digestor Dry biomass to biochar plant Wet biomass to biochar plant Combined heat and power (CHP) Carbon capture plant Gasification + water gas shift plant Methanation reactor	Cost 0,00 € 0,00 € 0,00 € 24.112,65 € 0,00 €	Size 0,000000 0,000000 0,000000	kg/s	Opera	tional costs for selected period	Cost	Amount	
Processes Processes	Element Dry anaerobic digestor Wet anaerobic digestor Dry biomass to biochar plant Wet biomass to biochar plant Combined heat and power (CHP) Carbon capture plant Gasification + water gas shift plant Methanation reactor	Cost 0,00 € 0,00 € 0,00 € 0,00 € 24.112,65 € 0,000 € 0,00 €	Size 0,000000 0,000000 0,000000	kg/s			Cost	Amount	
Processes	Dry anaerobic digestor Wet anaerobic digestor Dry biomass to biochar plant Wet biomass to biochar plant Combined heat and power (CHP) Carbon capture plant Gasification + water gas shift plant Methanation reactor	0,00 € 0,00 € 24.112,65 € 0,00 €	0,000000 0,000000 0,000000	kg/s				Amount	_
Processes	Wet anaerobic digestor Dry biomass to biochar plant Wet biomass to biochar plant Combined heat and power (CHP) Carbon capture plant Gasification + water gas shift plant Methanation reactor	0,00 € 0,00 € 24.112,65 € 0,00 €	0,000000 0,000000	kg/s	- 1	Produced by REP	0,00 €	0,00	M
Processes	Dry biomass to biochar plant Wet biomass to biochar plant Combined heat and power (CHP) Carbon capture plant Gasification + water gas shift plant Methanation reactor	0,00 € 24.112,65 € 0,00 €	0,000000		- ê	Consumed by IP	0,00 €	0,00	M
Processes	Wet biomass to biochar plant Combined heat and power (CHP) Carbon capture plant Gasification + water gas shift plant Methanation reactor	24.112,65 € 0,00 €		kg/s	. 8	Net consumption without investment	0,00 €	0,00	M
Processes	Combined heat and power (CHP) Carbon capture plant Gasification + water gas shift plant Methanation reactor	0,00 €	0,096451	kg/s		Mean peak power without investment	0,00 €	0,00	M
Processes	Carbon capture plant Gasification + water gas shift plant Methanation reactor	0.00 €	0,00	kWe		Consumed by P2G	255.536,86 €	152,08	M
Process D	Gasification + water gas shift plant Methanation reactor	0,00 €	0,000000	mol/s		Net consumption with investment	255.536,86 €	152,08	M
Ë E	Methanation reactor	0,00 €	0,000000	kg/s		Mean peak power with investment	312,50 €	0,02	M
E		0,00 €	0,000000	mol/s	-	Produced by REP	0,00 €	0,00	M
0	Electrolyser	0,00 €	0,00	kW	- <u>+</u>	Produced by IP	0,00 €	0,00	M
	Demineralizer	0,00 €	0,000000	mol/s	_ <u> </u>	Net production without investment	0,00 €	0,00	M
P	Precipitation collector	0,00 €	0,00	m²		Consumed by P2G	0,00 €	0,00	M
H	Heat exchanger	0,00 €	0,00	kW		Net production with investment	0,00 €	0,00	M
G	Gas compressor station	0,00 €	0,0000	kWe		Produced by REP	0,00 €	0,00	M
Т	Total for processes	24.112,65 €			- 155	Consumed by IP	0,00 €	0,00	M
0	Dry biomass storage	0,00 €	0,00	kg	. <u> </u>	Net consumption without investment	0,00 €	0,00	M
۷	Wet biomass storage	41.666,67 €	8.333,33	kg	j se f	Produced by P2G	0,00 €	0,00	M
8	Biochar storage	15.000,00 €	1.000,00	kg		Net consumption with investment	0,00 €	0,00	M
8	Biogas storage	0,00 €	0,00	kg	Water	Water from the grid consumed by P2G	0,00 €	0,00	m
- 18 H	Hydrogen storage tank	0,00 €	0,00	kg		Collected precipitation consumed by P2G	n/a €	0,00	m
dora o	Oxygen storage tank	0,00 €	0,00	kg	<u> </u>	Dry biomass bought	0,00 €	0,00	t
~ N	Methane storage tank	0,00 €	0,00	kg	te de la	Wet biomass bought	20.987,50 €	3.041,67	t
S	Syngas storage tank	0,00 €	0,00	kg	. 1	Biochar bought	0,00 €	0,00	t
c	Carbon dioxide storage tank	0,00 €	0,00	kg		Total cost of input materials	20.987,50 €		_
۷	Water storage tank	0,00 €	0,00	m ³		Hydrogen sold (in bottles)	0,00 €	0,00	t
T	Total for storages	56.666,67 €			- 18.	Oxygen sold (in bottles)	0,00 €	0,00	t
e ut	Electrical connection	3.576,39 €	0,02	MW	sa diti	Methane sold (in bottles)	0,00 €	0,00	t
a de Cri	Gas connection	0,00 €	0,00	MW	× ×	Biochar sold	547.500,00 €	365,00	t
n la N	Water connection	0,00 €	0,00	m³/h		Total revenue from additional sales	547.500,00 €		_
ŤŤ	Total for connections	3.576,39 €				Residue from dry anaerobic digester	0,00 €	0,00	t
Т	Total investment	84.355,71 €			a a	Residue from wet anaerobic digester	0,00 €	0,00	t
P	Payoff period	5,32 years			es i	Tar from gasification + water gas shift plant	0,00 €	0,00	t
					~	CO2 emitted	0,00 €	0,00	t
						Total cost of residues	0,00 €	4	
						Total operational cost without investment	0,00 €	_	
						Total operational cost with investment	-270.663,14 €	_	
						Savings with introduction of P2G	270.663,14 €		



Half subsidized, ten times the current gas price

anub anuP	e Transnational Programme			RESU	ILTS			
Inve	stment specifications			Oper	ational costs for selected period			
	Element	Cost	Size			Cost	Amount	
	Dry anaerobic digestor	0,00 €	0,000000 kg/s		Produced by REP	0,00 €	0,00	M
	Wet anaerobic digestor	0,00 €	0,000000 kg/s	è	Consumed by IP	0,00 €	0,00	M
	Dry biomass to biochar plant	0,00 €	0,000000 kg/s		Net consumption without investment	0,00 €	0,00	M
	Wet biomass to biochar plant	0,00 €	0,000000 kg/s		Mean peak power without investment	0,00 €	0,00	M
	Combined heat and power (CHP)	0,00 €	0,00 kWe	Ect.	Consumed by P2G	0,00 €	0,00	M
22	Carbon capture plant	0,00 €	0,000000 mol/s		Net consumption with investment	0,00 €	0,00	M
esse	Gasification + water gas shift plant	0,00 €	0,000000 kg/s		Mean peak power with investment	0,00 €	0,00	M
Proc	Methanation reactor	0,00 €	0,000000 mol/s		Produced by REP	0,00 €	0,00	м
	Electrolyser	0,00 €	0,00 kW		Produced by IP	0,00 €	0,00	M
	Demineralizer	0,00 €	0,000000 mol/s	Ea T	Net production without investment	0,00 €	0,00	м
	Precipitation collector	0,00 €	0,00 m ²		Consumed by P2G	0,00 €	0,00	м
	Heat exchanger	0,00 €	0,00 kW		Net production with investment	0,00 €	0,00	м
	Gas compressor station	0,00 €	0,0000 kWe	<u>କ</u> ଅ	Produced by REP	0,00 €	0,00	м
	Total for processes	0,00 €		 	Consumed by IP	0,00 €	0,00	м
	Dry biomass storage	0,00 €	0,00 kg	i i i i	Net consumption without investment	0,00 €	0,00	м
	Wet biomass storage	0,00 €	0,00 kg		Produced by P2G	0,00 €	0,00	м
	Biochar storage	0,00 €	0,00 kg	<u>6</u>	Net consumption with investment	0,00 €	0,00	м
	Biogas storage	0,00 €	0,00 kg		Water from the grid consumed by P2G	0,00 €	0,00	m
23	Hydrogen storage tank	0,00 €	0,00 kg	vvate	Collected precipitation consumed by P2G	n/a €	0,00	m
a de la como	Oxygen storage tank	0,00 €	0,00 kg		Dry biomass bought	0,00 €	0,00	t
ŝ	Methane storage tank	0,00 €	0,00 kg	t i	Wet biomass bought	0,00 €	0,00	t
	Syngas storage tank	0,00 €	0,00 kg	- 58	Biochar bought	0.00 €	0,00	t
	Carbon dioxide storage tank	0,00 €	0.00 kg	- 5	Total cost of input materials	0.00 €		-
	Water storage tank	0.00 €	0.00 m ³		Hydrogen sold (in bottles)	0.00 €	0.00	t
	Total for storages	0.00 €	· · · · ·		Oxygen sold (in bottles)	0.00 €	0.00	t
a t	Electrical connection	0,00 €	0,00 MW	als itic	Methane sold (in bottles)	0.00 €	0.00	t
tmer.	Gas connection	0.00 €	0,00 MW	- Pp 8	Biochar sold	0.00 €	0.00	t
Iange	Water connection	0.00 €	0.00 m ³ /h	- 1	Total revenue from additional sales	0.00 €		-
8 5	Total for connections	0.00 €	-/ / /		Residue from dry anaerobic digester	0.00 €	0.00	t
	Total investment	0.00 €		2	Residue from wet anaerobic digester	0.00 €	0.00	t
	Pavoff period	n/a vears		100	Tar from gasification + water gas shift plant	0.00 €	0.00	t
		July Pours		2	CO2 emitted	0.00 €	0.00	t
					Total cost of residues	0.00 €		·-
				L	Total operational cost without investment	0.00 €	-	
					Total operational cost with investment	0.00 €	-	
					Savings with introduction of P2G	0.00 €	-	
					sounds and an operation of the	0,00 €		



4. CONCLUSIONS

The results of the feasibility study showed us that usually the most ideal location for a P2G hub is a potential industrial facility or in some cases REP, as its operation can ensure a reduction in emissions and thus its sustainability. The expansion of industrial facilities and their transformation into P-2-G hubs can further help to reduce the demand for energy in the areas of industrial hubs and, consequently, to reduce their dependence on external networks of energy sources. In addition to the above-mentioned advantages, such hubs would help to meet the large energy self-sufficient needs of companies or Industrial Plants. Furthermore, the commercial consumption of the biogas would be also possible on these sites, given the production potential of the electrolysers of such facilities, which could help create hydrogen points. While this could result in some concentration of technology in the country, it could also create more power generation centres than currently exist, thus helping the already ongoing decarbonisation process.

The results also showed us that the establishing of P-2-G hub by the existing renewable energy plants does not always make sense. E.g., - The simultaneous construction of a P-2-G hub on the existing location of the SE PRAPRETNO photovoltaic power plant makes sense, perhaps only for the production of hydrogen with the help of an electrolyser, since the full utilization of this already existing location could be represented by the use of excess electricity (produced on a sunny day at the time, when the el. consumption in households is low) for the purpose of hydrogen production. The results also showed that implementing a P-2-G hub as an on-field project is feasible and economical, but its location is nevertheless very important. It is certainly important that both the IP, the REP and the potential on-filed P-2-G hub are located close to the electricity transmission grid and the natural gas transmission grid, close to transport hubs, primary biomass sources and other resources that are important for the smoothest possible operation of the P-2-G hub.