

The supplementary material consists of:

- Part A: Data on feedstocks, products, technologies and transportation costs
- Part B: Data on the locations of supply zones, plant sites and end users

Part A: Data on feedstocks, products, technologies and transportation costs

Table S1. Dry matter content of the feedstocks [1]

Feedstock	Dry matter content (%)
Corn silage	33
Cattle manure	10
Sunflower cake	92
Whey	5.5

Table S2. Biogas yield from different substrates [1]

Substrate	Biogas yield (m ³ /t of substrate)
Corn silage	200 [2]
Cattle manure	30
Sunflower cake	620
Whey	40
Liquid digestate	15

Table S3. Methane content in biogas from different substrates [1]

Substrate	Methane content (vol. %)
Corn silage	52.5
Cattle manure	55
Sunflower cake	60
Whey	60
Liquid digestate	60

Table S4. Conversion factors for CHP

Product	Electricity	Heat
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	(kWh/y)/m ³	(kWh/y)/m ³
Methane (m ³)	$0.38 \times \text{LHV}_{\text{methane}}$	$0.45 \times \text{LHV}_{\text{methane}}$

LHV_{methane} – lower heating value of methane, 8.58 kWh/m³ [3]

Table S5. Data for estimating the capital costs of technologies

Technology	“Known” investment (M\$)	“Known” capacity	Capacity exponent
Anaerobic digestion [1]	2.896	$3.7 \times 10^6 \text{ m}^3/\text{y}$	0.6
CHP [1]	1.333	8.19 GWh/y	0.6
Press (dewatering) [1]	0.479	50,000 t/y	0.3938
HTC* [4]	8.21	40,000 t/y	0.7368

* Reactor, filtration and drying unit included

Table S6. Assumed fixed and variable transportation costs of feedstocks and products

Feedstock or product	Road		Pipeline		Transmission lines	
	Fixed (\$/t)	Variable (\$/(t·km))	Fixed (\$/(km·y))	Variable (\$/(t·km) or \$/(GWh·km) or \$/(m ³ ·km))	Fixed \$/(km·y)	Variable \$/(GWh·km)
Corn silage	0.69	0.0074	/	/	/	/

Cattle manure	0.418	0.0332	29200	0.0125	/	/
Sunflower cake	0.270	0.0258	/	/	/	/
Whey	0.418	0.0332	29200	0.0125	/	/
Biogas	/	/	0	0.00002	/	/
Digestate	0.418	0.0332	29200	0.9	/	/
Solid digestate	0.418	0.0332	/	/	/	/
Hydrochar	0.418	0.0332	/	/	/	/
Electricity	/	/	/	/	0	0
Heat	/	/	29200	12.5	/	/

Table S7. Cost of feedstocks

Feedstock	Cost of feedstocks (\$/t)
Corn silage	45 [1]
Cattle manure	0
Sunflower cake	0
Whey	0
Water	1.09 [5]

Table S8. Selling price for products

Product	Selling price (\$/t) or M\$ per GWh)
Electricity	0.155 [6]
Heat	0.077 [7]
Digestate	4.86 [8]
Solid digestate	11.77 [9]
Hydrochar	150.00 [10]

PART B. Data related to the locations of the supply zones, plant sites and end consumers

Table S9. Latitudes and longitudes of the edge and center of supply zones i at L1 and total area of each zone [11].

Zone	Latitude of the edge of the zone	Longitude of the edge of the zone	Latitude of the centre of the zone	Longitude of the centre of the zone	Area (km ²)
i_1	46.278723	14.440201	46.204328	14.504943	288.59
i_2	46.115243	14.441555	46.044513	14.583004	297.55
i_3	46.417470	14.627610	46.380438	14.706136	186.50
i_4	46.212520	14.867391	46.247195	14.631872	266.00

<i>i</i> 5	46.081274	14.677782	46.133838	14.755117	169.00
<i>i</i> 6	45.996954	14.854102	46.044158	14.883628	316.00
<i>i</i> 7	45.876541	14.730041	45.947963	14.747207	315.60
<i>i</i> 8	46.528951	14.980958	46.416178	14.837528	196.00
<i>i</i> 9	46.296145	14.713048	46.296004	14.861663	164.00
<i>i</i> 10	46.102444	14.939946	46.189400	14.964223	205.60
<i>i</i> 11	45.844300	15.030602	45.887798	14.998348	234.20
<i>i</i> 12	46.300446	14.969045	46.393590	14.992861	168.00
<i>i</i> 13	46.440096	15.264793	46.460591	15.102052	143.00
<i>i</i> 14	46.369103	15.400881	46.344396	15.310806	136.00
<i>i</i> 15	46.272756	15.100813	46.255192	15.212393	212.00
<i>i</i> 16	46.365355	15.263600	46.360972	15.156655	116.00
<i>i</i> 17	46.191555	15.106642	46.258556	15.066330	130.00
<i>i</i> 18	46.118190	15.463213	46.209500	15.424074	218.00
<i>i</i> 19	46.223213	15.357537	46.136017	15.280878	288.40
<i>i</i> 20	45.887851	15.278401	46.004232	15.293820	343.40
<i>i</i> 21	46.004392	15.036572	45.946191	15.130386	174.40
<i>i</i> 22	46.035086	15.208965	46.115235	15.087348	198.40

Table S10. Latitudes and longitudes of demand locations j at L3 [11].

Zone	Latitude of the edge of the zone	Longitude of the edge of the zone
$j1$	46.139806	14.596392
$j2$	46.087556	14.486735
$j3$	46.355052	14.743349
$j4$	46.219817	14.612096
$j5$	46.170881	14.692117
$j6$	46.064797	14.820448
$j7$	45.961827	14.656652
$j8$	46.340941	14.834894
$j9$	46.319905	14.947487
$j10$	46.138195	14.993708
$j11$	45.912653	15.017591
$j12$	46.377135	15.046195
$j13$	46.499461	15.076980
$j14$	46.286328	15.306822
$j15$	46.247535	15.261911
$j16$	46.365271	15.103618
$j17$	46.279297	15.072654
$j18$	46.333887	15.428178
$j19$	46.162200	15.226344
$j20$	46.012661	15.468724
$j21$	45.892702	15.243741
$j22$	46.147897	15.046304

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Table S11. Latitudes and longitudes of the plant locations n at L2 [11].

Zone	Latitude of the edge of the zone	Longitude of the edge of the zone
$n1$	46.184917	14.946764
$n2$	46.113375	14.538541
$n3$	46.267055	15.284552
$n4$	46.425737	15.080502
$n5$	45.894795	15.093485

References

1. Egieya, J.M.; Čuček, L.; Zirngast, K.; Isafiade, A.J.; Pahor, B.; Kravanja, Z. Synthesis of biogas supply networks using various biomass and manure types. *Computers & Chemical Engineering* **2019**, *122*, 129–151.
2. Kucher, O.; Hutsol, T.; Glowacki, S.; Andreitseva, I.; Dibrova, A.; Muzychenko, A.; Szeląg-Sikora, A.; Szparaga, A.; Kocira, S. Energy potential of biogas production in Ukraine. *Energies* **2022**, *15*, 1710.
3. The Engineering ToolBox. Fuels - Higher and Lower Calorific Values. Available online: https://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html (accessed on 22 July 2024).
4. Akbari, M.; Oyedun, A.O.; Kumar, A. Comparative energy and techno-economic analyses of two different configurations for hydrothermal carbonization of yard waste. *Bioresource Technology Reports* **2019**, *7*, 100210.
5. MARIBORSKI VODOVOD, javno podjetje., d.o.o. Available online: <https://www.mb-vodovod.si/uporabniki/obracun-vode/obracun-in-cena-pitne-vode/cenik-vode/> (accessed on 12 July 2024).
6. BSP Energy Exchange LLC. Available online: <https://www.bsp-southpool.com/day-ahead-trading-results-si.html> (accessed on 14 August 2024).
7. Energetika Ljubljana. Available online: <https://www.energetika.si/ceniki/cenik-plin> (accessed on 14 August 2024).
8. Lamolinara, B.; Pérez-Martínez, A.; Guardado-Yordi, E.; Fiallos, C.G.; Diéguez-Santana, K.; Ruiz-Mercado, G.J. Anaerobic digestate management, environmental impacts, and techno-economic challenges. *Waste Management* **2022**, *140*, 14–30.
9. Jurgutis, L.; Šlepetienė, A.; Šlepetys, J.; Cesevičienė, J. Towards a full circular economy in biogas plants: Sustainable management of digestate for growing biomass feedstocks and use as biofertilizer. *Energies* **2021**, *14*, 4272.
10. Saba, A.; McGaughy, K.; Reza, M.T. Techno-economic assessment of co-hydrothermal carbonization of a coal-Miscanthus blend. *Energies* **2019**, *12*, 630.
11. Google Maps. Available online: maps.google.com (accessed on 6 June 2024).