Feasibility of CO_2 conversion to methanol: the case of upgrading a municipal solid waste (MSW) power plant

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The present work explores the economic feasibility of methanol production from the fluent gases of a MSW mass combustion plant for electricity generation. The overall methodology involves the comparison of the economic performance of the MSW-to-methanol integrated plant with that of the initial MSW-to-electricity installation, which was studied elsewhere [1]. The flow-diagram of the integrated MSW-to-MeOH plant and its main capacity features is depicted in Fig. 1. The integrated plant consists of the initial MSW-to-power plant and the operationally conjoined MeOH synthesis one. The power plant refers to a commercial technology applied for the MSW capacity (400 ktn/yr) of Eastern Macedonia & Thrace region, the composition of which were recently studied [2].

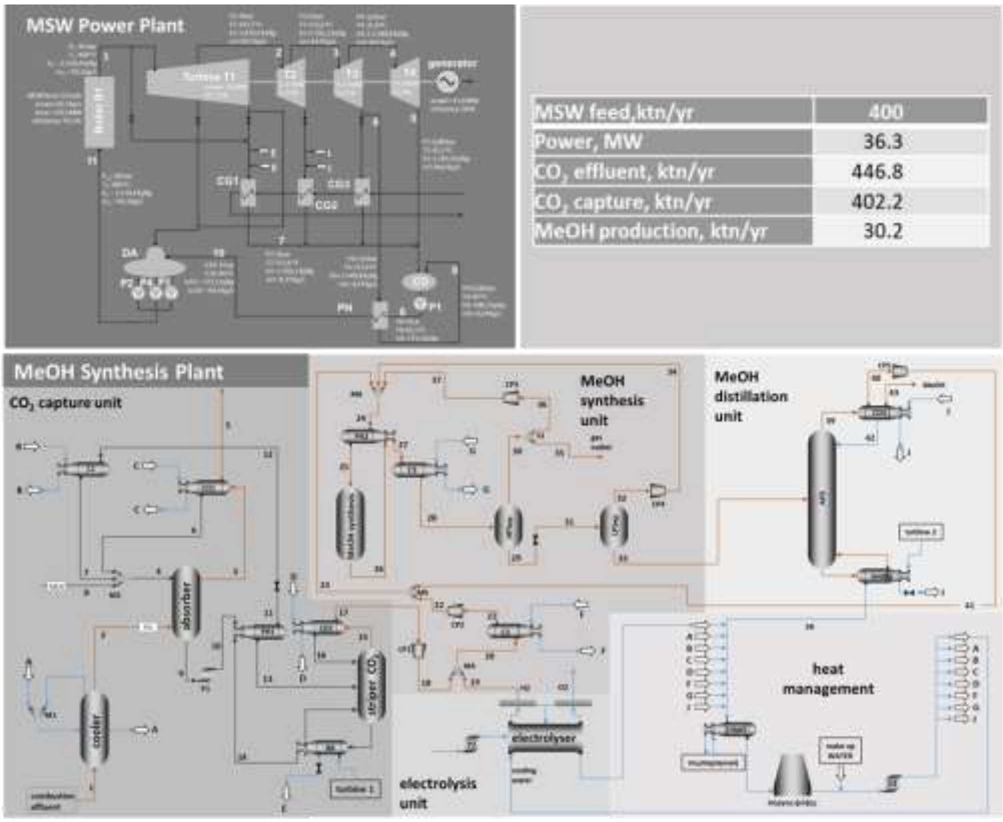

Figure 1. The integrated MSW-to-MeOH plant and its main operational characteristics.

Table 1. Capital (M€) and operational (M€/yr) costs of the integrated MSW-to-MeOH plant.

	CAPEX	OPEX		CAPEX	OPEX
Power Plant	197,80	7,62	**MeOH synthesis**	19,91	7,23
Electrolysis	5,65	0,09	**MeOH distilation**	3,16	
CO_2 capture	6,09		**total**	**232,61**	**14,94**

The power available for electrolysis is 32.6 MW and generates H_2, which is sufficient for the 90 % of the effluent CO_2. CO_2 is captured by mono-ethanolamine (MEA) [3]. The electrolyzer consumes 4,50 kWh/m^3 H_2 [4], and a CO_2/H_2 = 3.28 mixture is fed to the MeOH synthesis reactor. After consecutive separations and recycling, the overall CO_2/H_2 conversions were almost 100 % [5]. The initial capital (CAPEX) and annual operating (expenditure OPEX) costs were calculated according to literature [6-8].

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The corresponding CAPEXs and OPEXs for each sub-system are shown in Table 1.

The feasibility assessment was based on the comparison of MSW-to-MeOH financial perspectives to those of the MSW-to-Power plant [1], regarding MSW gate-fees between 50 and 110 €/tn. Figure 2 shows the variation of payout time (POT) on earnings before taxes and depreciation (EBTD) and on net profits (NP), with or without the subsidization for renewable electricity installations.

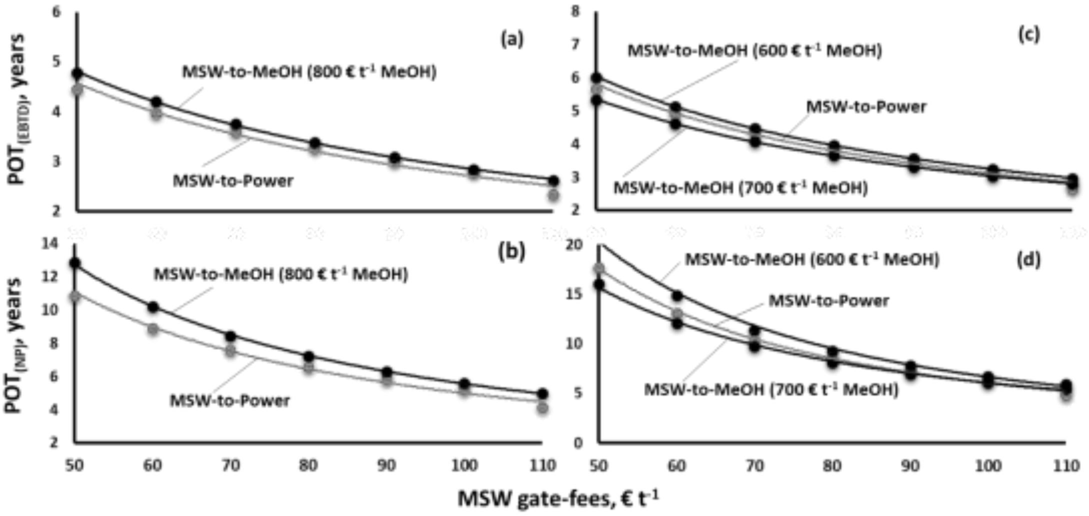

Figure2. POT for selected methanol ex-factory prices, with (a and b) and without renewable electricity subsidization (c and d) - grey curves refer to the MSW-to-Power plant.

Figure 2 shows that for subsidized renewable electricity (a and b) the feasibility of MSW-to-MeOH becomes comparable to the MSW-to-Power, for MeOH price at 800 €/tn. For this price, the POT drops to 3 years on EBTD and to 6 years on NP, for 90 €/tn gate-fees. Taking the subsidization of renewable electricity out of the account the feasibility of MSW-to-MeOH becomes comparable to MSW-to-power for 650 €/tn MeOH price. This price corresponds to 45 €/MWh of methanol's heating value, which is lower compared to oil (52 – 96 €/MWh, in the last decade, not taking into account distillation margins). Thus, methanol from MSW can be a competitive fuel, provided its subsidization through MSW treatment gate-fees as well as the subsidization of its renewability accordingly to the current subsidization of the renewable energy fraction from MSW-to-power plants.

Acknowledgments

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