

<b>TOWEFO</b> Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 1	of 8
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**ANNEX 8**  
**MODULES OF WASTEWATER TREATMENT**

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## 1 Wastewater Treatment Plant

<b>Name</b>	Wastewater treatment
<b>Reference year</b>	2000
<b>Geographic reference</b>	Italy
<b>Technological level</b>	modern
<b>Reference flow</b>	1000 lit of wastewater
<b>Equipment</b>	Physical-chemical-biological treatment plant operating mode: continuous processed waste water (m <sup>3</sup> /yr): 8,87E+06 electricity consumption (kWh/yr): 8,06E+06

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	(r) Coal (in ground)	kg	5,80E-02
	(r) Iron (Fe, ore)	kg	4,94E-04
	(r) Natural Gas (in ground)	kg	6,14E-02
	(r) Oil (in ground)	kg	1,64E-01
	(r) Uranium (U, ore)	kg	5,46E-09
	Wastewater	l	1,00E+03
	Water: Unspecified Origin	l	9,17E+00
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	2,00E-02
	(a) Arsenic (As)	g	9,75E-05
	(a) Benzene (C6H6)	g	2,86E-03
	(a) Butane (n-C4H10)	g	2,64E-02
	(a) Cadmium (Cd)	g	1,99E-04
	(a) Carbon Dioxide (CO2, fossil)	g	7,75E+02
	(a) Carbon Monoxide (CO)	g	3,88E-01
	(a) Ethane (C2H6)	g	2,12E-01
	(a) Ethylene (C2H4)	g	3,37E-02
	(a) Hydrocarbons (except methane)	g	1,18E+00
	(a) Hydrocarbons (unspecified)	g	6,34E-04
	(a) Hydrogen Chloride (HCl)	g	5,60E-02
	(a) Lead (Pb)	g	4,24E-04
	(a) Manganese (Mn)	g	3,44E-05
	(a) Methane (CH4)	g	5,66E+00
	(a) Nickel (Ni)	g	3,92E-03
	(a) Nitrogen Oxides (NOx as NO2)	g	1,71E+00
	(a) Nitrous Oxide (N2O)	g	1,46E-02
	(a) Propane (C3H8)	g	5,36E-02
	(a) Sulphur Oxides (SOx as SO2)	g	7,73E+00
	(a) Toluene (C6H5CH3)	g	2,59E-03
	(a) Vanadium (V)	g	1,57E-02
	(s) Arsenic (As)	g	4,87E-07
	(s) Chromium (Cr III, Cr VI)	g	6,10E-06
	(s) Zinc (Zn)	g	1,83E-05
	(w) Ammonia (NH4+, NH3, as N)	g	6,77E+00
	(w) Benzene (C6H6)	g	2,11E-03
	(w) Cadmium (Cd++)	g	5,94E-06
	(w) Chromium (Cr III)	g	1,28E-05
	(w) Chromium (Cr III, Cr VI)	g	3,90E-05
	(w) COD (Chemical Oxygen Demand)	g	5,85E+01
	(w) Nitrate (NO3-)	g	8,89E+00
	(w) Nitrogenous Matter (unspecified, as N)	g	1,58E+01
	(w) Oils (unspecified)	g	1,46E-02
<b>REMINDERS</b>	E Feedstock Energy	MJ	5,14E-01
	E Fuel Energy	MJ	1,06E+01
	E Non Renewable Energy	MJ	1,03E+01
	E Renewable Energy	MJ	8,81E-01
	E Total Primary Energy	MJ	1,12E+01
	Electricity	MJ elec	6,93E+00

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## 2 Ultra Filtration + Nano Filtration

<b>Name</b>	Ultra-Filtration+Nano-Filtration
<b>Geographic reference</b>	Italy
<b>Technological level</b>	modern
<b>Reference flow</b>	1000 lit of recycled water
<b>Equipment</b>	Membrane system absorbed power (kWh/m3)(nano-filtration): 1,36 absorbed power (kWh/m3)(ultra-filtration): 0,52

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	Flow	Units	Value
<b>INPUT</b>	(r) Coal (in ground)	kg	1,37E-01
	(r) Natural Gas (in ground)	kg	1,45E-01
	(r) Oil (in ground)	kg	3,69E-01
	Water: Unspecified Origin	litre	1,83E+00
	In Let Water	litre	1,23E+03
<b>OUTPUT</b>	(a) Alkane (unspecified)	g	4,69E-02
	(a) Arsenic (As)	g	2,31E-04
	(a) Benzene (C6H6)	g	6,61E-03
	(a) Butane (n-C4H10)	g	6,12E-02
	(a) Cadmium (Cd)	g	4,71E-04
	(a) Carbon Dioxide (CO2, fossil)	g	1,77E+03
	(a) Ethane (C2H6)	g	4,98E-01
	(a) Ethanol (C2H5OH)	g	4,06E-03
	(a) Ethylene (C2H4)	g	7,96E-02
	(a) Formaldehyde (CH2O)	g	6,82E-03
	(a) Heptane (C7H16)	g	6,62E-03
	(a) Hexane (C6H14)	g	1,32E-02
	(a) Hydrocarbons (except methane)	g	2,55E+00
	(a) Methane (CH4)	g	1,33E+01
	(a) Nickel (Ni)	g	9,28E-03
	(a) Nitrogen Oxides (NOx as NO2)	g	3,28E+00
	(a) Nitrous Oxide (N2O)	g	2,61E-02
	(a) Propane (C3H8)	g	1,25E-01
	(a) Propylene (CH2CHCH3)	g	2,75E-03
	(a) Sulphur Oxides (SOx as SO2)	g	1,82E+01
	(a) Vanadium (V)	g	3,70E-02
	(s) Arsenic (As)	g	1,15E-06
	(s) Chromium (Cr III, Cr VI)	g	1,44E-05
	(s) Zinc (Zn)	g	4,33E-05
	(w) Ammonia (NH4+, NH3, as N)	g	1,60E-02
	(w) Benzene (C6H6)	g	4,74E-03
	(w) Cadmium (Cd++)	g	1,27E-05
	(w) Chromium (Cr III)	g	3,02E-05
	(w) Chromium (Cr III, Cr VI)	g	8,75E-05
	(w) Nitrogenous Matter (unspecified, as N)	g	2,03E-02
	(w) Oils (unspecified)	g	3,29E-02
		Wastewater	litre
	Recycled water	litre	1,00E+03
<b>REMINDERS</b>	E Feedstock Energy	MJ	1,20E+00
	E Fuel Energy	MJ	2,44E+01
	E Non Renewable Energy	MJ	2,35E+01
	E Renewable Energy	MJ	2,09E+00
	E Total Primary Energy	MJ	2,56E+01
	Electricity	MJ elec	8,66E+00

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### 3 Reverse osmosis + Ultra Filtration

<b>Name</b>	Reverse osmosis+Ultra-Filtration
<b>Geographic reference</b>	Italy
<b>Technological level</b>	modern
<b>Reference flow</b>	1000 lit of recycled water
<b>Equipment</b>	Membrane system absorbed power (kWh/m3)(reverse-osmosis) 2,18 absorbed power (kWh/m3)(ultra-filtration): 0,52

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	<i>Flow</i>	<i>Units</i>	<i>Value</i>	
<b>INPUT</b>	(r) Coal (in ground)	kg	1,95E-01	
	(r) Natural Gas (in ground)	kg	2,06E-01	
	(r) Oil (in ground)	kg	5,25E-01	
	In Let Water	litre	1,23E+03	
	Water: Unspecified Origin	litre	2,60E+00	
<b>OUTPUT</b>	(a) Alkane (unspecified)	g	6,67E-02	
	(a) Arsenic (As)	g	3,28E-04	
	(a) Butane (n-C4H10)	g	8,70E-02	
	(a) Cadmium (Cd)	g	6,71E-04	
	(a) Carbon Dioxide (CO2, fossil)	g	2,52E+03	
	(a) Ethane (C2H6)	g	7,09E-01	
	(a) Ethylene (C2H4)	g	1,13E-01	
	(a) Formaldehyde (CH2O)	g	9,70E-03	
	(a) Heptane (C7H16)	g	9,42E-03	
	(a) Hexane (C6H14)	g	1,88E-02	
	(a) Hydrocarbons (except methane)	g	3,63E+00	
	(a) Methane (CH4)	g	1,90E+01	
	(a) Nickel (Ni)	g	1,32E-02	
	(a) Nitrogen Oxides (NOx as NO2)	g	4,67E+00	
	(a) Nitrous Oxide (N2O)	g	3,72E-02	
	(a) Propane (C3H8)	g	1,78E-01	
	(a) Propylene (CH2CHCH3)	g	3,91E-03	
	(a) Sulphur Oxides (SOx as SO2)	g	2,59E+01	
	(a) Toluene (C6H5CH3)	g	8,40E-03	
	(a) Vanadium (V)	g	5,27E-02	
	(s) Arsenic (As)	g	1,64E-06	
	(s) Chromium (Cr III, Cr VI)	g	2,05E-05	
	(s) Zinc (Zn)	g	6,16E-05	
	(w) Ammonia (NH4+, NH3, as N)	g	2,28E-02	
	(w) Benzene (C6H6)	g	6,75E-03	
	(w) Cadmium (Cd++)	g	1,80E-05	
	(w) Chromium (Cr III)	g	4,30E-05	
	(w) Chromium (Cr III, Cr VI)	g	1,25E-04	
	(w) Nitrogenous Matter (unspecified, as N)	g	2,90E-02	
	(w) Oils (unspecified)	g	4,68E-02	
		Wastewater	litre	2,35E+02
		Recycled water	litre	1,00E+03
<b>REMINDERS</b>	E Feedstock Energy	MJ	1,71E+00	
	E Fuel Energy	MJ	3,47E+01	
	E Non Renewable Energy	MJ	3,34E+01	
	E Renewable Energy	MJ	2,97E+00	
	E Total Primary Energy	MJ	3,64E+01	
	Electricity	MJ elec	1,23E+01	