Table 1. Foreground data summary for the production of heat and power from natural regeneration forestry residues (Sc1), VSRF poplar (Sc2) and willow (Sc3) biomass and residues from traditional poplar stands (Sc4)

	Sc1	Sc2	Sc3	Sc4
Inputs				
Materials				
Wood-based feedstock (kg)	1.94	2.53	2.55	2.52
Diesel -chipping (g)	2.13	--	--	1.92
Energy				
Electricity -CHP unit (kWh)	0.236	0.236	0.236	0.236
Transport				
Truck (kg·km)	1,550	88.6	89.1	50.5
Outputs				
Energy				
Electricity (kWh)	1.00	1.00	1.00	1.00
Heat to final use (MJ)	2.27	2.27	2.27	2.27
Emissions to air				
CO (g)	0.122	0.161	0.158	0.159
$PM_{2.5}$ (g)	0.061	0.080	0.078	0.079
NO_x (g)	0.098	0.129	0.128	0.127
Heat -waste (MJ)	11.84	11.84	11.84	11.84
Waste to treatment				
Ash to sanitary landfill (g)	77.5	38.0	39.4	93.4
Avoided products				
Electricity -Italian profile (kWh)	1.00	1.00	1.00	1.00
Heat from natural gas (MJ)	2.27	2.27	2.27	2.27

Table 2. Low heating values (LHV) specifications for the biomass sources under assessment

Biomass source	Moisture content	LHV	Source
Wood-based residues	35%	5.27 kWh·kg dm^{-1}	Proto et al. (2017)
VSRF poplar biomass	45%	5.27 kWh·kg dm^{-1}	Bacenetti et al. (2016)
VSRF willow biomass	45%	5.25 kWh·kg dm^{-1}	Bacenetti et al. (2016)
Poplar residues	41%	4.88 kWh·kg dm^{-1}	Direct estimation

kg dm= kg dry matter

Table 3. Primary inventory data summary associated with the production of wood-based residues from traditional poplar stands

Field preparation stage	
Inputs	
Diesel (kg/ha)	80
Cattle manure (t/ha)	50
Management stage	
Inputs	
Diesel (kg/ha)	650
Glyphosate and gluphosinate-ammonium - herbicide (kg/ha)	5
Deltamethrin - pesticide (kg/ha)	4
Water (m^3/ha)	4000
Harvesting and Soil recovery stage	
Inputs	
Diesel (kg/ha)	250
Outputs	
Poplar roundwood (t/ha)	120
Poplar residues (t/ha)	40

Table 4. Description of the main Ecoinvent ® database version 3.2 processes (Weidema et al., 2013) and other literature sources considered in this study for the background processes

Input	**Process**
Electricity	Electricity, medium voltage {IT}| market for | Alloc Rec, U
Heat	Heat, central or small-scale, natural gas {RER}| market group for | Alloc Def, U
Water	Tap water {Europe without Switzerland}| market for | Alloc Rec, U
Glyphosate	Glyphosate {GLO}| market for | Alloc Def, U
Deltamethrin	Pyrethroid-compound, {GLO}|market for|Alloc Def, U
Ash disposal	Wood ash mixture, pure {RoW}| treatment of, sanitary landfill | Alloc Def, U
Chipping (diesel)	Wood chipping, chipper, mobile, diesel, at forest road {GLO}| market for | Alloc Def, U
CHP (biomass)	Butnar et al. (2010)
CHP (emissions)	IPCC (2007) and EMEP/EEA (2013)
Diesel lorry (16-32t)	Transport, freight, lorry 16-32 metric ton, EURO5 {GLO}| market for | Alloc Def, U
VSRF poplar cultivation	González-García et al. (2012)
VSRF willow cultivation	Bacenetti et al. (2016)

Table 5. Characterisation results corresponding to each bio-energy scenario under assessment per functional unit (1kWhe)

Impact category	Unit	Sc1	Sc2	Sc3	Sc4
Climate Change (CC)	kg CO_2eq	$2.65 \cdot 10^{-1}$	$1.59 \cdot 10^{-1}$	$1.22 \cdot 10^{-1}$	$6.02 \cdot 10^{-2}$
Terrestrial Acidification (TA)	kg SO_2eq	$2.23 \cdot 10^{-3}$	$4.50 \cdot 10^{-3}$	$3.64 \cdot 10^{-3}$	$2.10 \cdot 10^{-3}$
Freshwater Eutrophication (FE)	kg Peq	$2.21 \cdot 10^{-5}$	$1.65 \cdot 10^{-5}$	$1.27 \cdot 10^{-5}$	$6.03 \cdot 10^{-6}$
Marine Eutrophication (ME)	kg Neq	$1.08 \cdot 10^{-4}$	$5.72 \cdot 10^{-4}$	$4.24 \cdot 10^{-4}$	$3.13 \cdot 10^{-4}$
Human Toxicity (HT)	kg 1,4-DBeq	$9.31 \cdot 10^{-2}$	$4.59 \cdot 10^{-2}$	$4.16 \cdot 10^{-2}$	$3.17 \cdot 10^{-2}$
Photochemical Oxidant Formation (POF)	kg PM10eq	$2.25 \cdot 10^{-3}$	$2.66 \cdot 10^{-3}$	$2.37 \cdot 10^{-3}$	$1.84 \cdot 10^{-3}$
Particulate Matter Formation (PMF)	kg NMVOC	$9.08 \cdot 10^{-4}$	$1.19 \cdot 10^{-3}$	$1.01 \cdot 10^{-3}$	$6.70 \cdot 10^{-4}$
Fossil Depletion (FD)	kg oil eq	$8.38 \cdot 10^{-2}$	$3.91 \cdot 10^{-2}$	$2.77 \cdot 10^{-2}$	$7.69 \cdot 10^{-3}$