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Renewable energy from mixed fuels: existing and new methods to measure their biogenic content and financial incentives

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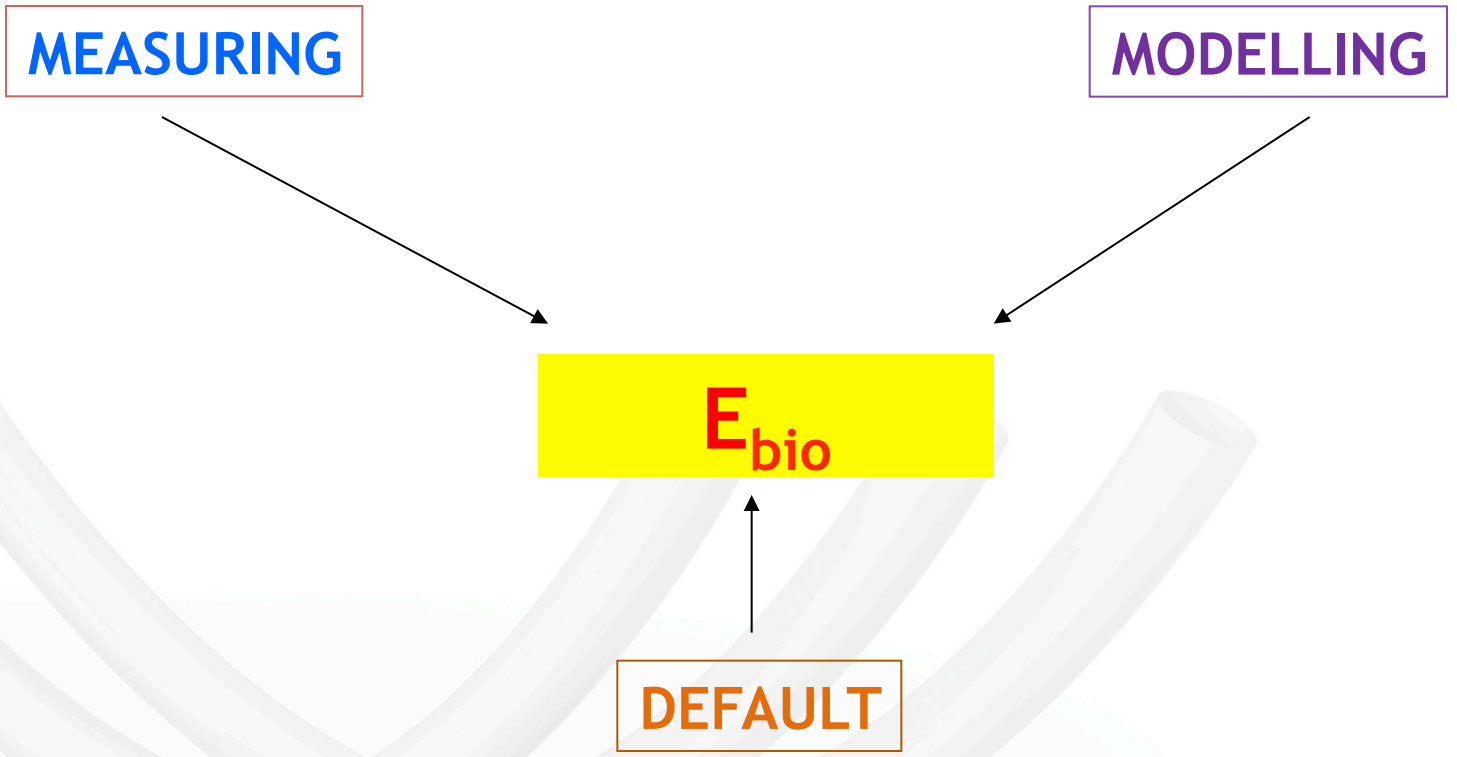
Renewable energy from mixed waste (E_{bio})

How WTE plants can assess it



DEFAULT

Ebio= calculated considering a **default %** of the total net energy produced **as due to the biogenic content of the waste**

ITALY **51 %** of total net energy **admitted as Ebio according to law** (no need of evidence about waste compostion required)

Eligible waste without specific mass limits:

MSW

SRF (only if from MSW)

Eligible waste with a mass limit (<30% of the total waste treated):

Selected not hazardous industrial wastes

SRF (from the selected not hazardous industrial wastes,only)

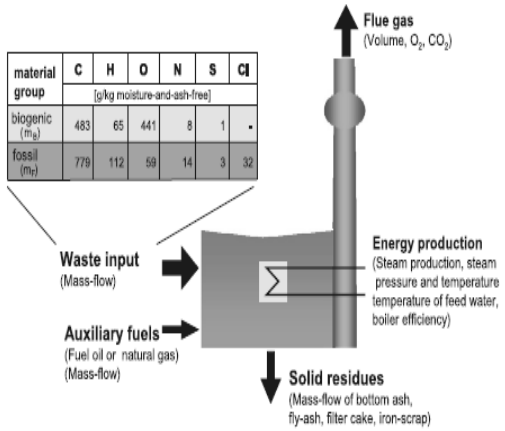
MODELLING

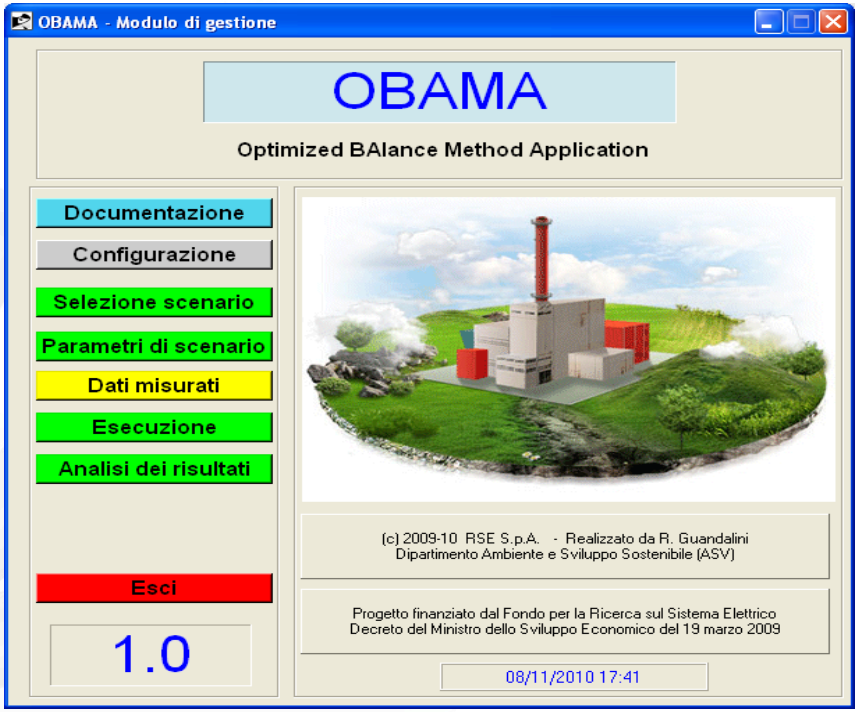
Ebio= calculated according to a **Mass and Energy Plant Balance Model** running on plant data

Mass balance	m_B	+	m_F	+	m_I	+	m_W	= 1
"Ash"-balance				+	m_I			= a_{waste}
Carbon-balance	$c_B \cdot m_B$	+	$c_F \cdot m_F$					= c_{waste}
Energy-balance	$HV_B \cdot m_B$	+	$HV_F \cdot m_F$			$-2.45 \cdot m_W$		= HV_{waste}
O_2-consumption	$o_2c_{,B} \cdot m_B$	+	$o_2c_{,F} \cdot m_F$					= o_2c_{waste}
Difference of O_2-cons. +CO_2-prod.	$d_{O_2\text{-}CO_2,B} \cdot m_B$	+	$d_{O_2\text{-}CO_2,F} \cdot m_F$					= $d_{O_2\text{-}CO_2,waste}$

Derived from operating data

material group	C	H	O	N	S	Cl
	[g/kg moisture-and-ash-free]					
biogenic (m_B)	483	65	441	8	1	-
fossil (m_F)	779	112	59	14	3	32



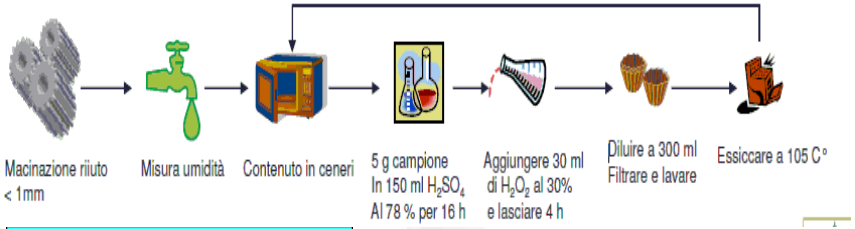


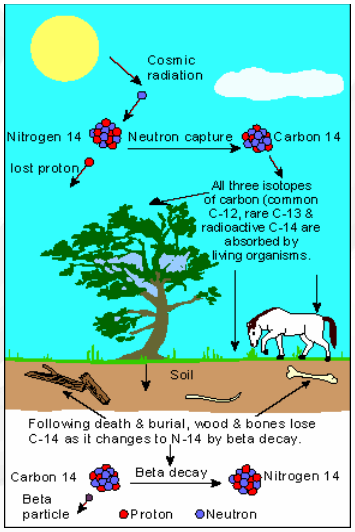
MEASURING - 1

Ebio= calculated based on a measure of the biogenic content of waste according to **mature analytical methods**

Admitted
by national legislations

- **Manual sorting method**
  (analysis of solid sample)
  Ref.Technical specification
  CEN/TS 15440
- **Selective dissolution method**
  (analysis of solid sample)
  Ref.Technical specification
  CEN/TS 15440
- **Pre-combustion ^{14}C method**
  (analysis of solid sample)
  Ref.Technical specification
  CEN/TS 15440

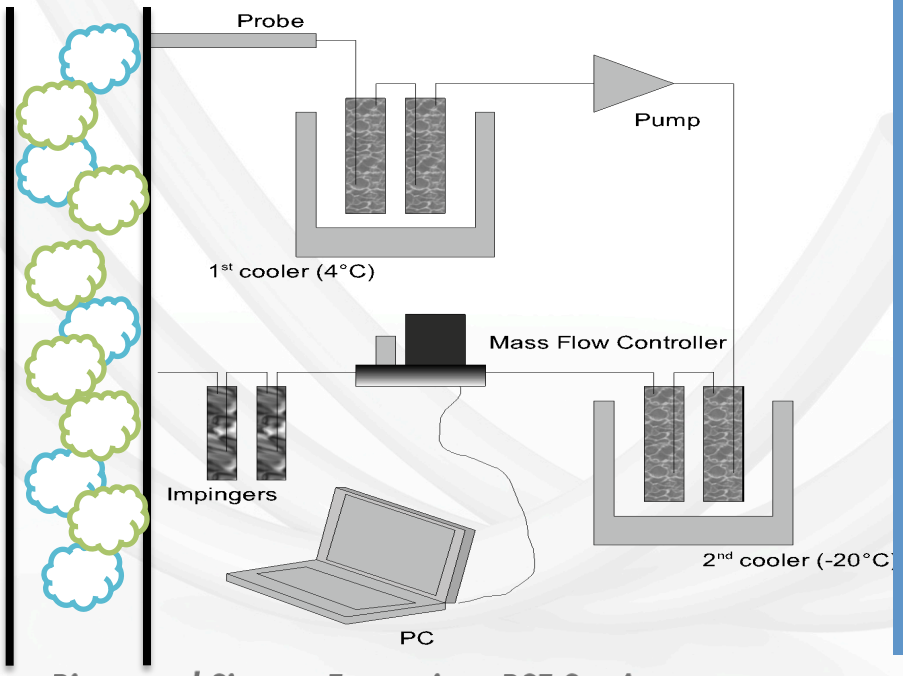




^{14}C measurement can be made by using three different instrumental techniques:
LSC (liquid scintillation counting;
BI (beta ionisation)
AMS (accelerated mass spectrometry

MEASURING - 2

Ebio= calculated based on a measure of the biogenic content of waste according to **mature analytical methods**



Waiting to be admitted by national legislations

- **Post-combustion ^{14}C method** (analysis of plant gaseous emissions)

Ref. Technical specification

Italy: **UNI prE0209B460** First TS available on a national basis)

ISO: **ISO/DIS 13833** (in progress)

A future reference method ?

A comparison of methodologies available to assess the biogenic content of wastes

Field campaigns carried out on some italian Wte plants

- Manual sorting method
- Selective dissolution method
- Pre-combustion ^{14}C method
- Post-combustion ^{14}C method
- OBAMA model

Tested on

WTE plants

Feeded with

SRF (from MSW)
MSW
Health care wastes
(mainly CER 180103)

Combustion technology
Moving Grate
Fluidized bed
Rotary kiln

WTE plant 1

Installed power MWe 84,4 **Authorized treatment** ton/y 810000
Combustion technology Moving Grate Feeding mix: MSW + other industrial wastes
During field campaign feeded with MSW only

Results

Manual sorting	$wt\%bio_{ar}$ = 67	$E_{bio}\%_{daf}$ =**50**	uncertainty **30%**
Post-combustion ^{14}C (LSC)	$wt\%bio_{daf}$ = 50	$E_{bio}\%_{daf}$ =**33**	uncertainty **24%**
OBAMA model	$wt\%bio_{ar}$ = 47	$E_{bio}\%_{daf}$ =**32**	uncertainty **6%**

WTE plant 2

Installed power: MWe 9,3 **Authorized treatment:** ton/y 75000

Combustion technology: Fluidized bed Feeding: CSS + other industrial wastes

During field campaign feeded with CSS from MSW only

Results			day 1	day 2	day 3
Selective dissolution		$wt\%bio_{daf}$ =	58,8	56,3	55,0
		$C_{bio}wt\%_{daf}$ =	46,1	43,5	42,5
		$E_{bio}\%$ =	na	na	na
Pre-combustion ^{14}C	(LSC)	$wt\%bio_{daf}$ =	67,0	72,7	67,2
		$C_{bio}wt\%_{daf}$ =	57,9	61,0	54,9
		$E_{bio}\%_{daf}$ =	**51,9**	**55,1**	**48,9**
Post-combustion ^{14}C	AMS)	$wt\%bio_{daf}$ =	54,3	55,0	53,6
		$C_{bio}wt\%_{daf}$ =	41,8	42,5	41,8
		$E_{bio}\%_{daf}$ =	**36,1**	**36,6**	**36,1**
	(LSC)	$wt\%bio_{daf}$ =	na	57,1	58,9
		$C_{bio}wt\%_{daf}$ =	na	44,6	46,3
		$E_{bio}\%_{daf}$ =	na	**38,7**	**40,4**

WTE plant 3

Installed power: MWe 10,5 **Authorized treatment:** ton/y 870000
Combustion technology: Moving Grate
Feeding: MSW + other industrial wastes
During field campaign feeded with MSW only

Results			**day 1**	**day 2**
Manual sorting	$wt\%bio_{ar}$	=	62,1	58,9
	$E_{bio}\%_{ss}$	=	**49,2**	**44,2**
	$(E_{bio}\%_{daf}$	=	**50,1**	**46,7**)
Post-combustion ^{14}C (AMS)	$C_{bio}wt\%_{daf}$	=	56,2	62,1
	$E_{bio}\%_{daf}$	=	**45,7**	**51,2**
OBAMA model	$wt\%bio_{ar}$	=	40,7	39,9
	$E_{bio}\%_{daf}$	=	**47,6**	51,7

WTE plant 4

Installed power: MWt 15 **Authorized treatment:** ton/y 20000

Combustion technology: Rotary kiln Feeding: Health Care Wastes

During field campaign feeded mainly with CER 180103

Results		ref. cer180103	day 1	day 2	day 3	average
Manual sorting	$wt\%bio_{ar}$ =	45,0				
	$E_{bio}\%_{ss}$ =	**34,1**				
Post-combustion ^{14}C	(AMS) $C_{bio}wt\%_{daf}$ =		24,3	24,8	21,9	
	$E_{bio}\%_{daf}$ =		**23,4**	**23,8**	**21,0**	
	(LSC) $C_{bio}wt\%_{daf}$ =		26,2	26,8	25,3	
	$E_{bio}\%_{daf}$ =		**25,1**	**25,7**	**24,3**	
OBAMA model	$wt\%bio_{ar}$ =					25,8
	$E_{bio}\%_{daf}$ =					**24,3**