



UNIVERSITÀ DEGLI STUDI  
DI MILANO

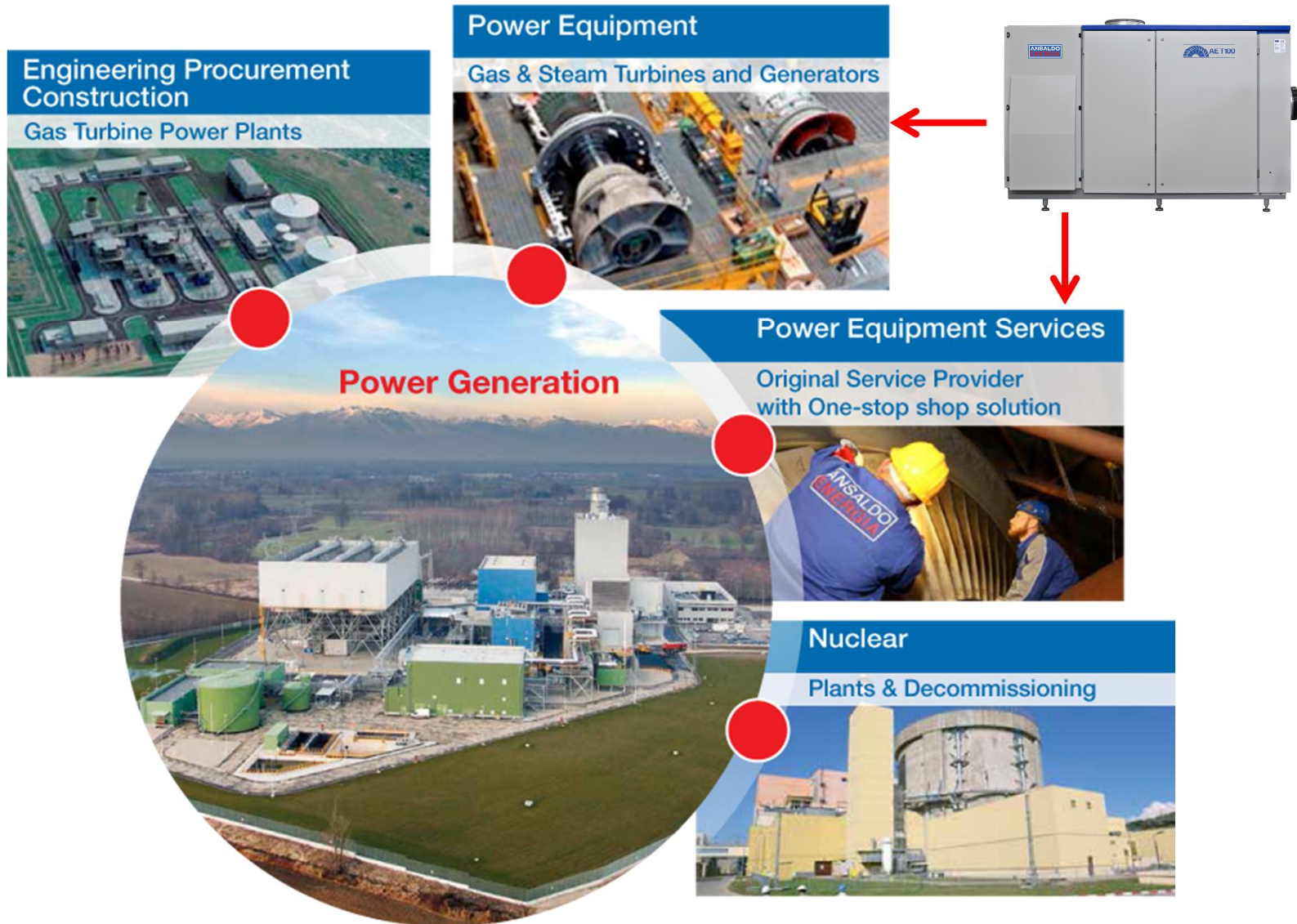
## HELE - High Efficiency Low emissions

**Cogenerazione con microturbine a gas: l'esperienza Ansaldo Energia col biogas**



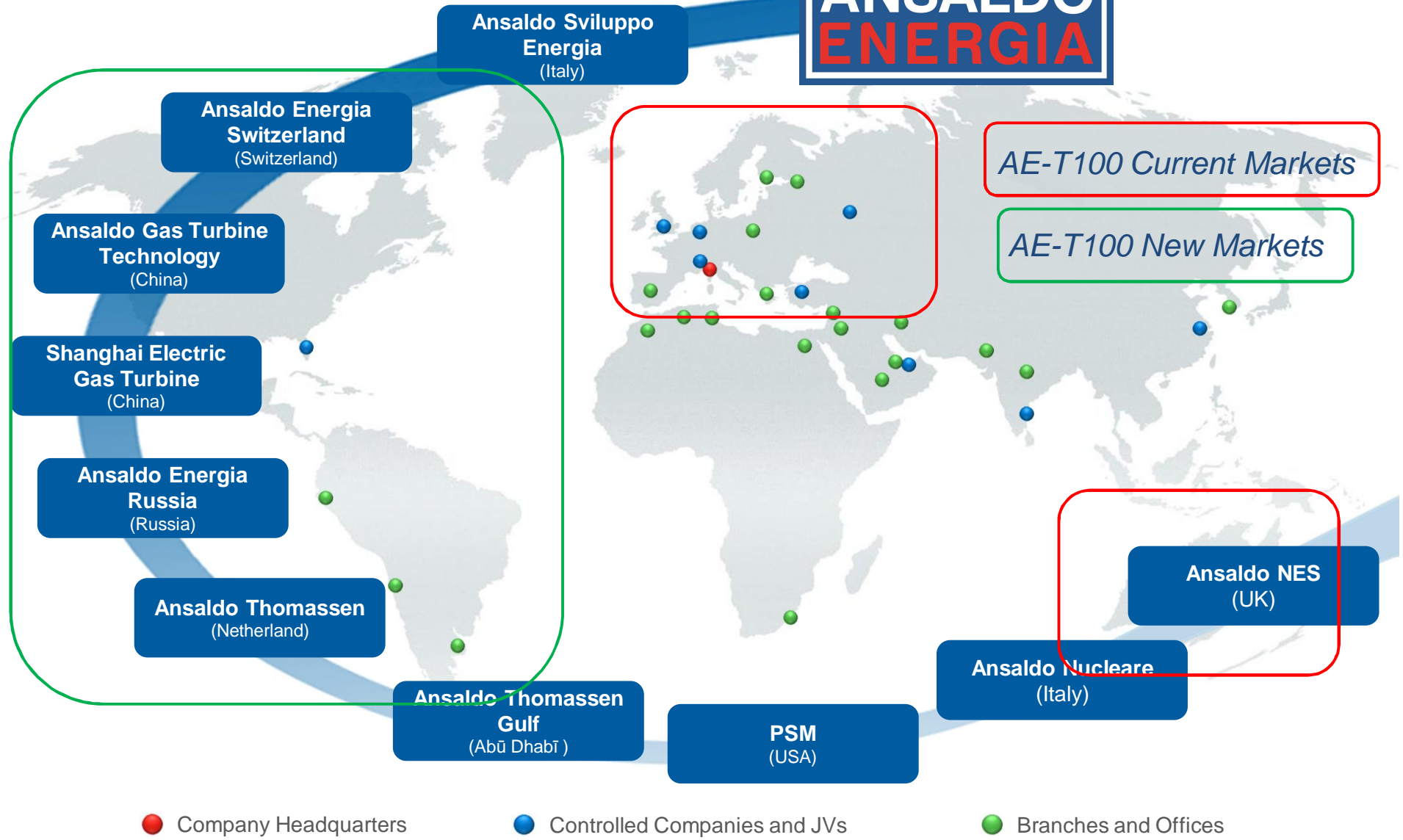


# Integrated Business Model for Power Generation Industry



**Total Awarded Projects  $\geq$ 190,000 MW in more than 90 countries**





● Company Headquarters

● Controlled Companies and JVs

● Branches and Offices



# More than 160 Years Background



Acquisition of Alstom advanced HDGT technology and Assets Acquisition of Power System Manufacturing

Incorporation of Joint Ventures with Shanghai Electric Company



100 years of Steam Turbine manufacturing

150<sup>th</sup> Gas Turbine manufactured

OSP™ concept launch

Total Technological Independence

Global leading OEM of GT and ST

**TODAY**

1853

Giovanni Ansaldo & Co. established

1923

First Power Plant

1962

First supercritical 600 MW Power Plant

1991

Ansaldo Energia established

2005

1995

First Combined Cycle Power Plant based on Ansaldo Energia GT

2007

2014

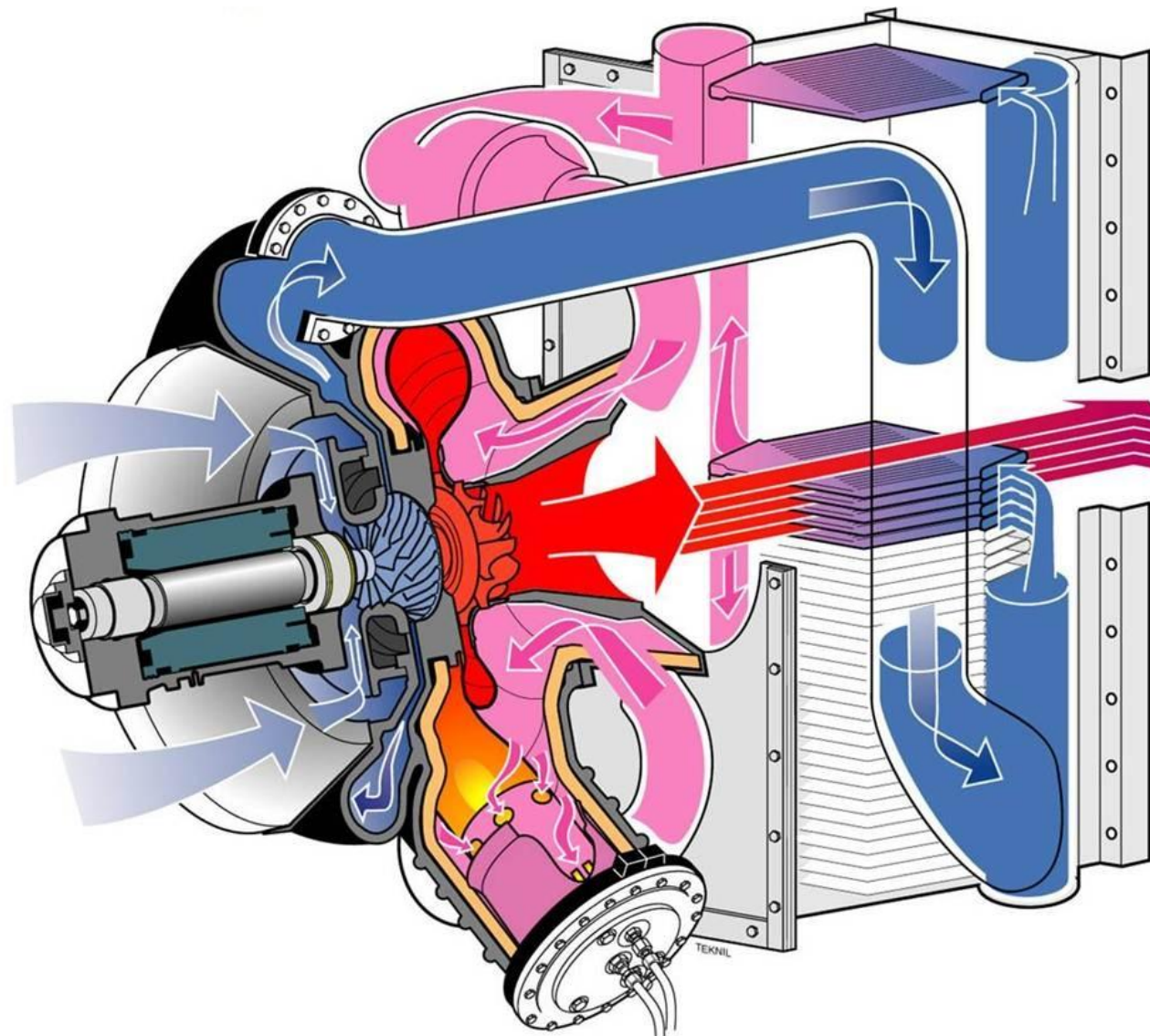
2012

2010





# Microturbine Working Principle AE-T100 POWER TRAIN





# Ansaldo Energia AE-T100 Micro Gas Turbine Evolution

*Ansaldo Energia has entered into the micro turbines business with the acquisition of Turbec business unit in late 2012.*





## AE-T100 Micro Turbines - Advantages

- Elevata efficienza totale
- Breve ritorno dell'investimento
- Bassa manutenzione
- Vita utile elevata
- Alta affidabilità
- Bassa rumorosità
- Basse emissioni
- Telecontrollo e telegestione
- Design compatto
- Flessibilità output termico
- Flessibilità combustibili



## Micro Turbines - Applications



### GAS NATURALE

- Civile, commerciale ed industriale
- Co e Tri-generation



### BIOGAS

- Discarica
- Fanghi depurazione acque reflue
- Digestione anaerobica



### EXTERNALLY FIRED

- Biomassa
- Solare



## Micro Turbines – Applications: Gas naturale

La versione a gas naturale della AE-T100 sia in configurazione cogenerativa che trigenerativa (in combinazione con un gruppo frigo ad assorbimento) è *una soluzione per una molteplicità di applicazioni:*



- Hotels
- Centri benessere
- Condomini
- Industria alimentare
- Lavanderie industriali
- Piscine
- Ospedali e case di riposo
- Allevamenti
- Distillerie e birrerie
- Impianti di verniciatura.

Le basse esigenze manutentive della AE-T100 la rendono estremamente attraente e competitiva nei confronti di sistemi convenzionali. È disponibile nelle versioni indoor e outdoor, entrambi i modelli rispettano i limiti di emissione e sono telecomprendibili e telegestibili

# Micro Turbines – Applications: Gas naturale

*Natural Gas & Biogas  
Models*



**CHP** - Pools & Leisure centres



**CHP** - Hotel, hospitals, retirement houses, condominiums



**CCHP** – cooling through hot water or exhaust gas



**Steam** (industrial)



**Drying processes** (industrial)



**Diathermic oil** (industrial)

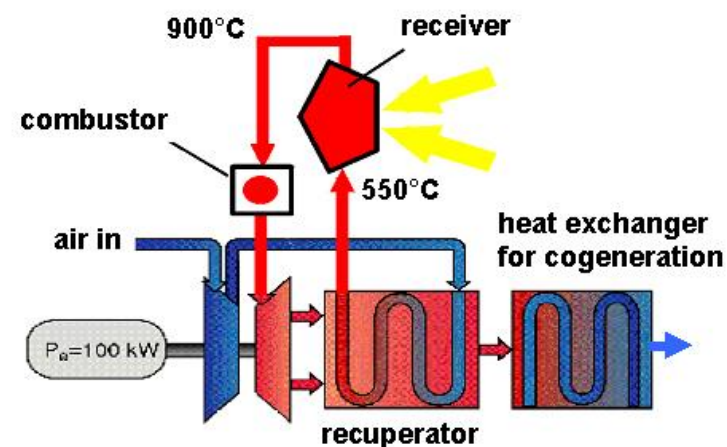
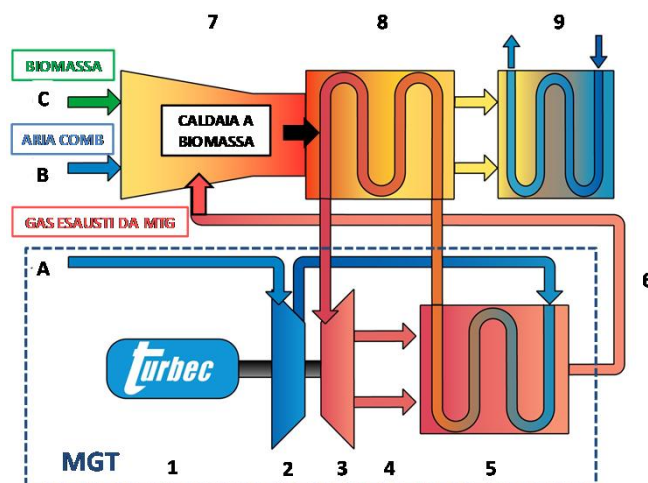


**Greenhouse**



## Micro Turbines – Applications: Externally fired

La AE-T100 è disponibile nella versione a combustione esterna EFMGT ( Externally Fired Micro Gas Turbine). Le due applicazioni principali sono in abbinamento ad una caldaia a biomassa o con un sistema a concentrazione solare.



## Micro Turbines – Applications: Externally fired





La AE-T100 tollera variazioni rilevanti della composizione e del potere calorifico del combustibile. È stata applicata in una vasta casistica di applicazioni e può essere adattata per soddisfare richieste particolari:

- Landfill gas
- Anaerobic digestion (biomass or sewage) gas



Biogas acceptable ranges:

- CH<sub>4</sub> (methane) > 40 %
- H<sub>2</sub>S (hydrogen sulphide) ≤ 1500 ppm = 2280 mg/Nm<sup>3</sup>
- Siloxane\* ≤ 100 mg/Nm<sup>3</sup>

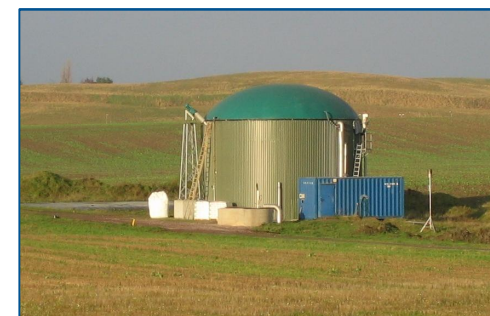
\*Decamethylcyclopentasiloxane



# Micro Turbines – Applications: Biogas



*WWTP – Waste Water Treatment Plants*



*Landfills and farms*

## AE-T100B – Main Technical Data

### General

Installation	Indoor / Outdoor
Size (WxHxL)	1200 x 1810/3300 x 2700 mm (P)
	1200 x 1810/3300 x 3900 mm (CHP)
Weight	2250 / 2750 kg (P)
	2770 / 3100 kg (CHP)

### Electrical data

Frequency output	50 Hz (60 Hz on request)
Voltage output	400 V (AC), three phases

### Fuel requirements

Required pressure	(6 ÷ 8) bar(g)
Required temperature	(0 ÷ 40) °C
CH4 min	> 40 %
H2S max	< 2880 mg/Nm <sup>3</sup> ≈ 1500 ppm(v)
SILOXANES max	< 150 mg/Nm <sup>3</sup>

### Performances

Electrical output	(105 ± 3) kWel
Electrical Efficiency	(30 ± 2) %
Fuel consumption	333 kWth ≈ 34 Nm <sup>3</sup> /h*
Exhaust gas flow	0.80 kg/s
Exhaust gas temperature	270 °C
Max exhaust pressure drop (without CHP-HE)	450 Pa
Sound Pressure - Average	72 dB(A) @ 1 m

### Emissions

NO <sub>x</sub>	< 7 ppm(v)
	< 14,5 mg/Nm <sup>3</sup> (15% O <sub>2</sub> )
	< 37,5 mg/Nm <sup>3</sup> (5% O <sub>2</sub> )
CO	< 3 ppm(v)
	< 3,75 mg/Nm <sup>3</sup> (15% O <sub>2</sub> )
	< 10 mg/Nm <sup>3</sup> (5% O <sub>2</sub> )





## AE-T100B – Main Technical Data

### Compliances

Machine Directive	2006/42/EC
EMC	2004/108/EC
Low-Voltage IT	CEI-021
Mid-Voltage IT	CEI-016
Low-Voltage DE	VDE
Mid-Voltage DE	BDEW
Safety	SIL 3



## AE-T100B – Main Application Cases with Biogas

### CHP APPLICATIONS IN WWTP:

deployed mainly through **exhaust gas / hot water heat exchanger** (supplied by Ansaldo Energia)

### CHP APPLICATIONS IN WWTP:

deployed also through **exhaust gas / heat recovery steam generator** (not supplied by Ansaldo Energia)  
for **sewage sludges thermal hydrolysis processes**:

**-digester loading increasing**

**-biogas production increasing**

**-pathogen-free and stabilized biosolids product**





Air  
Evacuation  
Fan

Biogas  
Safety Valves  
Box



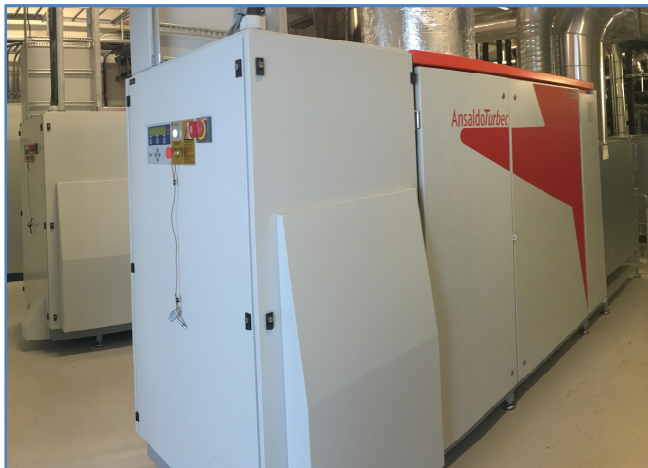
AE-T100B  
Micro Turbine

Exhaust Gas / Hot Water  
Heat Exchanger



Biogas  
Compressor  
(not supplied by Ansaldo)













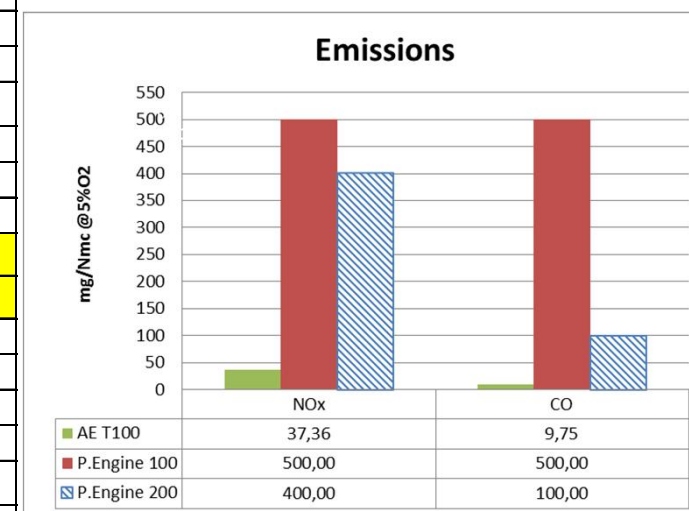
## AE-T100B – European WWTP Installations





# AE T100 Microturbine Vs Piston Engine Emissions

AE-T100						
Electrical Power	100	kW				
Thermal power	170	kW				
EI Efficiency	30	%				
NOx	7	ppm @15%O <sub>2</sub>	14,37	mg/Nmc @15%O <sub>2</sub>	37,36	mg/Nmc @5%O <sub>2</sub>
CO	3	ppm @15%O <sub>2</sub>	3,75	mg/Nmc @15%O <sub>2</sub>	9,75	mg/Nmc @5%O <sub>2</sub>
Oil consumption	15	l/6000h	0,0025	kg/h		
portata fumi	0,78	kg/s	0,641447	Nmc/s		
Densità fumi	1,216	kg/Nmc				
P.Engine 100						
Electrical Power	100	kW				
Thermal power	135	kW				
EI Efficiency	36	%				
NOx					500,00	mg/Nmc @5%O <sub>2</sub>
CO					500,00	mg/Nmc @5%O <sub>2</sub>
Oil consumption			0,125	kg/h		
portata fumi	0,146	kg/s	525	kg/h		
Densità fumi	1,211	kg/Nmc				
P.Engine 200						
Electrical Power	200	kW				
Thermal power	230	kW				
EI Efficiency	40	%				
NOx					400,00	mg/Nmc @5%O <sub>2</sub>
CO					100,00	mg/Nmc @5%O <sub>2</sub>
Oil consumption			0,08	kg/h		
portata fumi	0,26	kg/s	956	kg/h		
Densità fumi	1,211	kg/Nmc				



# AE T100 Microturbine Vs Piston Engine Emissions – 100kW size

AE-T100										
Electrical Power	100	kW								
Thermal power	170	kW								
El Efficiency	30	%								
NOx	37,36	mg/Nmc @5%O <sub>2</sub>	23,97	mg/s	86,3	kg/h	0,86	kg/kWh	690.262	kg/anno
CO	9,75	mg/Nmc @5%O <sub>2</sub>	6,25	mg/s	22,5	kg/h	0,23	kg/kWh	180.118	kg/anno
Oil consumption	0,0025	kg/h							20	L/anno olio
portata fumi	0,78	kg/s								
Densità fumi	1,216	kg/Nmc								
DIFFERENCES ON 8000 HOURS								1.043,84	ton/anno di Nox	
								1.553,99	ton/anno di CO	
								980,00	kg/anno di olio	
P.Engine 100										
Electrical Power	100	kW								
Thermal power	135	kW								
El Efficiency	36	%								
NOx	500,00	mg/Nmc @5%O <sub>2</sub>	216,8	kg/h			1,08	kg/kWh	1.734.104	kg/anno
CO	500,00	mg/Nmc @5%O <sub>2</sub>	216,8	kg/h			1,08	kg/kWh	1.734.104	kg/anno
Oil consumption	0,125	kg/h							1000	L/anno olio
portata fumi	0,146	kg/s								
Densità fumi	1,211	kg/Nmc								



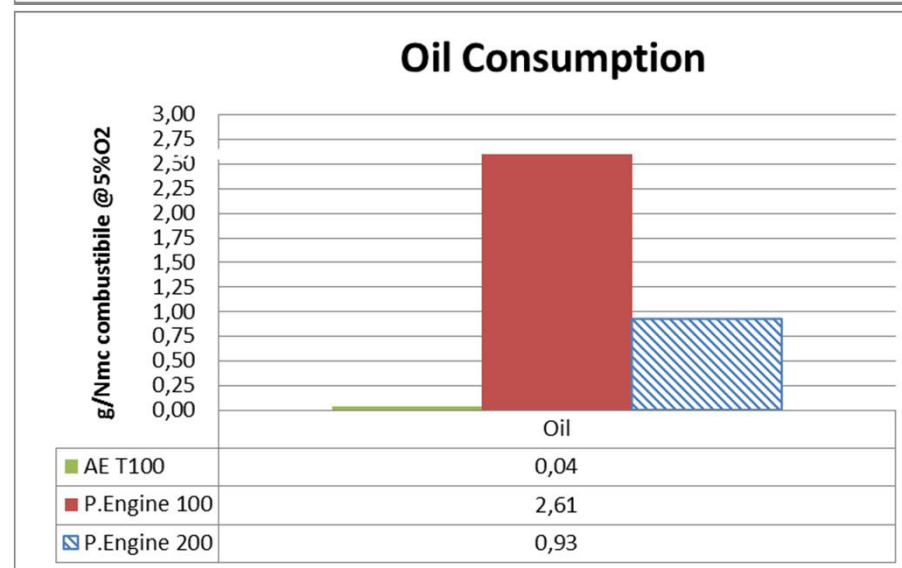
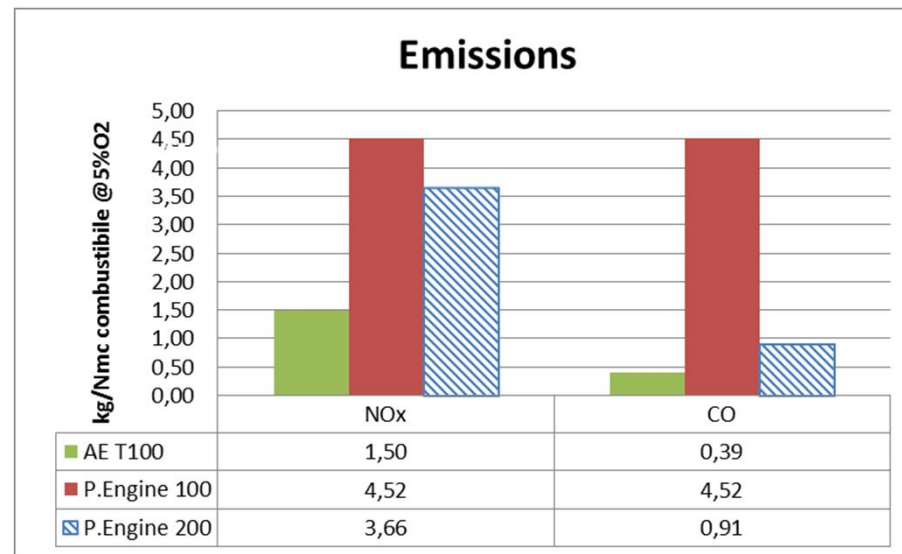
# AE T100 Microturbine Vs Piston Engine Emissions – 200kW size

2 x AE-T100										
Electrical Power	100	kW								
Thermal power	170	kW								
EI Efficiency	30	%						2 TIMES		
NOx	37,36	mg/Nmc @5%O <sub>2</sub>	23,97	mg/s	86,3	kg/h	0,86	kg/kWh	1.380.524	kg/anno
CO	9,75	mg/Nmc @5%O <sub>2</sub>	6,25	mg/s	22,5	kg/h	0,23	kg/kWh	360.237	kg/anno
Oil consumption	0,0025	kg/h							40	L/anno olio
portata fumi	0,78	kg/s								
Densità fumi	1,216	kg/Nmc								
									1.145,65	ton/anno di Nox
P.Engine 200									271,31	ton/anno di CO
Electrical Power	200	kW							600,00	kg/anno di olio
Thermal power	230	kW								
EI Efficiency	40	%								
NOx	400,00	mg/Nmc @5%O <sub>2</sub>	400	mg/Nm	315,8	kg/h	1,58	kg/kWh	2.526.177	kg/anno
CO	100,00	mg/Nmc @5%O <sub>2</sub>	100	mg/Nm	78,9	kg/h	0,39	kg/kWh	631.544	kg/anno
Oil consumption	0,08	kg/h							640	L/anno olio
portata fumi	0,26	kg/s								
Densità fumi	1,211	kg/Nmc								

# AE T100 Microturbine Vs Piston Engine

## Emissions on fuel consumption

AET100	NOx	1,50	kg/Nmc	combustibile
	CO	0,39	kg/Nmc	combustibile
	Oil consumption	0,04	kg/Nmc	combustibile
P.Engine 100	NOx	4,52	kg/Nmc	combustibile
	CO	4,52	kg/Nmc	combustibile
	Oil consumption	2,61	kg/Nmc	combustibile
P.Engine 200	NOx	3,66	kg/Nmc	combustibile
	CO	0,91	kg/Nmc	combustibile
	Oil consumption	0,93	kg/Nmc	combustibile



*Thanks for your attention*

*...AE-T100 questions?*

***Ansaldo Energia S.p.A.  
Micro Turbine***

***Ph. +39 010 655 7012***

***FAX +39 010 655 32 59***

***microturbine@aen.ansaldo.it***

**Proud to be here**

**ANSALDO  
ENERGIA**

ansaldoenergia.com

Ansaldo Energia reserves all right on this document that cannot be reproduced in any part without its previous written consent.  
Data are provided for reference only.