



WASTE TO ENERGY PLANT



DL GR01

The **DL GR01** Simulator allows you to study the operation and analyse the characteristics and fundamental physical parameters of a Waste-to-Energy Plant.

It consists of a panel that shows the complete diagram of the entire system, where there is a series of mini Consoles that display the values of the quantities that characterize the functioning of the simulator such as masses, temperatures, enthalpies, powers, efficiencies.

Each section of the system (oven, boiler, chimney, turbine, etc.) is characterised by the presence of a mini Console for displaying specific quantities, with the possibility of also varying some parameters to analyse operation in different operating conditions.



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The connection of the Simulator to the PC for supervision, graphic display of the quantities of interest, etc., is obtained via a special USB interface.

The Simulator is accompanied by the Windows application **DLworkspace** which provides an integrated teaching environment for using the Simulator itself.

This previous application brings together, in a single graphical user interface, all the tools required to use the Simulator:

- the Training Software (i.e. the teaching material) with the theoretical guide to the study topics, the guide to the exercises, and the questionnaires,
- the tools for the graphical visualization of the quantities acquired by the Simulator.

It is also possible to connect the Simulator to an **MQTT Broker** to publish all the information with the Internet of Things techniques and display them remotely on other computers.

It has the following technical characteristics:

- Synoptic panel with colour scheme of the system,
- 10 mini Consoles with 2.8" TFT display, resolution 240 x 320, and keypad with 5 keys,
- USB interface,
- Windows **DLworkspace** application,
- Management and graphic processing software,
- Training Software with texts, images, videos, questionnaires,
- Power supply 220 Vac \pm 10%, 50 Hz.

The curriculum includes the following topics:

- **Urban Solid Waste (USW/RSU).**
 - ◆ Division into categories,
 - ◆ The fundamental parameters,
 - ◆ Calculation of parameters for the waste-to-energy plant.
- **Waste-to-energy: introduction.**
 - ◆ The waste fuel,
 - ◆ Characteristic parameters.
- **Waste-to-energy: combustion.**
 - ◆ Combustion of waste,
 - ◆ The furnace and the boiler,
 - ◆ Mass and energy balances,
 - ◆ Flue gas purification.
- **Waste-to-energy: energy production.**
 - ◆ The steam Rankine cycle,
 - ◆ The turboalternator,
 - ◆ Electric energy produced and efficiency,
 - ◆ Thermal energy.

The trainer is provided with technical manuals for theory and exercises.



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DL GR01 Simulator

For the Simulator to work, the data characterising the **Urban Solid Waste (USW)** to be incinerated must be provided as input.

These data are:

- calorific value,
- relative humidity,
- ash percentage,
- the amount of air required.

These information's depend on the type of waste generated in a given territory, and on the percentages of any separate waste collection.

To calculate the above parameters, starting from the collection data, the **DLworkspace** contains the **Waste Calculator**.



	A	B	C	D	E	F	G	H	I	K	L
Municipal Solid Waste:											
Waste type	%	RD %	Out %	CV (ca...	Ashes %	Umidit...	C	H	O	S	
Organic substance:	30	15	30.00	4200.00	24.10	63.30	38.80	4.20	28.30	0.90	
Plastic:	14	15	14.00	30500...	1.50	4.00	65.60	9.30	17.00	0.20	
Paper:	25	15	25.00	12100...	18.60	15.80	39.20	2.80	37.90	0.90	
Textile:	7	15	7.00	5400.00	12.40	21.00	44.70	5.00	37.00	0.10	
Inerts:	24	15	24.00	0.00	85.00	3.75	9.10	1.10	2.70	0.10	
Totals:	100	0	100.00	8933.00	33.36	25.87	35.94	3.88	23.58	0.55	
Calculator values for the Waste-to-Energy Plant:											
Calorific value:	8933.00	[kJ/kg]									
Umidity:	25.87	[%]									
Ashes:	33.36	[%]									
Air:	5.49	[kg/kg]									

Waste Info

Once the collection percentages of the different types of waste and the related percentages of separate collection have been entered, the calculator automatically calculates the MSW parameters required by the Simulator.



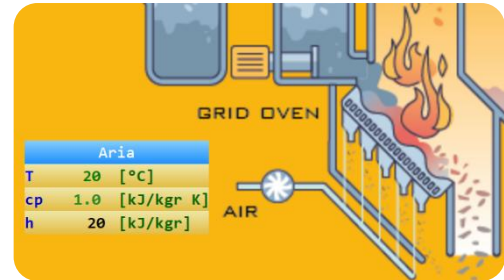
WASTE MANAGEMENT

The **DL GR01** Simulator therefore also becomes a tool for analyzing a territory and verifying the influence of the variation in separate waste collection on the significant parameters of the thermal destruction process.

The other sections of a waste-to-energy plant analysed by the Simulator are:

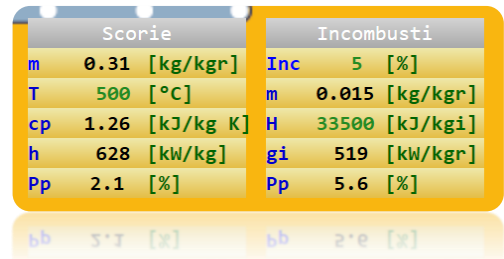
THE OVEN

In it, the waste is burned, with the addition of air in quantities equal to those indicated in the basic parameters.



WASTE AND UNBURNED MATERIALS

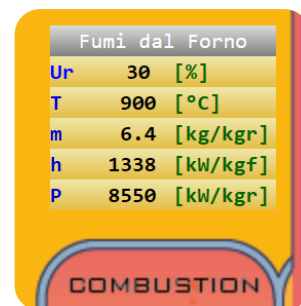
Their mass is calculated and the thermal power loss related to them is evaluated.



FUMES GENERATED BY THE OVEN

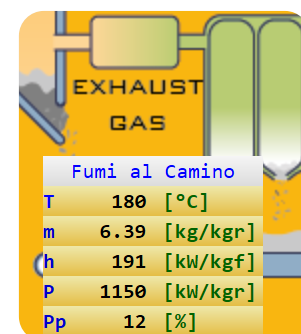
They contain the thermal energy produced by combustion that will then be transferred to the boiler's fluid to generate steam.

Their mass, temperature and enthalpy are calculated.



FUMES FROM THE CHIMNEY

By calculating their mass and lost energy.





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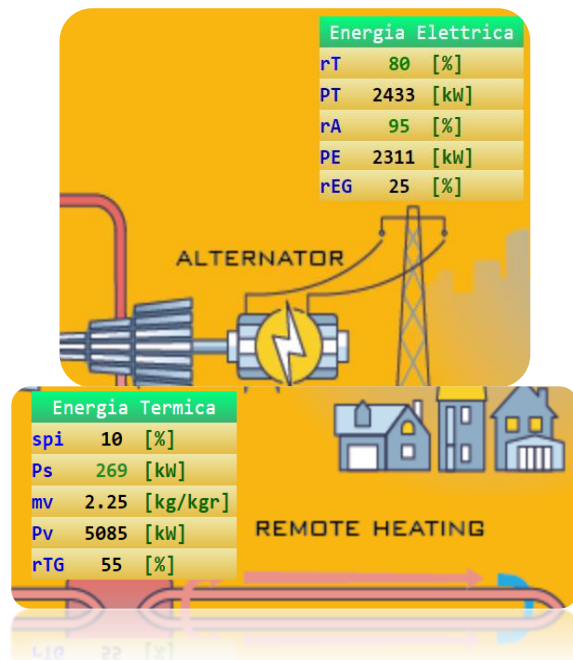
THE BOILER

Where the water enters, which is heated by the thermal power of the fumes and is transformed into superheated steam with its mass and thermal energy.



THE TURBOALTERNATOR

It consists of a turbine and an electric generator that transforms mechanical energy into electrical energy. The electrical power generated is a function of the thermal power of the steam and the efficiency of the generator. The thermal energy of the steam can also be used for **remote heating** applications.

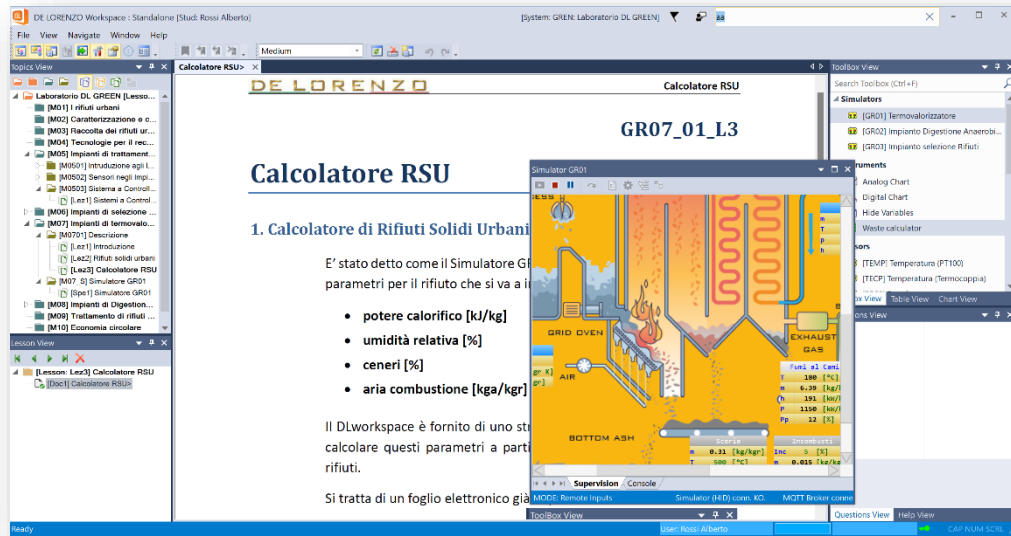




DLworkspace IDE

De Lorenzo Workspace is a Windows application that provides an Integrated Learning Environment (IDE) for training. It brings together, in a single graphical user interface, all the tools useful for Students to study and experiment, and for Teachers to teach and verify learning.

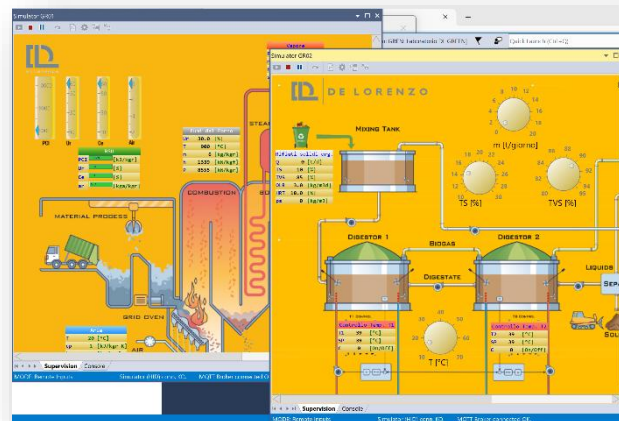
The figure shows an example.



You may notice:

- the list of topics and lessons on the left,
- the lesson pages in the centre,
- the supervision tools, videos and management of answers to questions on the right.

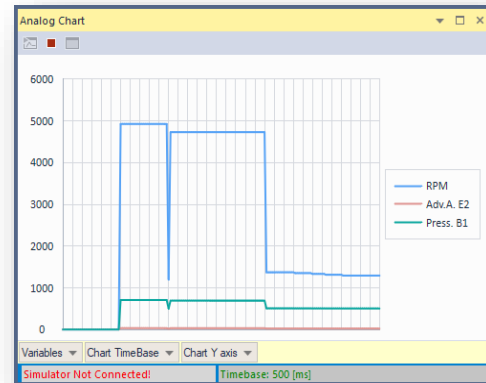
The same environment also houses the Simulator's tools for supervision and graphic processing.



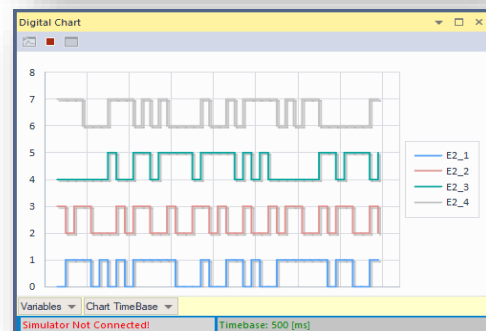


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The **Analog Chart** allows you to view the real-time trend of analog quantities during the simulation. It is possible to select multiple quantities at the same time.



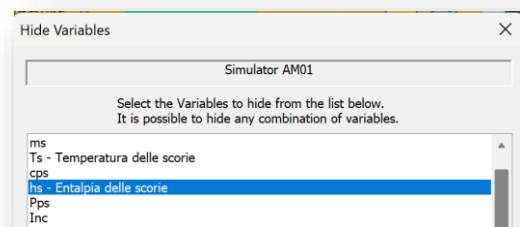
The **Digital Chart** allows you to view the real-time trend of ON-OFF quantities during the simulation.



Interactive questions

The **DLworkspace** environment allows the Teacher to ask interactive questions to the Students during the simulation. It is in fact possible to 'hide' the values of the variables displayed by the Simulator and request their calculation by the Student.

A special window allows the teacher to select the variables to hide.



The value of the variable no longer appears to the Student on the Simulator. He must calculate its value using mass balances, energy balances, or other methods depending on the type of variable.

Scorie	
m	0.31 [kg/kg _r]
T	500 [°C]
cp	1.26 [kJ/kg K]
h	???? [kW/kg]
Pp	2.1 [%]

In this way it is possible to directly verify the student's level of learning.



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Implementation of DL GR01 simulator in the DL GREENLAB laboratory

The **DL GR01** simulator, here proposed in individual mode complete with its management software, can be integrated into the laboratory **DL GREENLAB (COURSE FOR THE STUDY OF URBAIN WASTE DISPOSAL)** which also includes two other simulators **DL GR02 (Anaerobic Digestion Plant)** and **DL GR03 (Solid Waste Selection Plant)** with the aim of having an in-depth and complete course on the processes of urban waste disposal.

Specifically, the student acquires comprehensive training on all the following topics:

- **The product composition of urban waste.**
- **The main processes and flows of urban waste management.**
- **The main urban waste treatment processes.**

And thanks to the three simulators mentioned above, the **DL GREENLAB** laboratory allows for the faithful reproduction of urban waste disposal plants with the aid of a **DL WORKSPACE** learning tool which consists of a multimedia teaching platform.

For more detailed information, please refer to the catalogue **DL GREENLAB**.