LA MIA ENERGIA Scarl

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Direzione: Forum Ricerca via Cerro snc - 03043 Cassino (Fr)

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PV-MOREDE

Photo**V**oltaic

panels

MObile **RE**cycling **DE**vice

DELIVERABLE D 3.3

Second PV-Morede device manufactured

AGREEMENT NUMBER:
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Second unit plant "Pv-Mo.Re.De."
(Photo Voltaic panels Mobile Recycling Device)
for the recovery of material from the photovoltaic cell

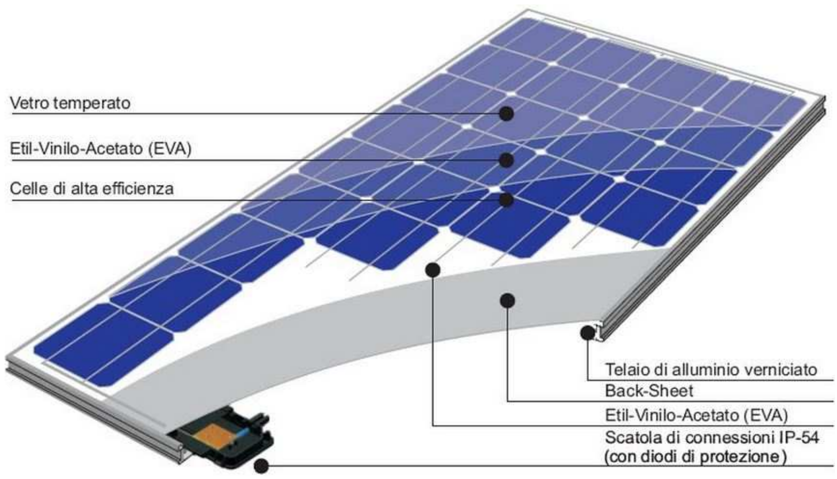
TECHNICAL REPORT

This report describes the characteristics and specifications of the second mobile unit Pv-Mo.Re.De., an innovative plant in the treatment at the end of life of the photovoltaic panels.

In particular, the construction of the mobile relates to a system for disassembly of a photovoltaic panel to allow the recovery of raw materials present in it.

The standard crystalline silicon photovoltaic panel is generally composed of:

- A protective sheet on the top side exposed to light, characterized by high transparency (the most used material is tempered glass);
- An encapsulation material to avoid glass-cell direct contact, able to eliminate the interstices due to surface imperfections of the cells and to electrically insulate the cell from the rest of the module; in the processes that use the lamination step is often used Ethylene-Vinyl-Acetate (EVA);
- A supporting substratum (glass, metal, plastic);
- A metal frame (frame), usually aluminum.



Section of a photovoltaic panel

In the crystalline silicon modules are used metal contacts, for connection of the cells, are welded subsequently to the construction of the cells; in the thin film modules the electrical connection is a part of the process of production of the cell and is secured by a layer of transparent metal oxides, such as zinc oxide or tin oxide.

In particular, each photovoltaic panel may differ from one another, for example, for the thickness of the layers, by the percentages of the component materials used, in the size, etc ..

In the case where a photovoltaic panel is to be replaced (for example because it was damaged or because it reaches the end of life), it is possible to proceed to its disassembly, or the separation of the different layers that compose it, to allow the recovery of raw materials in the panel.

There are several known methods for disassembly in order to separate the different and recovery the raw materials present in a photovoltaic panel; generally comprise the following steps:

a. a process of mechanical grinding, realized by the use of a crushing machine, following which the photovoltaic panel is reduced into fragments;
b. one or more thermal processes to determine, in each fragment, the detachment of one or more layers of materials;
c. one or more chemical processes, during which the fragments are dipped in an acidic solution to enable recovery of silicon and of some metals present in the photovoltaic cell.

Methods b. and c. described above have some drawbacks.

In fact, for a given photovoltaic panel disassembling, the thermal process and the chemical process must be planned from time to time depending on the type of photovoltaic panel, which means that such processes will be different, for example, depending on the thickness of the layers of the panel, the type and percentage of materials used, their size, etc ..

In practice, therefore, they must be chosen the chemical agents and the related assays to be used for the specific treatment, the temperatures to be employed, the duration of the various processes. This is expensive in amount of time and cost of designing for each type of panel to be treated.

Another drawback is due to the fact that the thermal processes give rise to the production of gases containing substances highly harmful, which require specific treatments abatement, onerous and also constitute a form of environmental hazard. More dangerous substances are contained in the washing water that can be used on completion of the heat treatment.

The chemical processes, therefore, are not only burdensome for the large quantities of chemical agents used but also very dangerous to the environment.

Finally, the energy used to accomplish both the chemical processes that thermal ones is considerable.

The main purpose of the mobile plant Pv-Mo.Re.De. it is to overcome the above drawbacks. The goal is achieved by proposing a system of disassembly of the photovoltaic panel such as to allow the recovery of raw materials present therein, without the need for adjustments to the process in function of the specific type of the panel, then a "universal" solution, suited for the treatment of any type of photovoltaic panel.

Generally, a photovoltaic panel, once assembled, includes:

- A photovoltaic cell, comprising siliceous material, copper and silver;
- A layer of glass for the protection of the photovoltaic cell;
- A first layer of plastic material for the protection of the photovoltaic cell;

- A second layer of plastic material for the protection of the photovoltaic cell.

In particular, the photovoltaic cell is disposed between the first and the second layer of plastic material.

When the photovoltaic panel is in use, of course, the layer of glass (transparent) is external and is arranged upward with respect to the first layer of plastic material (which is also transparent and includes, for example, Ethylene-Vinyl-Acetate, also known as "EVA"). This one is disposed above the photovoltaic cell (usually there is a plurality of photovoltaic cells) and above the second layer of plastic material too (for example a layer of polyvinyl fluoride, in particular in the film produced by DuPont under the trade name "Tedlar").

The Pv-Mo.Re.De. (Photovoltaic Mobile Recycling Device) uses an innovative technology for the recycling of photovoltaic panels (inside of a technology mainly directed to thermal-chemical treatements, as described above), exclusively mechanical (owner La Mia Energia Scarl patent BO/2013/A000701) can recycle almost the whole photovoltaic panel maximizing the recovery of materials (aluminum, glass, active photo materials, copper) reusable in new production processes and useful to produce energy at the same time (CDR, Eva and Tedlar). The implementation process of mechanical recovery of photovoltaic panels compared to their fixed installations (incinerators or plants leaching processes thermo-chemical) lead many advantages:

- Reduced environmental impact and reduced CO2 emissions;
- Lower production of waste;
- Simplification of the administrative management for the compliance with the rules of the sector;
- Saving and reduction in manufacturing costs compared to fixed industrial factories;
- Universality in the treatment of panels of 1st, 2nd and 3rd generation;
- Use of material in new processes from recovered waste;
- Mobility and improved logistics management.

The mobile device, in fact, is able to operate directly on the spot where the photovoltaic modules are installed, in plants dedicated to their recycling, in the production plants.

This peculiarity makes the system highly competitive compared to "traditional systems" as it dramatically reduces the intermediate logistic, with reduction of costs excluding the collection centers and intermediate storage that, with the costs of transport, provide a strong increase in its total cost of ownership.

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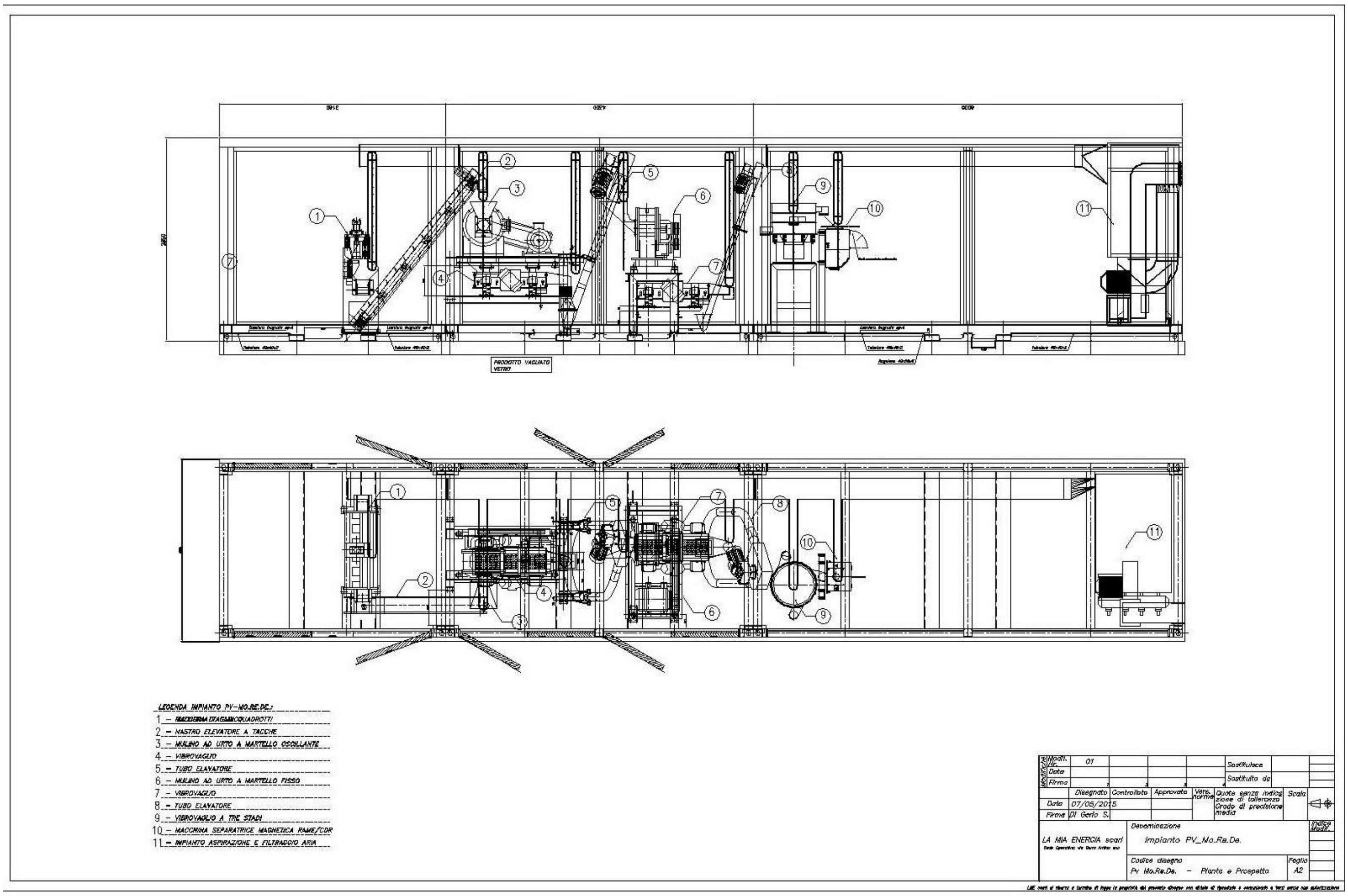
State of the art for the second mobile system Pv-Mo.Re.De.

The mobile plant Pv-Mo.Re.De. ("Photo Voltaic panels Mobile Recycling Device") used in the treatment and recycling of photovoltaic modules consists of nr. 3 steel box of self-supporting frame in HEA, box all acoustically and thermally insulated with rock wool D40, 40 mm thick, with more openings furniture.

The photovoltaic module to be subjected to recycling treatment is preliminarily weighed. It is then, in the pretreatment step and reclamation module, the extraction of the aluminum frame and the removal of the connection cable and the junction box (these components if broken, would strongly contaminate the by-products of manufacturing processes derived from it) .

Then the module is placed in mobile plant Pv-Mo.Re.De. to start the recycling treatment which consists in the succession of the phases of volumetric reduction, detachment of the scrap glass, detachment of the silicon, separation of plastics from copper.



Pv-Mo.Re.De. unit - Plant and Prospectus

The first process, carried out with the machine "tagliaquadrotti" (design and realization by La Mia Energia Scarl), is functional to the reduction of the glass into pieces of size specification 100x100 mm and suitable to the next separation treatment of the glass .

It is formed by two shoulders self supporting metal sheets of a thickness of 30 mm each with, on the inside, the fixed matrix bolted to the side walls and resting on two lugs welded to said walls.

The matrix is made from a sturdy composed sheet on which are applied the specific cutting inserts, made of ultrarapid HSS.

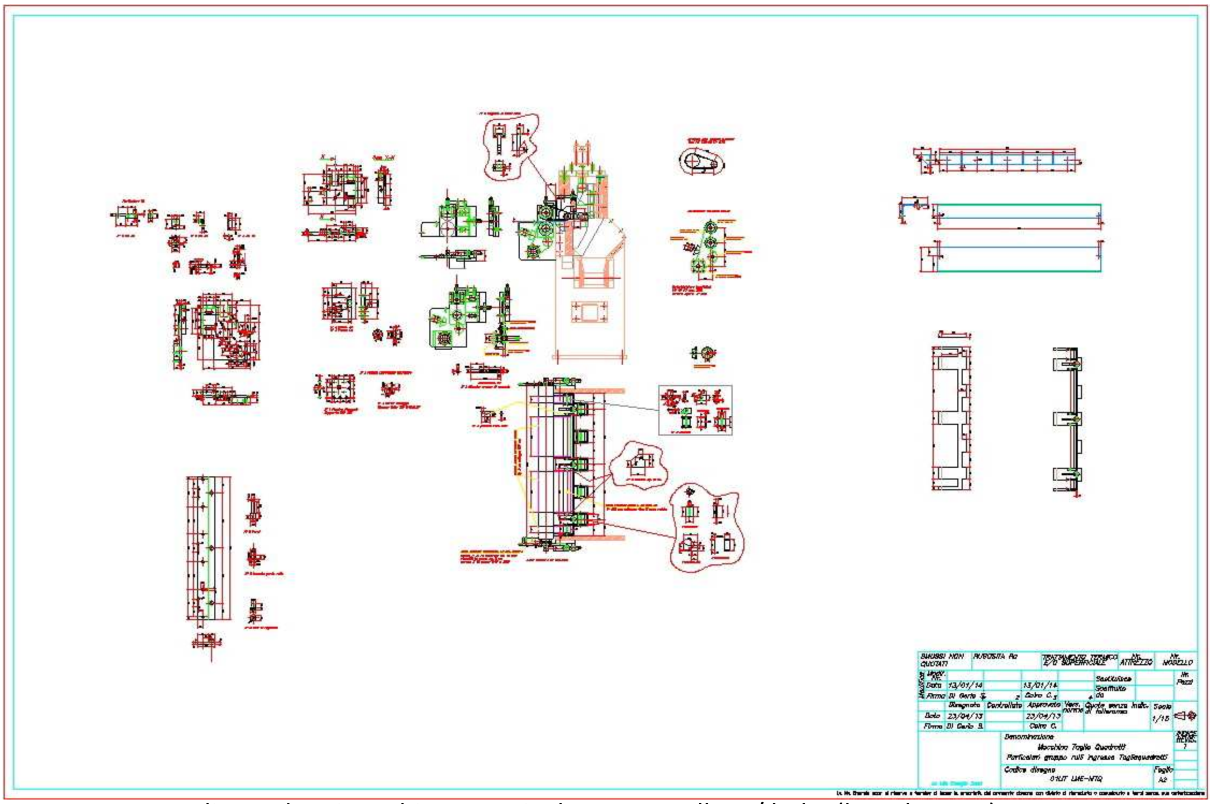
The movable die against which ensures the cutting of panels is realized as the fixed matrix, and is guided on the end by a system of linear guides with linear bearings.

The movement of the reciprocating type takes place through a hydraulic cylinder placed on top of the machine, fixed on a plate bolted to the structure.

The machine is equipped with discharge conveyors for product adduct on special extraction ribbon and fairings accident prevention and safety switch, in accordance with current safety standards.

The extraction of the material under the machine is ensured by a ribbon in continuous, connected with the starting of the machine.

► *Compared to the solution adopted in the first prototype, in the second plant, it is automated the insertion and advancement of the photovoltaic panel (devoid of aluminum frame, junction box and associated wiring) in the machine tagliaquadrotti, providing on this a special automatic transmission rollers / belts registers with centering and contrast, increasing from one side the working capacity of the machine (reduction of the times of registration) but mainly greatly enhancing its capacity and precision in the cutting of the photovoltaic panel in the dimensions required specifications and it is critical for successful continuation of the process (the table with CAD drawings representing changes to tagliaquadrotti). It is also enhanced its simplified hydraulic system and the electrical machine management, remaining unchanged throughout the security system. On the part of interconnection with the conveyor belt notches it is installed a fairing security for the purpose of eliminating any leakage of material and increase the comfort of the working environment.*



Tagliaquadrotti machine - particular group rollers / belts (last changes)

The photovoltaic panel truncated in the particle size desired (optimum size 100 x 100 mm), is sent to the conveyor belt at the loading hopper of the oscillating hammers mill (1st crushing stage of the process).

The tape is made of rubber with supports arranged transversely with cups where are collected the wafer squares of the photovoltaic cell treated and then transported to the hopper of the 1st crushing machine.

The material thus transported is conveyed by gravity from above into the hopper of the 1st crushing machine (oscillating hammers mill).

It is constituted by a single body (the casing of the machine) made of cast iron, with front cover also made of cast iron, openable for the activities of ordinary and extraordinary maintenance.

The grinding chamber is internally protected by replaceable plates. Toothed parts and hammers are made of steel casting with a high content of manganese or chromium alloys particularly resistant to wear. The hammers are with low wear. Grid with longitudinal dividers of 25 mm.

Here the material has its first crushing stage where it realizes the phase of separation of the glass from the holder of EVA.

► *In the embodiment of the second Pv-Mo.Re.De. unit, in order to improve the functionality of the oscillating hammers mill, it has been modified the geometry of the swinging hammer: it is thus obtained a better regulation of its trajectory over the cycle of rotation, leaving more space than the first impact wall, for the passage of a greater quantity of material to be treated to the first impact, and then gradually reduce*

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the section of passage between the hammers and impact wall, in step with the reduction in volume of the processed material. It is thus increased the effect of crushing, decreasing the absorption peaks of electrical power, while ensuring a more balanced functioning of the machine. This substantial change on the device inside of the mill has determined roughly an increase of the processing capacity of the material of 20%. Other remedial work carried out was that of a carter on the line conveyor with particular attention to the area of the transfer between conveyor and hopper of the mill (reduction / cancellation of the dispersion of the material in the environment).

In the next step the vitreous product is sifted and the resulting cullet has the characteristics as defined by the EU Regulation no. 1179/2012.

The sifting of the material is realized with a rectangular vibrating plate (dimensions 1000 x 300 mm) composed of a carbon steel netframe.

The network with light mesh and holes of 6 mm diameter is fixed to the structure with specific clamping screws net hooks, all suspended on nr. 4 support springs.

The drive of the machine is made with nr. 2 vibrators.

The product from the 1st stage of crushing is collected in the separator (rectangular table) where the motion due to the stacker-rotary vibrators determines transport, sieving and address to the exhaust ports dedicated.

In this phase, it realizes the separation of the glass (the value of the mesh network hole of 6 mm); the sieved material (<6 mm) constitutes the so-called MPS (Glass ready baked), ejected with a circular screw of a diameter ø 120 mm outside the cowling of the container for loading into the collecting container outside.

The material is instead collected on the loading hopper of the first conveyor chain.

► *In this section of the system, compared to the first embodiment, it is proceeded to a full carter on the entrance area of the rectangular vibrating sieve, in order to eliminate all possible leaks of dust arising from the process of sieving of the reduced material (problem manifested in the first building) in order to safeguard the safety and health of workers, thus preserving the areas of work and reducing to "Zero" the pollution impact on the environment.*

The extraction of the material from the rectangular separator and its subsequent transport to the 2nd stage of crushing, is made with a loading conveyor chain. The conveyor is of the type with tubes with lengths of 2000 mm and a diameter of ø 114 mm.

The machine adopts a system of chain transport with printed plastic-plates placed at regular intervals. The chain moves the material inside the tubes with high speed; chain flexibility allows its use in any situation.

The movement is given by a group of towing. The product is introduced inside the circuit through a loading hopper: the discharge of the material to be treated is loaded into the hopper of the 2nd crushing mill. The drive unit, the compensating unit and the mouths of loading and unloading are made of carbon steel. The pipes are made of carbon steel galvanized. The group and the rotating conveyor chains are made of cemented carbon steel.

► *In this section there isnt any change compared to the first plant built.*

The material produced by the oversize basically consists of Eva, Tedlar and siliceous material, it is introduced in the second crushing mill (mill impact hammer set) where it undergoes a careful process that allows to get a grind very fine and uniform associated with sands and / or powders.

Also the rectangular vibrating plate (dimensions 1000 x 300 mm) used in this section of the plant has features and operation similar to that described above. The net of the sieving is instead with light mesh and holes of a diameter of 2 mm. The product fraction is intercepted by the oversize fraction, particle size greater than 2 mm, and the gap constitutes the processing carried out in this phase consists of plastics and coded as CDR.

The plastic picked up from the hopper of the plate is conveyed on a circular spiral with a diameter of ø 120 mm which protrudes from the casing of the container for loading into the collecting container outside. In the below sieve instead, the fraction of product (compound mixed plastic materials, copper and silicon) whose particles have dimensions of less than 2 mm, is collected containing significant quantities of valuable metals which subsequently will be appropriately treated.

The mixed powder that escapes under the plate is channeled into a chain conveyor (analogous to that described above, but with a tube diameter ø 76 mm), which lifts the material and transfers it in a circular sieve to three separation stages, each with respective net vibrant plate, with three grain sizes specifications.

The first coarse separation is mainly composed of plastic and copper, with a particle size comprised in a range of 2 to 0.5 mm. This protrudes from the first upper stage, directly into the hopper for feeding a parting machine for non-ferrous metals and based on the principle of the currents induced by a rotating magnetic field, thus qualifying the process for the recovery of the filaments of copper, any metals and plastic.

The second fraction separated is in the range between 0.5 mm and 0.315 mm and protrudes from the second stage of the sieve circular. It is conveyed to fall from the inside of a pipe with a diameter ø 60 mm in a recovery container.

The third separation is related to material particles with a size less than 0.315 mm and protrudes from the third separation stage of the circular sieve. It is conveyed into fall inside a pipe of diameter ø 60 mm up to the collection container.

From the mixed compound (plastics, copper and silicon), treaty in the circular sieve with the three separation stages with the three product fractions:

- MPS containing low silicon with a particle size from 0.5 to 0,315 mm;
- MPS containing high content of silicon with a particle size <0.315 mm;
- Mixed plastic / copper with a grain size from 2 to 0.5 mm.

► *In this section (flaking of silicon) was not introduced any major changes compared to the first plant, since the products of processing already meet the desired specifications. Even here, however, it is proceeded to a full carter on the entrance area of the rectangular vibrating sieve, in the same way and with the same final objectives previously described.*

The by-product (particle size from 2 ÷ 0.5 mm) is a matrix constituted by a heterogeneous mixture of shapeless plastic (Eva / Tedlar) and fragments of copper purified from the silicon; it is sent to the separating machine whose operation is based on the principle of the induced currents generated by a rotating magnetic field. The induced currents circulating in the non-ferrous metal to be separated creates a repulsion force such as to cause a jump, an expulsion from the flow of inert material, and then the separation of it from the inert material which continues its normal path. From the heterogeneous shapeless matrix it is made the separation of the two fractions of plastic and copper.

► *In this section, phase of separation of the copper from the CDR, was not introduced any major changes compared to the first plant. It has been repositioned the machine with an optimization of the spaces available, in order to increase the safety of personnel.*

Unchanged the plant for uptake of dust from the atmosphere, according to what has already been prepared on the first mobile unit.

It is recalled that the suction system can treat air containing very fine powders, retaining a very high and almost constant collection performance, even for particles having sizes less than 1 ÷ 0.5 microns. In this way there is a filtration efficiency of 99.99%. The realization is performed with modular panels, made of galvanized steel with frontally thicknesses of max 30/10, and a barrier to collision of heavy thickness placed internally to the inlet mouth of the pollutant, in order to have an heavier first pre-felling of dust safeguarding the duration of the filtering cartridges.

The washing cycle is variable in function of the real needs of the plant at which the dust collector is connected. The control device is designed in order to obtain both the variation of the cleaning time and the variation of the frequency of the air.

This working flexibility facilitates the physical phenomena arising from the secondary countercurrent washing which causes the detachment of the layer of powder deposited on the fabric, in order to clean the same in depth, returning the maximum of the permeability.

The self-cleaning occurs by flowing the jet of compressed air at 6 ÷ 7 atmospheres through the solenoid valves from the inside of the cartridges. The lower body is fulled of a collection hopper with a mouthpiece for the direct discharge of waste to fall into a bin releasable equipped with wheels and portholes for the inside vision.

The group is designed to work in depression, so the dusty air enters the preliminary chamber which facilitates decantation of the larger particulates and then up the inside of the cartridge and filtered out from above via a connector. The filter media used for the realization both of the cartridges is felt anti-static polyester, therefore also suitable for finer dust. The filter is accessible from the upper doors and can be inspected from the side also needed to check the condition of the cartridges.

► *In this section there isnt any change compared to the first plant built.*

Extensions and prospects of use of Pv-Mo.Re.De.

The current situation of the photovoltaic market in Italy is characterized by the presence of 526,463 plants, with a capacity corresponding to 17,080 MegaWatt, with a particular concentration in the regions of Lombardia, Emilia Romagna and Triveneto.

The plants with capacity of less than 6 kWp account for 26% of total output and 83% of total installations, numbers that highlight how the residential market has grown.

In Europe, considering the more than 25 years since the beginning of the aplication of this technology and the growth of more than 50% of the photovoltaic power installed in the last five years in the three main markets (Italy, Germany and France), it can be said that the management the end of life is a market that will soon explode and then grow steadily.

The number of installations of photovoltaic systems with thin-film modules is growing throughout Europe and especially in hot countries of the Mediterranean area.

The technologies of the products available on the market are becoming more numerous and there is a particular interest in the thin film technology for the low cost of purchase of the modules and for the benefits related to the temperature coefficient. In fact, the low temperature coefficient of the thin film confirms the expectation that a PV system can give energy comparable to systems based on modules in poly or mono crystalline.

This analysis has determined the strategic decision to "open", with the second mobile system, also to the thin film modules highlighting even more the "universality" of the application Pv-Mo.Re.De technologies also very different in particular in 'approach to recycling at end of life.

Thin film panels technology

The thin-film cells are composed of semiconductor material deposited, usually as gas mixtures, on supports such as glass, polymers, aluminum, which give physical consistency to the mixture. The semiconductor film layer is a few microns, compared to crystalline silicon cells which have a thickness of hundreds of microns.

Therefore, the material saving is considerable and the possibility of having a flexible support increases the field of application of the thin-film cells.

The materials used in this type of panels are:

- Amorphous silicon;
- CdTe (cadmium telluride-cadmium sulphide);
- GaAs (gallium arsenide);
- CIS, CIGS, CIGSS (based alloys of copper and indium diselenide double).

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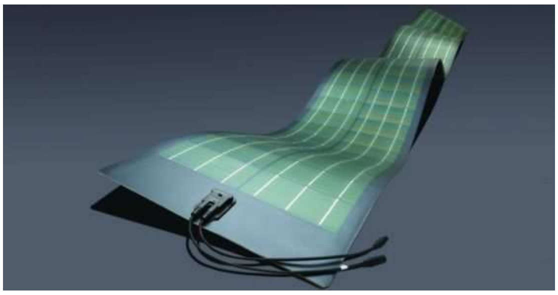


thin film stick

Amorphous silicon (a-Si) deposited as film on a support (such as aluminum) is the opportunity to have the PV at a reduced cost compared to crystalline silicon, but the cells verge to worsen over time. The amorphous silicon can also be "sprayed" out of a thin sheet of plastic material or flexible. It is mainly used when you need to minimize the weight of the panel and to adapt to curved surfaces. The yield (5 to 6%) is very low due to the many resistances that the electrons have to face in their flux. Also in this case the cell verge to worsen their performance over time. An interesting application of this technology is the tandem, which combines a layer of amorphous silicon with one or more layers of junction crystalline silicon; thanks to the separation of the solar spectrum, each junction positioned in sequence works at its best and guarantees higher levels in terms of both efficiency and durability warranty. CdTeS solar cells are composed of a layer P (CdTe) and one N layer (CdS) which form a PN hetero junction. CdTeS cells have higher efficiency than those in amorphous silicon: 10 ÷ 11% for industrial products (15.8% in laboratory tests). In the large-scale production of technology CdTeS is the environmental problem of the CdTe contained in the cell, which, not being soluble in water and more stable than other compounds containing cadmium, it can become a problem if not properly recycled or used.

GaAs technology is currently the most interesting from the point of view of the efficiency achieved, higher than 25 ÷ 30%, but the production of such cells is limited by the high cost and the scarcity of the material, to be used especially in the industry of "semiconductor High speed switching "and optoelectronics. In fact, GaAs technology is used primarily for space applications where small size and weight are important.

Modules CIS / CIGS / CIGSS technology are still under study and development. In place of silicon are used special alloys such as:

- Copper indium selenide (CIS);
- Copper, indium, gallium and selenite (CIGS);
- Copper, indium, gallium, sulfur and selenite (CIGSS).

The efficiency is currently of 10 ÷ 11% and the performance remain stable over time; as for the mono and poly crystalline silicon it is expected to reduce the cost of production. The market share of thin-film technologies is still very low (+/- 7%), but these technologies are seen as the solution with the most potential in the medium to long term, even for a significant reduction in prices.
Depositing the thin film directly on a large scale, up to more than 5 m^2, can avoid the processing scraps typical of the operation of cutting the wafers of crystalline silicon ingot from starting. The deposition techniques are low in energy consumption and therefore the relative payback time is short, that is, how much time should operate a photovoltaic system to produce the energy used to manufacture it (approximately 1 year for the thin films of amorphous silicon, against the 2 year for crystalline silicon).
Compared to crystalline silicon modules, the thin-film modules have a lower efficiency dependence on the operating temperature and improved response even when the component of diffused light is stronger and when they are low levels of radiation, especially on cloudy days .

	Silicon monocrystalline	**Silicon polycrystalline**	**Silicon amorphous**
η Cell	16÷17%	14÷16%	7÷8%
Advantages	high η η stable stable technology	lower cost Easier manufacture optimal footprint	lower cost Reduced influence of temperature Energy efficiency in diffuse radiation
Disadvantages	Greater quantity of energy necessary for manufacturing	Sensitivity to impurities in the manufacturing	Larger dimension Cost structure and assembly time

Comparing panels - Monocrystalline, Polycrystalline and Amorphous

	GaAs Arseniurio di Gallio	**Telleiuro di Cadmio**	**CIS Diseleniuro di Indio eRame**
η Cell	32,5%	12,4÷13,4%	13,6÷14,6%
Advantages	High resistance to high temperatures (ok for concentrators)	Low cost	very stable
Disadvantages	Tossicità Disponibilità dei materiali	toxicity Availability of materials	toxicity

Comparison of main types of panels - Amorphous Silicon

On the basis of these observations and in the perspective of a considerable increase in the use of this type of photovoltaic panels, it is implemented the idea of being able to use the system Pv-Mo.Re.De. also for the treatment and recovery of materials from the photovoltaic panels in thin film. These are devoid of a true support structure of aluminum (hence a simplification of the treatment cycle in the preliminary phase of reclamation) and remains intact throughout the potential of the working cycle / treatment brilliantly imagined and tested for the panels poly / mono crystalline also for this type of photovoltaic panel. Study activities (test) is started with the second plant Pv-Mo.Re.De. realized.

Global Service M.A.D.T. (Monitoring, Analysis, Decommissioning and Traceability):

In the interim, including the construction of two mobile systems, La Mia Energia has developed a system called Global Service MADT, a plus with Mobile Pv-Mo.Re.De., thet allows to analyze the efficiency of the intact photovoltaic panels in reference to Standard Test Conditions, allowing the release of certification for each individual PV panel that could be put on the market; this process integrates the decommissioning activities at the site (via technology PV-Mo.Re.De.) aimed at promotion of recycling.

The system M.A.D.T. includes the traceability of all actions ranging from disassembly to the sell or the warehousing for certified panels. The traceability is carried out with instrumentation equipped with wireless protocols that, in real time, transfer to a storage system and processing the measurement results associated to the photovoltaic panel in question, identified with a new barcode of service assigned or with the original barcode, following and documenting the path of the product from its packaging until removal (panel efficient) or at its entrance to the plant Mobile Pv_Mo.Re.De. (Panel reaches the end of life).

M.A.D.T. exploits, with a proprietary engineering, technology RFID (Radio Frequency Identification) for radio frequency identification of individual PV panel or component of value that should be easily traced and identified in the interim and final storage areas; the information collected through the gaps strategically placed at the operations site, transferred to the wireless management system allow real-time identify of each element in each individual process intervened in the pipeline.

The reuse activity of photovoltaic modules, with the mobile plant Pv_Mo.Re.De. and the system MADT, will be characterized by the following processing steps listed briefly below:

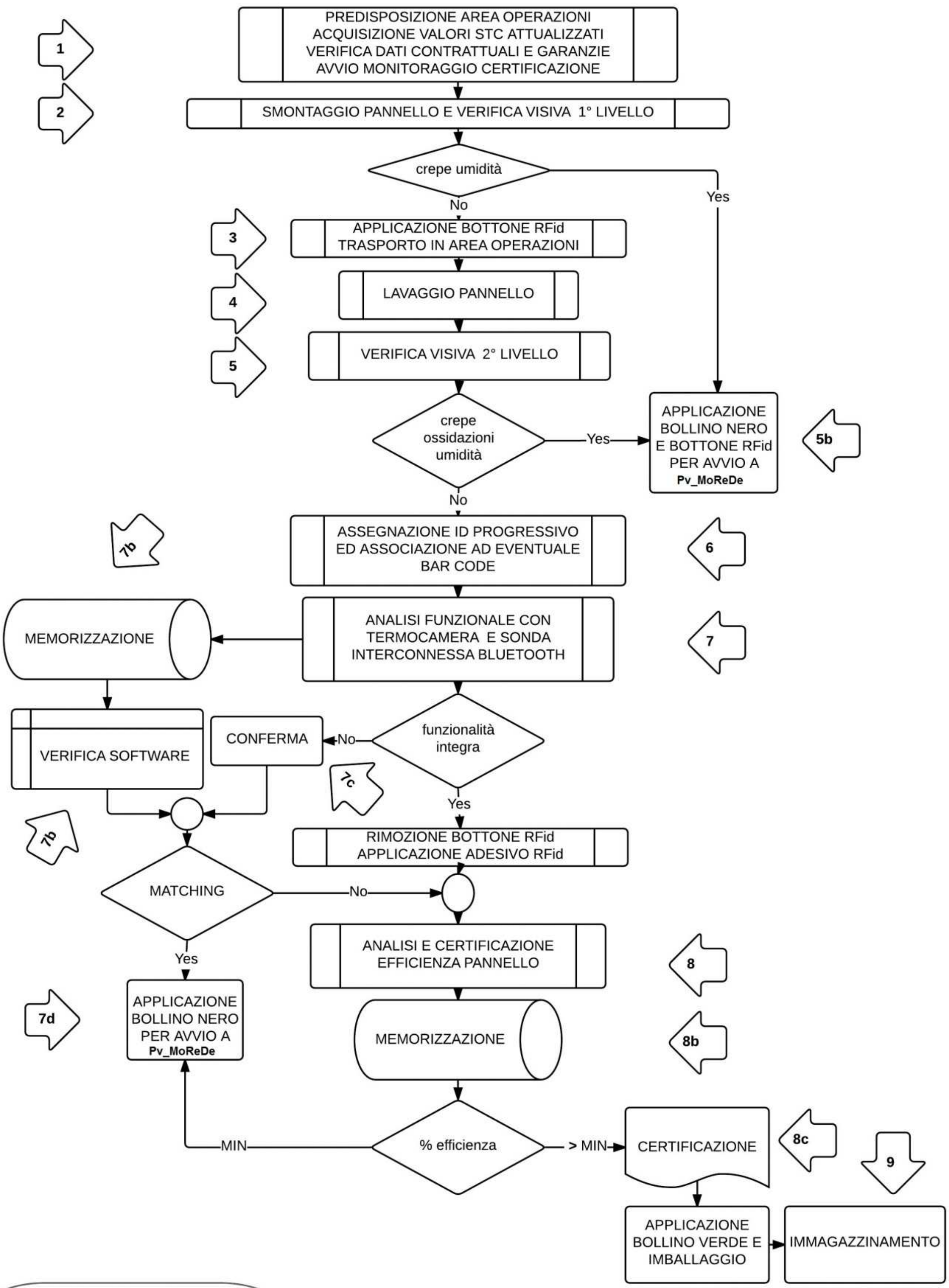
a. **dismantling of photovoltaic modules:** these activities related to the electrical disconnection and the undocking (2) of the photovoltaic modules from the support structures on which they are mounted (1), carried out with the necessary care and treatment to preserve any integrity ; the application of RFID tags and dismantling of the panels will be carried out by expert personnel equipped with screwdrivers or saw for fasteners excessively oxidized.

b. **1st level visual inspection:** visual inspection of the photovoltaic panel disassembled and evaluation of operating conditions of the component carried out by the operator based on specific parameters of feedback. Each team will have technical expertise required to ensure the reliability of the result. Visual checks are conducted to detect specific characteristics that occur on the surface (surface condition, breaks, gaps, imperfections, evident anomalies);

c. **transportation in the verification area:** photovoltaic modules, that at the first visual analysis will results not eligible will be appropriately branded with RFID button to clearly sign the target to recycle and will be transferred in the area dedicated; all others will be launched to the PV_test for the subsequent process of thermographic analysis and electronic measurement.

d. **PV_test**: In the specific area dedicated to the producibility assessment, the module will be carried out for the following activities:

- **washing (only for intact modules):** the modules are carefully washed and dried, mainly for proper protocol analysis of performance and efficiency, and subjected to a more careful analysis of visual level 2; modules are discarded properly branded and equipped with RFID button to signal unequivocally the target area will be transferred to recycling; the integer modules will continues in testing for subsequent analysis and measurements;
- **thermography:** thermographic analysis of the photovoltaic module with its characteristic IV; the operator's measures will be checked with their storage and batch processing to confirm the data analysis with a dedicated software. This process determines the operability of the module concerned. The modules intact are sent in a test area for subsequent control of efficiency.
- **Analysis:** electronic analysis according to EN 50160. This process determines the actual efficiency of the module compared to the original Standard Test Conditions. Those with efficiency equal to or greater than the agreed minimum are certified, packaged and stored ready to be placed on the professional market with the certification and measures papers in order to increase the interest of the market and to ensure this in the investment; if the panels effectively lower the minimum agreed, they will be launched in recycling.
- **start recycling:** modules not ok on the thermographic test, with the specific software, will be discarded, otherwise they will continue the testing phases.



La Mia Energia

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The photovoltaic panels that on thermographic and electronics test have recorded efficiency compared to the Standard Test Conditions, higher than the minimum requirement, will be packaged and placed in the appropriate platforms to be transported to the store.

Each platform can be up to n°. 40 photovoltaic panels already grouped by homogeneous efficiency in order to take stock of the warehouse and identify the type request in real time.

This solution will also enable logistics to significantly reduce costs.

The panels will be stored, each with his individual folders related containing image and reports of thermographic, graphs and reports of the electronics analysis and related certification; said documentation will be linked to the specific photovoltaic panel with code RIFD attributed and by the original bar code necessary to counter the trade of photovoltaic panels stolen.

The data will be registered on the web based "Virtual Warehouse" with the detail of photovoltaic panels available highlighting certification and documentation over the status of protected storage and the condition "ready to ship". The system of certification and traceability of the panels is intended to guarantee the sale on the market that is showing considerable interest.

On a German web platform for the sale of professional photovoltaic used panels, the polycrystalline 230 wp panels are sold on average at 60,00 Euro per module when 7 to 8 years old.

► *This is a service that La Mia Energia Scarl want to develop strategically and make available through the mobile plant Pv-Mo.Re.De.*

LA MIA ENERGIA Scarl

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Virtual Warehouse

Mia Energia Scarl has developed a Virtual Warehouse on a web platform for the real-time consultation of the detail on the "state" of photovoltaic panels for which carries out:

1. Consortium services for producers or importers of photovoltaic panels in order to comply with local regulations;
2. Collective System with authorization for storage in dedicated plant;
3. Storage for panels destined to MADT or Pv-Mo.Re.De.

The idea was born from the need to optimize the management of modules in accordance with law. Nr.49 of 03.14.2014 of WEEE and also the market of used photovoltaic modules which support of all the activities of Pv-Mo.Re.De. with the integration of the service M.A.D.T.

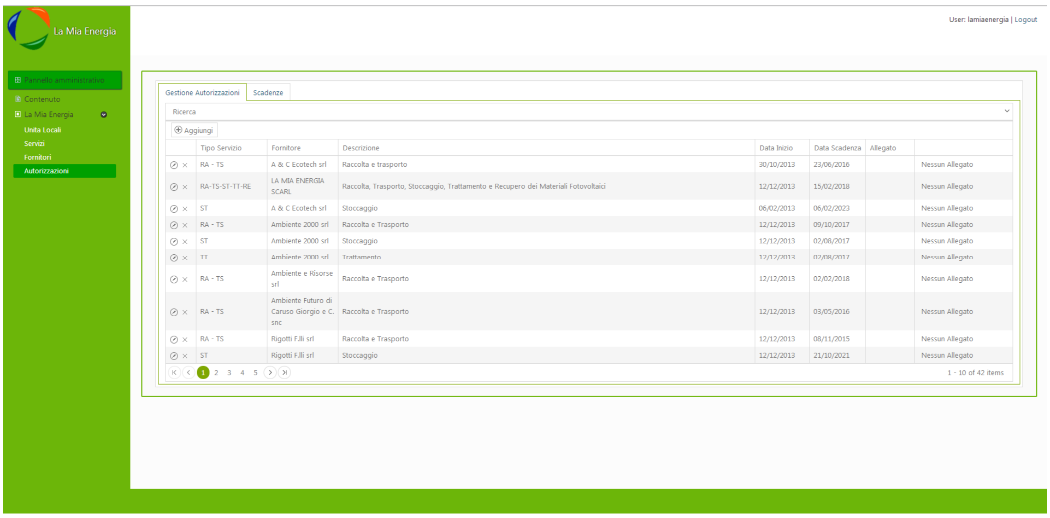
It is an accurate database with the following functions:

- Tracking photovoltaic modules, since they are placed on the market at the time of their operational use;
- Classify modules such WEEE;
- Order flows market output, depending on the use chosen by the end user.

For MADT, according to archive data, create the web cards describing in detail the photovoltaic panels available and highlighting certification and documentation over the status of protected storage and the condition "ready to ship".

The system of certification and traceability of the panels is intended to guarantee the sale on the market that is enjoying considerable interest.

Here are some video maps of the “Virtual Warehouse” web platform:



Moduli Totali Certificati **63829** Indietro

Contratti | Moduli

Elenco Contratti

Ricerca

Numero Contratto	Totale Moduli	Esercizio	Data	Cliente	Indirizzo	Note
11	816	2013	29/3/2013	C.S. Group srl	VIA S.CANI SNC 92023 - CAMPOBELLO DI LICATA (AG)	
12	102	2013	29/3/2013	Pisano srl	VIA MAFALDA DI SAVOIA,14 91100 - TRAPANI (TP)	
13	830	2013	29/3/2013	Società Agricola Agrisole srl	Corso Italia,33 80016 - Marano di Napoli (NA)	
14	94	2013	29/3/2013	Mondo Verde Energia	Via della Bonifica,12 84025 - Eboli (SA)	
15	100	2013	29/3/2013	New Energy Power srl	Viale P.L Nervi, 246 - Latina (LT)	
16	1022	2013	29/3/2013	Tecnoenergia srl	Via Figliardi, snc 84091 - Battipaglia (SA)	
17	3540	2013	29/3/2013	So Ge srl	Viale Europa 84091 - Battipaglia (SA)	
18	3102	2013	29/3/2013	Beta Cavi srl	Via delle Industrie Z.I. 84091 - Battipaglia (SA)	
19	108	2013	29/3/2013	Elettropimpianti f.lli Cisani	Via G.Deledda,6 24030 - Mapello (BG)	
20	3678	2013	29/3/2013	Tecsolis Spa	Via Baraggino ex cava snc 10034 - Chiavasso (TO)	

1 2 3 4 5 6 — 11 - 20 of 60 items

Elenco Unità Locali

Totale Moduli	Soggetto Gestore	Indirizzo	Numero Pratica GSE	Coordinate GPS	Num. Attestato	Note	Attestato	Allegato	Attestato per il GSE
168	FULL RESIDENCE SRL	S.S. 228 DEL LAGO DI VIVERONE, 35 10100 - BUROLO (TO)	774638	45.471413N - 07.920911E	56		pdf	pdf	pdf
3510	NOVA CALABRIA SRL	S.S. BAGNARA SNC - LOCALITA' PIANI CORONA 89020 - MELICUCCA (RC)	813319	38.303566N - 15.860538E	57		pdf	pdf	pdf

1 — 1 - 2 of 2 items

Moduli Totali Certificati **63829** Indietro

Contratti | Moduli

Elenco Moduli

Ricerca

Numero Seriale	Marca	Modello	Peso	Responsabile	Numero Pratica GSE
XH72M1900801110773	Zhejiang Shinew Photoelectronic Technology Co. Ltd.	XH-72M-190	15.6	Arch Energy srl	808104
XH72M1900801110762	Zhejiang Shinew Photoelectronic Technology Co. Ltd.	XH-72M-190	15.6	Arch Energy srl	808104
XH72M1900801110803	Zhejiang Shinew Photoelectronic Technology Co. Ltd.	XH-72M-190	15.6	Arch Energy srl	808104
XH72M1900801110472	Zhejiang Shinew Photoelectronic Technology Co. Ltd.	XH-72M-190	15.6	Arch Energy srl	808104
XH72M1900801110439	Zhejiang Shinew Photoelectronic Technology Co. Ltd.	XH-72M-190	15.6	Arch Energy srl	808104
XH72M1900801110142	Zhejiang Shinew Photoelectronic Technology Co. Ltd.	XH-72M-190	15.6	Arch Energy srl	808104
XH72M1900801110116	Zhejiang Shinew Photoelectronic Technology Co. Ltd.	XH-72M-190	15.6	Arch Energy srl	808104
XH72M1900801110493	Zhejiang Shinew Photoelectronic Technology Co. Ltd.	XH-72M-190	15.6	Arch Energy srl	808104
XH72M1900801110068	Zhejiang Shinew Photoelectronic Technology Co. Ltd.	XH-72M-190	15.6	Arch Energy srl	808104
XH72M1900801110172	Zhejiang Shinew Photoelectronic Technology Co. Ltd.	XH-72M-190	15.6	Arch Energy srl	808104

1 2 3 4 5 6 7 8 9 10 ... — 1 - 10 of 63829 items

LA MIA ENERGIA

ATTESTATO DI ADESIONE DEL PRODUTTORE AL CONSORZIO LA MIA ENERGIA

LME /13 DATA EMISSIONE

1 CONTRAENTE N° CONTRATTO del 27/01/2014

Denominazione o Ragione Sociale

Indirizzo

Codice Fiscale 05151631210

2 PRODUTTORE SOGGETTO RESPONSABILE

Denominazione o Ragione Sociale

Indirizzo

Codice Fiscale 09715571007

3 CERTIFICHIAMO LA PRESA IN CONSEGNA DI MODULI FOTOVOLTAICI PER LO SMALTIMENTO / RECUPERO A FINE VITA DEI NUMERI SERIALI COME DA ALLEGATO AL PRESENTE CERTIFICATO

"Regole applicative per il riconoscimento delle tariffe incentivanti" (DM 5 Maggio 2011 e DM 5 Luglio 2012) - Disciplinare Tecnico del GSE Dicembre 2012

1. N° 5000 Marca SHARP Modello NAE120G5 Peso 24
Unità Locale
2. N° 3080 Marca SHARP Modello NAE130G5 Peso 24
Unità Locale
3. N° Marca Modello Peso
Unità Locale
4. N° Marca Modello Peso
Unità Locale
5. N° Marca Modello Peso
Unità Locale

TOTALE MODULI N° 8080 (specifiche dei numeri di seriali riportati in allegato n. 1)

4 GARANZIA

Data inizio garanzia di trattamento a fine vita Moduli giacenti in magazzino

5 FIRME

FIRMA DEL CONTRAENTE FIRMA DEL CONSORZIO La Mia Energia Scarl

6 RISERVATO AL CONSORZIO Idoneo ai sensi del Disciplinare Tecnico pubblicato in attuazione delle Regole Applicative per il riconoscimento delle tariffe incentivanti (DM 5 maggio 2011 e DM 5 luglio 2012).

Si dichiara di aver ricevuto la somma di Euro al Trust Free Energy in data

con Bonifico N°

PER IL CONSORZIO

LA MIA ENERGIA Scarl
Sede Legale: via M.T. Cicerone 14/L - 86079 Venafro (Is)
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Final (average) for the treatment / testing of nr. 225 photovoltaic panels mono / polycrystalline worked with the second mobile Pv_Mo.Re.De .:

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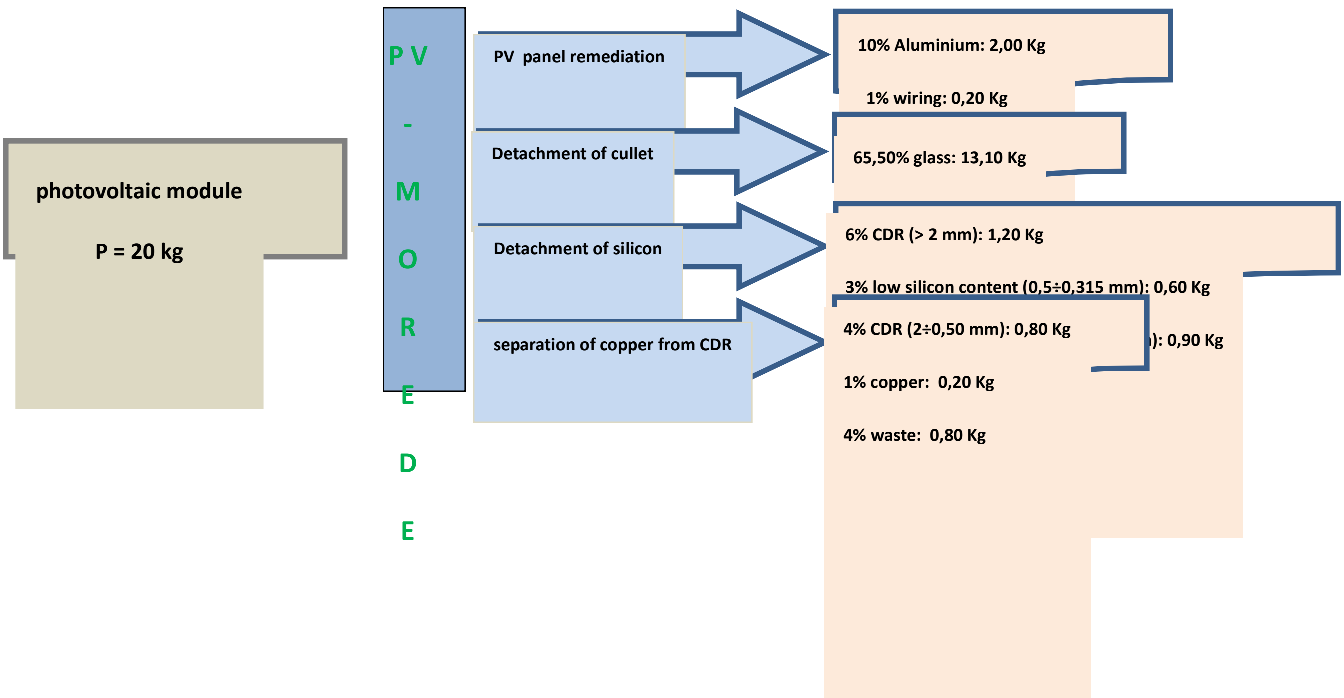
P.IVA 10656421004
Tel / Fax 0776.300717

FLOW-CHART OF THE REPORT ON AVERAGE QUANTIFICATION OF PV MODULE TREATED:



Characterizations mobile unit Pv-Mo.Re.De.	
average life of the mobile unit	**8 years**
average daily operation	**8 h/day**
operating days in a year	**230 days/year**
operating hours in a year	**1840 h/year**
panels treated in a year	**73.600 photovoltaic panels** with a processing capacity of about 0.80 tons/h or 40 panels/h with weight reference panel of 20 kg