LA MIA ENERGIA Scarl
Sede Legale: via M.T. Cicerone 14/L - 86079 Venafro (Is)
Direzione: Centro Ricerca via Cerro snc - 03043 Cassino (Fr)
Sede Tecnica ed Operativa: via Cavallara snc - 03030 Castrocielo (Fr)
P.IVA 10656421004
Tel / Fax 0776.300717

PV-MOREDE

Photo**V**oltaic

panels

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

DELIVERABLE D 5.3

MARKETING ANALYSIS INCLUDING PESTEL SWOT AND PORTER ANALYSIS

AGREEMENT NUMBER:
ECO/12/333078/SI2.658616

Cassino, UPDATE 30/09/2015

LA MIA ENERGIA Scarl
Sede Legale: via M.T. Cicerone 14/L - 86079 Venafro (Is)
Direzione: Centro Ricerca via Cerro snc - 03043 Cassino (Fr)
Sede Tecnica ed Operativa: via Cavallara snc - 03030 Castrocielo (Fr)
P.IVA 10656421004
Tel / Fax 0776.300717

2. Market Analysis Summary / Scenarios

Although there are still no market analysis that can provide reliable data concerning the amount of photovoltaic panels at the end of life (EOL), there are researches validated at European level that estimate scenarios for each EU country in terms of installed power, contemplating different assumptions depending on policy effectiveness of incentives to support investments in alternative energy . Studies currently accredited are those of EPIA and those of the European Commission DG Environment updated to May 2012.

About the market for photovoltaic panels at the end of life, the uncertainty of potential market estimates decreases the further in the timeline, while greater uncertainty may persist in the short term .

We still make reference to this as in the initial project draft. During the drawing up of estimates of business development of the LME, data in these studies were adopted as reference, choosing the less optimistic (moderate) scenarios to make projections more conservative and cautious.

Moreover currently solar companies do not have a clear recycling plan, and for this reason the market size for the recycling of solar panels is uncertain.

The industry has seen an exponential global growth in the market in the past decade shown in Figure below (source EPIA 2012 - Global annual installed PV capacity in GW)

Country	Scenario	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EUROPE											
Austria	Moderate	28	33	53	96	176	280	400	540	700	880
	Policy-Driven						380	660	1,100	1,600	2,200
Belgium[a]	Moderate	27	108	627	1,044	2,018	2,400	2,700	3,100	3,400	3,800
	Policy-Driven	[26]	[103]	[597]	[994]	[1,922]	2,600	3,200	3,800	4,400	5,000
Bulgaria	Moderate	0.1	1	7	35	135	280	430	580	780	980
	Policy-Driven						380	660	1,000	1,400	1,900
Czech Republic	Moderate	3	64	462	1,952	1,959	2,000	2,000	2,000	2,100	2,200
	Policy-Driven						2,000	2,100	2,300	2,600	3,100
Denmark	Moderate	3	3	4	6	16	40	70	110	150	200
	Policy-Driven						70	140	240	340	440
France	Moderate	26	84	269	988	2,659	3,200	3,700	4,200	4,700	5,200
	Policy-Driven						4,700	6,700	8,700	10,700	13,200
Germany	Moderate	4,170	5,979	9,785	17,193	24,678	28,700	30,700	33,700	36,700	39,700
	Policy-Driven						32,700	37,700	42,700	47,700	52,700
Greece	Moderate	8	18	55	205	631	1,100	1,900	2,100	2,600	3,100
	Policy-Driven						1,400	2,200	3,000	3,900	4,900
Hungary	Moderate	0.3	0.4	1	2	4	10	30	80	100	150
	Policy-Driven						20	70	170	370	670
Italy	Moderate	93	432	1,144	3,470	12,754	15,800	17,300	19,000	21,000	23,300
	Policy-Driven						16,800	21,800	24,800	27,800	30,800
Netherlands	Moderate	48	52	63	83	103	130	160	280	430	630
	Policy-Driven						150	250	450	750	1,300
Poland	Moderate	1	1	1	2	3	0	50	150	300	500
	Policy-Driven						0	100	300	600	1,100
Portugal	Moderate	16	68	112	150	183	230	310	430	600	800
	Policy-Driven						230	330	530	830	1,300
Romania	Moderate	0.01	0.01	1	2	3	30	80	150	250	400
	Policy-Driven						200	600	1,200	2,000	3,000
Serbia	Moderate	N/A	N/A	N/A	0.5	0.5	30	230	580	930	1,300
	Policy-Driven						150	450	900	1,400	1,900
Slovakia	Moderate	2	2	3	148	468	500	550	650	800	1,000
	Policy-Driven						520	620	820	1,100	1,600
Slovenia	Moderate	1	2	9	35	81	140	200	270	340	420
	Policy-Driven						180	310	460	630	830
Spain[a]	Moderate	724	3,568	3,588	4,029	4,400	4,500	4,500	4,800	5,100	5,600
	Policy-Driven	[690]	[3,393]	[3,417]	[3,837]	[4,191]	4,700	5,200	6,000	6,800	7,800
Switzerland[a]	Moderate	34	46	72	111	216	320	440	590	770	976
	Policy-Driven	[32]	[43]	[69]	[106]	[206]	420	720	1,100	1,600	2,100
Turkey	Moderate	0.01	0.3	0.4	0.5	6	20	70	170	320	520
	Policy-Driven						90	250	590	1,200	1,900
Ukraine	Moderate	N/A	N/A	N/A	3	190	290	440	640	890	1,200
	Policy-Driven						540	1,000	1,700	2,600	3,800
United Kingdom	Moderate	16	22	29	91	875	1,100	1,400	1,600	1,900	2,100
	Policy-Driven						2,900	4,100	5,600	7,400	9,400
Rest of Europe[b]	Moderate	56	70	74	132	158	220	330	490	730	1,200
	Policy-Driven						340	730	1,400	2,400	4,000
TOTAL EUROPE	Moderate	5,257	10,554	16,357	29,777	51,716	61,320	67,810	76,190	85,590	95,350
	Policy-Driven						73,470	89,970	108,960	130,120	154,940

This publication has been produced with the assistance of the European Union. The contests of this publication are the sole responsibility of La Mia Energia SCARL and can in no way be taken to reflect the views of the European Union.

LA MIA ENERGIA Scarl
Sede Legale: via M.T. Cicerone 14/L - 86079 Venafro (Is)
Direzione: Centro Ricerca via Cerro snc - 03043 Cassino (Fr)
Sede Tecnica ed Operativa: via Cavallara snc - 03030 Castrocielo (Fr)
P.IVA 10656421004
Tel / Fax 0776.300717

Market Segment:

Currently most solar panels are made of crystalline silicon wafers (Si and a-Si based panels), while the second most common PV technology used in panels are thin-film. The % of crystalline panels installed, has varied along last 20 years, as they are substituted by other PV panels technologies. The current % of crystalline panels is estimated to be between 60 – 75% of overall installed capacity.

year	Si + a-Si	Other
2005	98%	2%
2006	97%	3%
2007	95%	5%
2008	91%	9%
2009	84%	16%
2010	86%	14%
2016	72%	28%

Annual global PV capacity (GW) for various PV technologies

Solar photovoltaic panels are designed to last for a long period of time by withstanding several years of atmospherics agents. The estimated lifecycle of the solar panels is about 25 years, a duration in which the customers are generally guaranteed that the solar panel will run at 80% of its original efficiency. According to an article by Green machine (Knight, 2010) solar panels have a lifespan of 25 years and those that were installed in the early 1990s are reaching their end-of-life soon. Although this may be true, there are few companies that are recycling their damaged solar panels.

Yet as the oldest PV panels are reaching their end-of-life, this trend will continue to grow day by day and will have a significant increase after 2025.

Several studied were made for estimating the quantities of EOL panels during next years, or which could be the quantities of damaged panels per year compared to the installed ones.

At the beginning of our project and for the first revision of our business plan, also according to the studies carried out at European level by private research institutes, we considered the following % of waste to determine the quantities of material be treated for disposal and recovery :

- **0.31% of installed quantities** for the end of life for damages determined by different causes (atmospheric agents, natural death) and we named them **End of Life panels (EOL)**
- **0.85 % of installed quantities** reaches the end of life because of damages during the transportation, assemblage of production defects (with guarantee changes), which we will name **Waste of production cycle (WASTE).**

This publication has been produced with the assistance of the European Union. The contests of this publication are the sole responsibility of La Mia Energia SCARL and can in no way be taken to reflect the views of the European Union.

LA MIA ENERGIA Scarl
Sede Legale: via M.T. Cicerone 14/L - 86079 Venafro (Is)
Direzione: Centro Ricerca via Cerro snc - 03043 Cassino (Fr)
Sede Tecnica ed Operativa: via Cavallara snc - 03030 Castrocielo (Fr)
P.IVA 10656421004
Tel / Fax 0776.300717

Nevertheless, very contrasted opinions and studies emerged during these last two years, making the estimation of EOL and wasted panels very uncertain. For a principle of prudence in drafting the business plan, we have decided to make reference to one of most accredited recent analysis made by the Energy Department's National Renewable Energy Laboratory (NREL) in USA, which asserts that "*Solar photovoltaic (PV) systems affected by defective or underperforming panels is very low — **just 0.1 % per year** according to new data of 50,000 systems installed between 2009 and 2013".*

Even if most european research institutes consider these conclusions too conservatives, we decided to review our business plan on the base of this assertion.

As part of our development plans, after Italy, we selected countries in Europe to which starting since the beginning a work of market penetration . These countries were selected for the density of solar panels installed , of their obsolescence and the local sensitivity towards environmental and recycling issues.

To estimate our market potential, the size of the organizational structure and costs, the assessment of revenues , we have to make some assumptions:

Estimation of potential market in target countries.

Detailed cumultaive historical market data and outlook until 2016 (MW) - (Source EPIA)

Country	Scenario	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Market Share
France	Moderate	26	84	269	988	2.659	3.200	3.700	4.200	4.700	**5.200**	5,4%
Germany	Moderate	4.170	5.979	9.785	17.193	24.678	28.700	30.700	33.700	36.700	**39.700**	41,4%
Italy	Moderate	93	432	1.144	3.470	12.754	15.800	17.300	19.000	21.000	**23.000**	24,0%
Spain	Moderate	724	3.568	3.588	4.029	4.400	4.500	4.600	4.800	5.100	**5.600**	5,8%
Total Target Countries		**5.013**	**10.063**	**14.786**	**25.680**	**44.491**	**52.200**	**56.300**	**61.700**	**67.500**	**73.500**	**77%**

Data on MW produced by photovoltaic panels installed in different countries are officially provided by EPIA (2012)

We have estimated then the cumulative quantities (in MW) of defective panels per year coherently with the assumption that only 0,1% should be defective or unperforming.

Detailed cumulative estimation of defective panels until 2016 (MW) - 0,1% Defective per year

Country	Scenario	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
France	Moderate	0,0	0,1	0,3	1,0	2,7	3,2	3,7	4,2	4,7	**5,2**
Germany	Moderate	4,2	6,0	9,8	17,2	24,7	28,7	30,7	33,7	36,7	**39,7**
Italy	Moderate	0,1	0,4	1,1	3,5	12,8	15,8	17,3	19,0	21,0	**23,0**
Spain	Moderate	0,7	3,6	3,6	4,0	4,4	4,5	4,6	4,8	5,1	**5,6**
Total Target Countries		**5,0**	**10,1**	**14,8**	**25,7**	**44,5**	**52,2**	**56,3**	**61,7**	**67,5**	**73,5**

To transform the estimated MW of capacity installed in Tons of material to be treated it's assumed that 1MW installed=75 tons of solar panels installed. This assumption was initially validated at EU level by an important research centre.

This publication has been produced with the assistance of the European Union. The contests of this publication are the sole responsibility of La Mia Energia SCARL and can in no way be taken to reflect the views of the European Union.

LA MIA ENERGIA Scarl
Sede Legale: via M.T. Cicerone 14/L - 86079 Venafro (Is)
Direzione: Centro Ricerca via Cerro snc - 03043 Cassino (Fr)
Sede Tecnica ed Operativa: via Cavallara snc - 03030 Castrocielo (Fr)
P.IVA 10656421004
Tel / Fax 0776.300717

The converted quantities in tons equivalent installed in target countries are reported in the following table:

Detailed cumulative estimation of Tons of defective panels until 2016 Tons - 1MW = 75 Tons											
Country	Scenario	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
France	Moderate	2	6	20	74	199	240	278	315	353	390
Germany	Moderate	313	448	734	1.289	1.851	2.153	2.303	2.528	2.753	2.978
Italy	Moderate	7	32	86	260	957	1.185	1.298	1.425	1.575	1.725
Spain	Moderate	54	268	269	302	330	338	345	360	383	420
Total Target Countries		**376**	**755**	**1.109**	**1.926**	**3.337**	**3.915**	**4.223**	**4.628**	**5.063**	**5.513**

Table illustrate the estimated dimension of our reference market for next three years.

Detailed cumulative estimation of MW and Tons of defective panels to be treated x year by PVMOREDE device based on initial estimated market penetration										
% Market penetration x Target Country					MW x Target Countries			Tons Equivalent x Target Countries		
Country	Scenario	1st Year	2nd Year	3rd Year	1stYear ('14)	2nd Year ('15)	3rd Year ('16)	1stYear ('14)	2nd Year ('15)	3rd Year ('16)
France	Moderate	3%	5%	8%	0,126	0,235	0,416	9	18	31
Germany	Moderate	2%	5%	8%	0,674	1,835	3,176	51	138	238
Italy	Moderate	4%	8%	12%	0,760	1,680	2,760	57	126	207
Spain	Moderate	3%	5%	8%	0,144	0,255	0,448	11	19	34
				Total Target Countries	**1,7**	**4,0**	**6,8**	**128**	**300**	**510**

Demand point of view

Solar energy is considered as a clean solution because it is a renewable energy source. However, if the solar industry is to truly present a sustainable solution it must account for the photovoltaic solar panels' end-of-life phase.

According to several analysis made comparing systems for energy production, the future of the solar panels depends primarily on the cost. The goal of the solar industry is to reach an installed price of €0.90/W. When looking at the installed cost of a system, not only is the cost of the module accounted for but also the cost of the balance of system. In 2010, the average installed cost was €3.0 In order to reach €0.90/W, it is expected that the cost for manufacturing PV module decreases from €1,53/W in 2010 to €0,45/W.

For this reason (including a shorter ROI), in the recent past, several incentives were adopted by governments for a certain period. Now the approach seems to be toward the substitution of existing panels with much more efficient ones. The technology gap in 20 years is huge, and the efficiency of current solar panel results almost 4 time compared with the oldest. Now that national policies do not drive more the market, the current starting trend is to substitute the old - but still running solar plants - with new much more efficient. This should speed up the trend in recycling and the need of solar plant management system. Likewise Europe's policy shows a clear trend towards waste avoidance, recycling, and eco-design requirements.

This publication has been produced with the assistance of the European Union. The contests of this publication are the sole responsibility of La Mia Energia SCARL and can in no way be taken to reflect the views of the European Union.

Few solar companies have a clear strategy for panels recycling, and they appear unattracted in reusing materials from recycled panels; at the contrary, several municipalities show how recycling various parts of solar panels can be mutually beneficial to them as well as to the customers and companies. If companies produce their solar panels more environmentally friendly, the various municipalities can take advantage by accepting those items for recycling and reusing or reselling those items to companies that can benefit from the reuse.

Due to the lack of panels at their end-of-life, the recycling process is primarily used for recovering materials from broken panels or manufacturing scraps and by the substitution of existing solar plant system with new ones.

Competitors and supply point of view

Even if the cumulative estimation of detective panel to be treated appear an extremely interesting business since the closest future, only two solar companies have implemented a recycling process for their solar panels, Deustche Solar and First Solar.

Deutsche Solar recycling process was designed in 2003 for the recycling of crystalline silicon panels. Through a thermal process, plastic components are separated from the panel, while the remaining parts are manually removed. Once the components (glass, aluminum, steel, etc.) are separated, they are sorted and placed into their respective established recycling processes. The solar cells, on the other hand, are retched into wafers.

First Solar's treatment process for their CdTe panels was developed in the late nineties and was established in 2003. The collected panels are first shredded and put into a hammer mill in order to break the glass down to four to five mm pieces. The semiconductor materials are then separated through the addition of acid and hydrogen peroxide. The glass shards are then filtered out of the liquid waste through the usage of a vibrating screen. These shards are then rinsed, leaving the glass cullet, which can then be used to manufacture new glass pieces. The liquid that the glass was removed from gets pumped into precipitation unit where the semiconductor materials can be filtered out and recovered. Figure 4 displays the process in which First Solar's CdTe panels are recycled. First Solar states that their recycling process can recover 90% of the glass and 95% of the semiconductor materials for reuse in new PV panels.

Legal framework

The new WEEE Directive 2012/19/CE has introduced the extension of the scope to the photovoltaic panels, not previously covered. Despite the fact that such Directive had to be transposed in each EU member State before 14 February 2014, the situation in the examined countries has shown a general time-delay in each adoption process: in Germany, Spain and France, the respective proposed Draft Decrees are still under consultation or are nearest to be published in the related Official Journal. In Italy, the Decree has been published in the Official Journal on 28 March 2014.

Although this decree provides for the possibility of collection systems of both individual and collective type, through properly authorized consortium, it is assumed that the stringent requirements and the necessary documentation needed in case of an individual system, could lean the recycling-market of solar panels towards to a greater

This publication has been produced with the assistance of the European Union. The contests of this publication are the sole responsibility of La Mia Energia SCARL and can in no way be taken to reflect the views of the European Union.

LA MIA ENERGIA Scarl
Sede Legale: via M.T. Cicerone 14/L - 86079 Venafro (Is)
Direzione: Centro Ricerca via Cerro snc - 03043 Cassino (Fr)
Sede Tecnica ed Operativa: via Cavallara snc - 03030 Castrocielo (Fr)
P.IVA 10656421004
Tel / Fax 0776.300717

diffusion of collective systems.

The authorization to operate of the PV-Morede treatment plant in the different countries is determined by national regulation on waste and waste treatment plants, so that it differs from one State to another and, in general, it refers to procedures that are not specific for WEEE.

Moreover in case of transfer of waste from a country to another, further specific norms have to be considered and supplementary permits must be achieved by LME.

The release of the Authorization in Germany requires the fullfillment of Federal (national) and of Lander regulation, so that the procedure may also vary depending on the local Authority. Depending on the period of operation (more or less than one year), on the characteristics of the waste, on the size of the plant and of the temporary material storage site, either a simplified or a full Authorization is required.

French legislation addresses “movable treatment plants” in a specific category, so that – under certain requisites - it is possible to get the Authorization for a limited time period without a full investigation on the plant; the possibility of a simplified procedure is enabled in case of an operation time shorter than one year.

In case of Spain, main relevant regulation on the topic of waste management and environmental protection have been identified; however, the Authorization procedure, also in this case, is dependent on the local Authority (Autonomous Communities).

This publication has been produced with the assistance of the European Union. The contests of this publication are the sole responsibility of La Mia Energia SCARL and can in no way be taken to reflect the views of the European Union.

LA MIA ENERGIA Scarl
Sede Legale: via M.T. Cicerone 14/L - 86079 Venafro (Is)
Direzione: Centro Ricerca via Cerro snc - 03043 Cassino (Fr)
Sede Tecnica ed Operativa: via Cavallara snc - 03030 Castrocielo (Fr)
P.IVA 10656421004
Tel / Fax 0776.300717

SWOT Summary

In the business assessment, we took into account of risks related to the loss of competitiveness and difficulties of market penetration, which we summarise in Potential Market Barriers and SWOT Analysis.

MARKET BARRIERS	OUR SOLUTION
• Start up company	• The device has attractive aspects compared to competitors because of local treatment and on-demand. • The potential growth rate of the sector is extremely high and maintains a good level of controlled growth in the business and in the organization • Organizational and technical support resulting from the collaboration with universities and international research centres.
• Competitors in collecting panels	• Since there is no industrial systems established and recognized as valid, there's in the world market the largest organization of collection of panels : PV Cycle • PV Cycle is a world organization that gathers panels to arrange for subsequent treatment , although at the moment it has not yet defined a technology industry (but we know that there are ongoing investigations in this direction) . PV Cycle is one of the partners who has LME as leader. It will be our policy to try to become the trading partner .
• Solar panels disposal still in development and definition phase	• The legislation at European and national level introduces the creation of a network of persons possessing the necessary authorization for the transport and processing of solar modules with the availability of staff , professionally trained in handling this type of waste . Organizations that can meet these requirements , should adopt initially an extremely flexible and cost management to compensate the small amount of panels at the time to dispose, while LME comes as concept to supply this need by anticipating the times.
• Low number of panels at the end of life.	• The current low demand for panel disposal creates a barrier for disposal industrial systems, but this create also for us an opportunity. • PV-MOREDE system can be used for all operators that aim to be conformed to requirements for recycle and treatment of EOL panels (e.g., installation panels companies, waste transporters, waste disposal companies).

This publication has been produced with the assistance of the European Union. The contests of this publication are the sole responsibility of La Mia Energia SCARL and can in no way be taken to reflect the views of the European Union.

LA MIA ENERGIA Scarl
Sede Legale: via M.T. Cicerone 14/L - 86079 Venafro (Is)
Direzione: Centro Ricerca via Cerro snc - 03043 Cassino (Fr)
Sede Tecnica ed Operativa: via Cavallara snc - 03030 Castrocielo (Fr)
P.IVA 10656421004
Tel / Fax 0776.300717

SWOT ANALYSIS

STRENGTHS	WEAKNESSES
- Reducing the unit cost of recycling for small amounts (small batches) - Low initial investment by users - Not mature market that justifies the investments of permanent industrial system - Possibility to immediately start the recycle of panels and the disposal of material to re-use - Low pollutant emissions coming from the reduction of the panel transport to disposal centres. - Reduction transports for panel and its component management	- Not known innovative solution - Low number of panels to treat - Lack of financials - Lack of partnership
OPPORTUNITIES	**THREATS**
- Entry in a market characterized by an important growth perspective. - Integrated service of panel producers, seller/installers, transporters, offering them a competitive and alternative strategy.	- Difficulty to present PV-MOREDE in International market - Risk to be acquired by competitors

This publication has been produced with the assistance of the European Union. The contests of this publication are the sole responsibility of La Mia Energia SCARL and can in no way be taken to reflect the views of the European Union.