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Needs of multidisciplinary training for engineers: Efficiency, sustainability and profitability of solar energy plants

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Abstract

New challenges are been imposed on the markets of developed and developing countries. On the one hand, it has come the phenomenon of globalization. And the other is the economic and environmental sustainability. In a world dominated by technology, engineers as mentors and supporters are expected to gear the decisions of companies' investments. Besides the technical characteristics of any investment, project design usually involves its economic valuation and profitability analysis. So, to meet the multidisciplinary labor market demands, engineering students require some knowledge of economic analysis techniques to complete their education. In this study we use both capital budgeting and energy production techniques to analyze the yield of photovoltaic power plants. First of all, we describe the technical characteristics of a solar installation addressed to electricity production and we estimate the energy output, which mainly depends on the solar irradiation hitting the solar modules. Further, taking into account the energy production we apply capital budgeting techniques to assess the profitability of such investment. Regarding economics we describe the main concepts: the net present value, the internal rate of return and the payback. These are standard viability indicators to assess the profits and assist the investor in business decisions. These parameters are estimated for two photovoltaic power plants located in Spain and Gemany, which starts its production activity at present, without any kind of economic incentives. Indeed, the addition of capital budgeting techniques would expand the success chances in renewable energy projects.

Keywords

Solar Energy Investments, Capital Budgeting, Net Present Value, Profitability, Energy Production in PV Plants

1. Introduction

The massive use of energy, in most parts of the Earth, makes traditional energy sources starts to show signs of depletion. At the same time the use of clean energy sources is needed due to the increasing degree of environmental pollution, as it is pointed out, by various organizations, both in Europe and in the rest of the world, which leads to include in the concept of sustainable development both economic and environmental dimension. Electricity demand has been growing since its inception, and forecasts of future ensure further growth if possible.

Accordingly with the European Union (EU) countries are making efforts to battle climate change such as global warming and depletion of natural resources. So, the EU has developed specific programs to incentive the implantation of clean and non-contaminant energy sources. In this regards some EU countries have launched dissimilar legislation in order to promote the use of sustainable energy sources with different degrees of success [1]. Some EU countries are making efforts to encourage the diffusion of sustainable technologies. In this respect it should simultaneously achieve two issues; technical effectiveness and economic efficiency. Technical effectiveness depends on the progress of technologies involved. Economic efficiency is essential for dissemination and progressive replacement of other technologies that do not meet sustainability requirements.

As the Energy Sector is currently a deregulated uncertain and highly competitive sector that has not always been the case. At its inception the Energy Sector was regulated and monopolistic, mainly due to technological reasons and market constraints as entry barriers. The forecasts for Renewable Energy Sector are of growth without any doubt. And this represents an opportunity business that companies could not afford to miss. Indeed, investment decisions in Renewable Energies are based on the conviction that clean energies are crucial to keep a green planet but also on the profitability of such investment. Thus, Engineers have to meet both technological and economic aspects of this technology. In this way Engineers can make the best of the market incorporating financial knowledge to technological knowledge, their traditional knowledge area.

The present scenario has favored investments in alternative energy sources. Society is concerned by climate changes and global warming, consequently, economic policy decisions have to take into account sustainability and respect for the environment. Among these conditions we can underline: economic stability, low interest rates, high-energy prices, and change in the cultural values [2]. In addition the development of new and appropriate technologies, issues related to their financial and economic viability and financing of renewable energy systems are being given considerable importance. Despite all the above the promotion of clean energy strongly depends on incentive policies, as was the case in the countries were these technologies have developed: USA, Great Britain, Germany and Spain; even though these incentives have not been the panacea to the energy problems [3]. However, even in the absence of incentive policies the existing photovoltaic (PV) technology is matured enough to be considered as a lucrative business, at least in regions with high levels of solar irradiation [4].

Engineering students should be aware of the most efficient technologies to generate green electricity but they should also be able to submit the related economical features to investors. Therefore, a basic knowledge of economic techniques is essential to justify the investments. To promote the dissemination of this technology for both small businesses and individuals, engineers have to show companies the related economic studies and be able to advise them as a way to diversify the business and achieve the return on assets. In case of domestic economies investment in renewable energies can be presented as a long-term, easy and safe investment that does not require any specific financial or technological knowledge.

In this paper, we analyze the competencies required for modern engineers regarding generation of green energy through PV installations. These competencies should include both technical and financial knowledge. Technical knowledge includes the assessment of existing technologies and how to install and calculate the energy production of a PV plant while financial awareness involves techniques for presenting return analysis and other financial parameters of PV installations. In particular we have developed an example of a medium size PV installation located in Valencia (Spain) and in Berlin (Germany). This example could be adapted to any other locations by taking into account their respective solar irradiation data as well as their energy policies.

2. Technical Features: Production of Electricity with a Solar Energy Plant

A photovoltaic cell, also known as a solar cell, directly converts light energy into electrical energy without the need for chemical reactions or fuel. The majority of solar panels are composed of numerous silicon wafers wired together to produce direct current (DC) electricity. The generated electric energy can be stored in suitable batteries or fed into the electric network by using a device called inverter, which is used to convert this DC electricity into alternating current (AC). Indeed since PV plants are able to feed AC electricity directly into the network through the use of very efficient inverters; the PV solar energy has boosted the implantation of PV solar energy plants due to the simplicity and lower cost of these systems with respect to those using batteries. The assessment of the exact electrical output depends on complex factors, such as the angle, direction and efficiency of the panels, sunshine, temperature and weather.

Electrical output varies and is dependent upon factors such as the amount of available light, the position and angle of the solar panels, ambient temperature, the efficiency of the panels and the voltage supplied by the system. It is often a challenge to calculate how much kilowatt-hour (kWh) electricity are produced by a solar system as the conditions can change in seconds, but a good estimate of the average power production can be made using straightforward techniques.

Keeping panels clean, in full sunshine and pointing directly toward the sun will maximize the output. However, such systems involve the use of sun trackers in order to keep the surface of solar modules always perpendicular to sun. These kinds of systems are already available but on this example we are going to refer to static PV modules without sun trackers.

To get the most from solar panels, you need to point them in the direction that captures the most solar radiation. But there are a number of variables in figuring out the best direction. The best placement for solar panels depends on the location they are installed. Solar panels should always face true south if you are in the northern hemisphere, or true north if you are in the southern hemisphere. It is worthy to notice that true north is not the same as magnetic north. However, true north or south can be easily found by using the standard Global Position System (GPS) devices, which are nowadays available in practically all smart phones.

The next issue is related to the tilted angle from horizontal. Books and articles on solar energy often give the advice that the tilt should be close to the latitude where the PV installation is located [5]. Given the latitude in Europe all fixed PV installation should have an inclination between 35º and 50º with respect to the horizontal.

Peak sun hours are found by dividing the entire solar irradiance that falls on one square meter during the day by 1 kW/m^2. For example, if a location receives four peak sun hours, it has received the equivalent of four hours at 1 kW/m^2 per hour, although it may have been accumulated at varying rates over a much longer period. This information is available in specialized websites. See for example the link http://solargis.info/.

Equivalent Sun Hours (ESH) refers to the equivalent number of hours per day when solar irradiance average is 1 kW/m^2. For example, four equivalent sun hours (4 ESH) means that the energy received during total daylight hours equals the energy that would have been received had the irradiance for four hours been 1 kW/m^2. This is a very interesting concept since it allows calculating, in a simple way, the electricity production of a PV installation over a given period. To obtain the electricity production of a 20 kW PV installation the simplest method is to multiply the Equivalent Sun Time in the location by the peak power specified by the manufacturer of the PV modules. Nowadays all PV modules are tested under AM1.5 conditions which refer to a solar irradiation of 1 kW/m^2. Therefore, the simplest way of calculate the electricity production of a PV installation over a period is to multiply the Equivalent Sun Time by the peak power of the modules specified by the manufacturer.

Table 1 displays the latitude and solar irradiation data of two European cities; Valencia (Spain) and Berlin (Germany). The Equivalent Sun Time and the estimated energy production for a 20 kW PV plant is also included. As expected the higher the latitude the lower the solar irradiation and the electricity production of PV plants. The study is made for a PV plant of 20 kW PV because it meets the goals of the Spanish energy policy measures, being accessible to small companies or households and the PV plant with this dimension, can also be fitted on roofs or facades of buildings fulfilling another aim of multifunctionality.

Table 1. *Solar irradiation data and estimated electricity production for a 20 kW PV plant in some European cities. (Source: http://solargis.info/)*

Location	Parallel	Solar irradiation (Kwh/m^2)	Equivalent Sun Time (h/year)	Electricity production (Kwh/year)
Valencia (Spain)	40º N	1,720	1,720	34,400
Berlin (Germany)	52º N	1,240	1,240	24,800

3. Economic Study

Stakeholder theory presents the maximization of the market value of a company as a main objective. To achieve the objective, firms have to invest profitably and diversify risks. So, when companies purchase new assets the main purpose is to enhance future results. For this reason, the first step is to state if the company should make the capital outlay in the new assets to carry out the investment. A forecast for the cash flow should be made in order to estimate the new yield. The projected cash flows must also reflect the risks the company takes and changes in the market framework [6].

The main economic parameters to be taken into account before taking the decision on an investment are: (a) Capital Outlay, (b) Lifespan or Economic life and (c) Cash-flow. The Capital Outlay in an investment is necessary expenses a company do for the start-up of new machinery to begin to generate income from the production. In our case of study, we consider that the investment (or machinery) is the installation of solar panels for the production of electrical energy installed on warehouse rooftops.

The utile surface allows the fitting of about 200 square meters of Si-standard PV panels with a peak power of 20 kW. The market specific for the capital outlay in a PV plant is 60,000 €, for both countries the same outlay it has been estimated since Germany and Spain belong to the EU and has similar tax regulation. These data were confirmed in the market for solar installations with these technical characteristics.

The second parameter is the lifespan which is estimated in 25 years. This is justified into two reasons. Firstly due to the agreement with the Public Administration which establish a maturity of 25 years; and the secondly due to the guarantee of technique efficiency of up to 80 % of the potential production given by manufacturer.

Solar panel's technology use single-crystal silicon material on the basis of a large dissemination in the European market, with excellent technical results. As shown by the fact that many installations are reaching end of their lifespan and continuous working with profits.

The most arduous task is to forecast the cash-flow in an investment, given that it deals with estimating the inflows and payments, or outflows, generated by the investment along the lifespan. So, being an estimation, we should mention additional considerations:

- The inflows and outflows are on the last day of each period.
- We do not take into account payments pertaining to financing. That is, we do not weigh up financial charges, principal refund, etc. The financing costs are reflected in the calculation of profits, and are used to calculate the tax to pay and the rate of return.
- Taxes are payment cash in the cash flow.

$$Cash\ Flows = Inflows - Outflows$$

Following the consideration above, to estimate inflows we base our calculus in the BOE (*Boletin Oficial del Estado)* 10392/2010 published, for our first example: the PV installation in Valencia (Spain). As mentioned before technical specifications for the production of energy are based on the forecast of solar hours, location of panels and appropriate inclination of panels. In the same way we have stated the inflows of the power plant in Berlin (Germany), according to the German Renewable Energy Sources Act, of

February 2011.

The estimated production is 34,400 kWh for each year in Spain and 24,800 kWh in Germany (See Table1). Following technical specifications of panels industry the power degradation is 0.5% annually, in both countries. With this data it will be possible to obtain an estimation of the electricity produced each year of the lifespan of the PV plant.

Next step is to assess annually income, thus we introduce the tariff that is multiplied by the production to achieve the inflows of the first year. On the date when the PV plant started activity in 2013 the tariff was 15.0938 c€/kW in Spain and 17.02 c€/kW in Germany. The updates for the annual tariff are made in accordance with the prevalent legislation and incorporating the inflation rate to the increase in the tariff. The projection for inflation is 2.20 % taking in account the macroeconomics targets of the European Union, and the OCDE forecasts.

The maintenance expenses and the insurance are included in the payments of the PV plant. On the basis of the information provided by the firm, maintenance expenses are about 3% of the income and insurance 6 %. These values coincide with market criteria for other installations with similar characteristics. We used the same criteria for expenditure in the two countries, since the market conditions are very similar in both because of being member of the European Union. Thus, we can obtain the cash flow for every year of lifespan. Detailed analysis in Table 2 and Table 3 show that inflow and income agree every year, because incomes are collected each financial period. On the other hand the payments and outflows don't coincide for two motives. The first one is depreciation that entails an expense but not an outflow for the firm; and the second one is financial charges associated obtain funds. We have assumed that capital outlay is supported by a loan in market conditions amortized in 7 years.

The same study can be done for any location in any other European region or country. In this case the student has to take into account two factors. The first is the latitude for obtaining the solar irradiation and/or ESH of the location and then the electricity production. And the second is the status quo of the energy policy to be aware of tariffs' details and conditions during the lifetime of the PV plant.

4. Methods for Investment Valuation

A company has to confront situations with limited capital, and managers have to satisfy shareholders expectative. Therefore, the firm must invest in every project that is worth more than it costs. To make a property selection of investments, it has to take into account the time value of money and the risk involved the project proposed.

A techno-economic analysis has been used for project cost control, profitability analyses, planning, scheduling and the optimization of operational research, etc. For PV systems, it is necessary to work out their economic viability so that users of this technology can know its importance and can utilize the area under their command to their best advantage. An effective economic analysis can be done using cost analysis knowledge with cash flow diagrams. First of all, we defined Cash Flow as movements of money in and out of any business; indeed it is the primary indicator of business health [7]. Several Capital Budgeting Criteria have to be used to analyze the profitability of the investment made. Pay-Back (PB), Net Present Value (NPV) and Internal Rate of Return (IRR) are widely used to conduct profitability analyses. Let's go on to define these criteria [8, 9].

PB is the number of years required to recover the initial investment exactly (Capital Outlay), and is computed by summing the annual cash flow values and by estimating the period throughout the relation. A PB analysis provides an easy-to-apply and intuitive decision process. However, PB undergoes many well-known deficiencies as an investment analysis tool, and the most obvious kind is the inability to distinguish between short- and long-lived investments.

The NPV is the difference between the value of incomes and the expenses incurred from an investment until the date the investment was made. Thus the NPV provides an estimate of the net financial benefit provided to the organization if this investment is undertaken [10]. A positive NPV means positive surplus, indicating that the investor's financial position will improve if the project goes ahead. Obviously, a negative NPV indicates financial loss.

$$\mathrm{NPV} = -\mathrm{CO} + \mathrm{NCF}_1(1+r)^{-1} + \cdots + \mathrm{NCF}_n(1+r)^{-n} \quad (1)$$

where CO is the capital outlay, r is the interest rate, and n is the technology life [11].

Despite the NPV being easy to use, because it is an intuitive tool, it also presents some limitations in terms of: (i) the discount rate chosen for its estimation; a very low interest rate value, an alternative with profits spread far into the future may unjustifiably appear more profitable than an alternative whose profits are more quickly made, but are of a smaller amount in undiscounted terms; (ii) the distinction between a project with capital outlay and of lower cost, thus the NPV does not offer any indication of the scale of efforts required to achieve the results.

The IRR is a discount of investment worth and is used as an index of profitability for the appraisal of projects. The IRR is defined as the rate of interest that equates the NPV of a series of Cash Flow to zero. Mathematically, the IRR satisfies the equation [6]:

$$0 = -\mathrm{CO} + \mathrm{NCF}_1(1+IRR)^{-1} + \cdots + \mathrm{NCF}_n(1+IRR)^{-n} \quad (2)$$

The IRR is widely accepted and used in the appraisal of projects because it is an indicator of the project's expected return of profitability. The IRR is easily compared with the banking worth rates or the cost of the funds used to finance the project [7].

5. Results

Table 2.a gives the production and economic data of a 20 kW PV plant located in Valencia (Spain) for the 25 years of

operation of the plant. The electricity production and Net Cash Flow for a PV plant is calculated for 25 years because most suppliers of PV modules assure that the PV modules will provide a minimum of 80% of their nominal production after 25 years of operation. In Table 2.a the electricity production has been calculated taken into account a reduction of the production of 20% in 25 years due to aging.

Table 2.a. *Net Cash Flow for a PV plant in Valencia (Spain)*

Year	Capital Outlay (€)	Electricity Production (kWh)	Tariff (c€/kWh)	Income (€)	Expenditure Maintenance (€)	Insurance (€)	Net Cash Flow (€)
0	60,000						-60,000.00
1		34,400	15.09	5,192.27	155.77	311.54	4,724.96
2		34,228	15.43	5,279.96	158.40	316.80	4,804.77
3		34,057	15.77	5,369.14	161.07	322.15	4,885.92
4		33,887	16.11	5,459.83	163.79	327.59	4,968.44
5		33,717	16.47	5,552.04	166.56	333.12	5,052.36
6		33,549	16.83	5,645.82	169.37	338.75	5,137.69
7		33,381	17.20	5,741.18	172.24	344.47	5,224.47
8		33,214	17.58	5,838.14	175.14	350.29	5,312.71
9		33,048	17.96	5,936.75	178.10	356.21	5,402.44
10		32,883	18.36	6,037.02	181.11	362.22	5,493.69
11		32,718	18.76	6,138.99	184.17	368.34	5,586.48
12		32,555	19.18	6,242.68	187.28	374.56	5,680.83
13		32,392	19.60	6,348.11	190.44	380.89	5,776.78
14		32,230	20.03	6,455.33	193.66	387.32	5,874.35
15		32,069	20.47	6,564.36	196.93	393.86	5,973.57
16		31,908	20.92	6,675.24	200.26	400.51	6,074.47
17		31,749	21.38	6,787.98	203.64	407.28	6,177.06
18		31,590	21.85	6,902.63	207.08	414.16	6,281.39
19		31,432	22.33	7,019.22	210.58	421.15	6,387.49
20		31,275	22.82	7,137.77	214.13	428.27	6,495.37
21		31,119	23.32	7,258.33	217.75	435.50	6,605.08
22		30,963	23.84	7,380.92	221.43	442.86	6,716.64
23		30,808	24.36	7,505.58	225.17	450.34	6,830.08
24		30,654	24.90	7,632.35	228.97	457.94	6,945.44
25		30,501	25.45	7,761.26	232.84	465.68	7,062.75

Table 2.b. *Net Cash Flow for a PV plant in Berlin (Germany)*

Year	Capital Outlay (€)	Electricity Production (kWh)	Tariff (c€/kWh)	Income (€)	Expenditure Maintenance (€)	Insurance (€)	Net Cash Flow (€)
0	60,000						-60,000.00
1		24,800	17.02	4,220.96	126.63	253.26	3,841.07
2		24,676	17.39	4,292.25	128.77	257.54	3,905.95
3		24,553	17.78	4,364.75	130.94	261.88	3,971.92
4		24,430	18.17	4,438.47	133.15	266.31	4,039.01
5		24,308	18.57	4,513.43	135.40	270.81	4,107.23
6		24,186	18.98	4,589.67	137.69	275.38	4,176.60
7		24,065	19.39	4,667.19	140.02	280.03	4,247.14
8		23,945	19.82	4,746.01	142.38	284.76	4,318.87
9		23,825	20.26	4,826.17	144.79	289.57	4,391.82
10		23,706	20.70	4,907.69	147.23	294.46	4,466.00
11		23,588	21.16	4,990.58	149.72	299.43	4,541.43
12		23,470	21.62	5,074.87	152.25	304.49	4,618.13
13		23,352	22.10	5,160.59	154.82	309.64	4,696.13
14		23,235	22.59	5,247.75	157.43	314.86	4,775.45
15		23,119	23.08	5,336.38	160.09	320.18	4,856.11
16		23,004	23.59	5,426.51	162.80	325.59	4,938.13
17		22,889	24.11	5,518.17	165.55	331.09	5,021.53
18		22,774	24.64	5,611.37	168.34	336.68	5,106.35
19		22,660	25.18	5,706.15	171.18	342.37	5,192.59
20		22,547	25.74	5,802.52	174.08	348.15	5,280.29
21		22,434	26.30	5,900.53	177.02	354.03	5,369.48
22		22,322	26.88	6,000.19	180.01	360.01	5,460.17
23		22,211	27.47	6,101.53	183.05	366.09	5,552.39
24		22,100	28.08	6,204.58	186.14	372.28	5,646.17
25		21,989	28.69	6,309.38	189.28	378.56	5,741.54

The tariff is the present price of the electricity in the country and an inflation rate has to be supposed for the overall period. The annual income of the PV plant is then the electricity production multiplied by the electric tariff. Finally, to calculate the Net Cash Flow, the expected expenses (Maintenance and Insurance) have to be subtracted from the income. Maintenance and Insurance expenses have been calculated as a percentage of the electricity production.

Table 2.b gives the electric production, income and Net Cash Flow for 25 years of operation of a PV plant located in Berlin (Germany). Comparing the data for the two studied locations it can be observed that the production is higher in Spain because the higher irradiation available, and the electric tariff is higher in Germany than in Spain, but this difference is not big enough to compensate the lower irradiation. Therefore the Net Cash Flow is always higher in Spain than in Germany for a similar PV plant.

Applying criteria of capital budgeting described above the results are as expected. Investments in solar PV plant are efficient from both technical and economical points of view. Both profitability and return of this type of investment are positive in a 25 years period. The values obtained for the NPV of a PV plant depend on the location and for a discount rate of 4% gives the following quantities:

$$\text{NPV(Valencia)} = -60{,}000 + 4{,}724.96(1+4\%)^{-1} + \cdots + 7{,}062.75(1+4\%)^{-25} = 27{,}877.94€$$

$$\text{NPV(Berlin)} = -60{,}000 + 3{,}841.07(1+4\%)^{-1} + \cdots + 5{,}741.54(1+4\%)^{-25} = 11{,}438.79€$$

Values used for the CF_i are shown in Table 3, and it has been applied the cash-flow after tax with the aim of take into account all expenses involved with the investment, even tax. This allows us to present the students the difference between profits and cash-flow. If we repeat the operation with different discount rates, it is observed that after 5% the NPV becomes negative and that means that the investment after this rate does not provide profits. The firm has to know the cost of capital.

Table 3. *Net Present Value*

Discount Rate (%)	NPV (Valencia)	NPV (Berlin)
0	85,475.26 €	58,621.49
1	67,048.66 €	46,281.92
2	51,668.12 €	30,778.59
3	38,762.83 €	20,287.46
4	27,877.94 €	11,438.79
5	18,649.55 €	3,936.74
6	10,785.38€	-2,456.30
7	4,409.67	-7,931.97

With the formula of the IRR, by taking data from the Table 3, also with CF after tax, the result is:

$$0 = -60000 + 4{,}724.96(1+\text{IRR\%})^{-1} + \cdots + 7{,}062.75(1+\text{IRR\%})^{-25}$$

Figure 1 shows the Net Present Value as a function of the discount rate for two Photovoltaic Plants with a peak power of 20 kW located in the two sites mentioned in the paper; Valencia (Spain) and Berlin (Germany). As discussed previously for every discount rate the NPV for a PV plant is always higher when it is located in Spain than in Germany. The abscise point is the Internal Rate of Return where the NPV is zero and it is also higher in Spain than in Germany. Negative values of the NPV mean that the addition of updated CF is less than the capital outlay, and therefore the investment generates losses for the company.

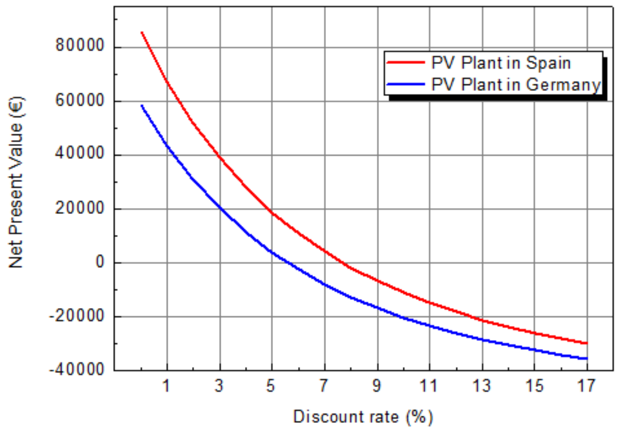

Figure 1. *NPV for a 20kWp PV plant located in Spain and Germany.*

Table 4 summaries the IRR for a 20 kWp PV plant operating in Spain and Germany. The IRR is 5.59% for Germany and 7.68% for Spain, which is the gross return of the solar PV plant and it is workable for a firm that has a cost of capital below this IRR. Finally, the Pay back is about 13 years for Germany and 11 years for Spain.

Table 4. *Internal Rate of Return*

Location	Valencia	Berlin
IRR (%)	7.68	5.59

6. Conclusion

Under the multi-functionality principle of firms and markets, a modern engineer has the challenge to be addressed on matters of technologies and economics. To spread engineers' competencies and facilitate their integration in the labor market both technological and financial abilities have to be incorporated to their background. With this aim in mind, particular attention must be paid to providing the engineer comprehensive information on the benefits of use of renewable energy. We believe that in higher education engineering' students should be trained in both disciplines.

Chiefly in countries, such as Spain and Germany, firstly their important potential for PV plants due to its high solar irradiation levels, and the former for it support to clean energies. We could also highlight that the state of technology also has additionally helped small companies and household to access of investment in PV plants. In our case focused in

Spain, after several years of incentive policies for renewable energies mainly related to tariff regulations, the grid-parity for photovoltaic installations has been reached or they are very close. In spite of the apparent chaos occurred with the incentives the policies developed in Spain have succeeded. The incentives related to photovoltaic energy installations as well as the rest of renewable sources have been reduced in the last decade but the drop in the costs of photovoltaic installations has compensated the tariff reductions. To guarantee the future of renewable energies in Europe a legal frame has to be established in all countries and the suitable characteristic of new legal frame should guarantee its long-term stability.

We have shown in this paper the importance of including both technical and economical formation in the background of modern engineers. Such formation will allow future engineers to find their site in the promotion and business of renewable energies. Business in PV solar plants has low risk because the investment is mainly released in the beginning, the reliability of related technology is guarantee for 25 years and the raw materials (Sun irradiation) are assured at zero cost. The main risk factor involves the legal frame in which this business has to survive. Tariff limits, limitations in irradiation sun time or any kind of new taxes for producing clean energy are the main risks of this activity. However, we expect that in the near future the European Union will be able to pave the way for allowing a rapid spread of renewable energies by setting stable rules in the overall EU for the promotion of such energies. Indeed, the multidisciplinary training of new engineers would influence in this challenge.

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