FROM MARGINAL TO RENEWABLE ENERGY SOURCES SITES

M2RES

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SOUTH EAST EUROPE
Transnational Cooperation Programme

# INVESTMENT PROPOSAL: THE CASE OF SKLAVE VILLAGE

# The case of Sklave village

**General information:**

- Exhausted open cast sand and stone quarry on Sandanski municipality owned terrain – 18,000$m^2$ in Southwestern Bulgaria near Sklave village
- GPS coordinates: +41° 31' 31.26" North, +23° 19' 32.83" East
- The quarry is closed and the production process is stopped
- Infrastructure on place: service road, few buildings in place
- The quarry is located at the boundary of Sklave village a few hundred meters from the village center
- There is already a grid line present at the site. The local grid operator is CEZ Bulgaria and it is responsible for issuance of the grid connection permit
- No biomass available ,excellent solar conditions 1,400kWh/kWp per year for crystalline PV technology, low annual mean wind speed
- There aren't any known Natural, Environmental, Technical/Infrastructural, Socio – cultural or legal constraints


**Figure 1: Exhausted open cast sand and stone quarry near Sklave village**

**Technical analysis:**

The investigated terrain has a surface area of 18,000 $m^2$, which according to table n. 3 in the M2RES Marginal Guideline could accommodate a PV park with an average capacity of 900kWp. Current prefeasibility study is exploring the opportunities for construction of a photovoltaic power plant with the same capacity – 900kWp.

Solar irradiation data, the surface roughness and the elevation as well as the average monthly temperature were acquired from the Institute for Energy and Transport part of the Joint Research Centre at the European Commission. For the energy yield and financial calculations RET screen software was used.

Sklave is situated in the Southern part of Bulgaria, very close to the border with Greece. The climate is continental Mediterranean[1], which is a mild variety of the subtropical climate. The summer is hot and the winter is mild. The solar irradiation is relatively high as seen from table 1.

| Month | Irradiation on horizontal plane [Wh/m2/day] | Irradiation on plane at angle 34deg. [Wh/m2/day] | Average daytime temperature [°C] |
|---|---|---|---|
| January | 1760 | 2860 | 2.7 |
| February | 2760 | 3950 | 4.8 |
| March | 4050 | 4950 | 8.2 |
| April | 5220 | 5530 | 12.9 |
| May | 6230 | 5970 | 18.4 |
| June | 7140 | 6530 | 22.6 |
| July | 7220 | 6740 | 25.0 |
| August | 6520 | 6670 | 24.8 |
| September | 4750 | 5520 | 19.8 |
| October | 3230 | 4430 | 15.0 |
| November | 2050 | 3260 | 9.0 |
| December | 1550 | 2640 | 4.0 |
| **Year** | **4380** | **4930** | **15.2** |

**Table 1: Solar irradiation and daytime temperatures at the site – Average for 10 years period[2][3]**

The surface is predominantly flat there is a negligible change in the elevation alongside the site. The average elevation is 210m, the highest point is at 211m and the lowermost point is at 206m. The southern part of the site has a slight slope facing south. There aren't any significant obstacles such as mountains or high buildings to shadow the area. That'sthe reason why, there aren't any expected losses due to shadowing effects. The terrain topography and the sun path during the shortest and the longest day in the year are presented on the figure below:

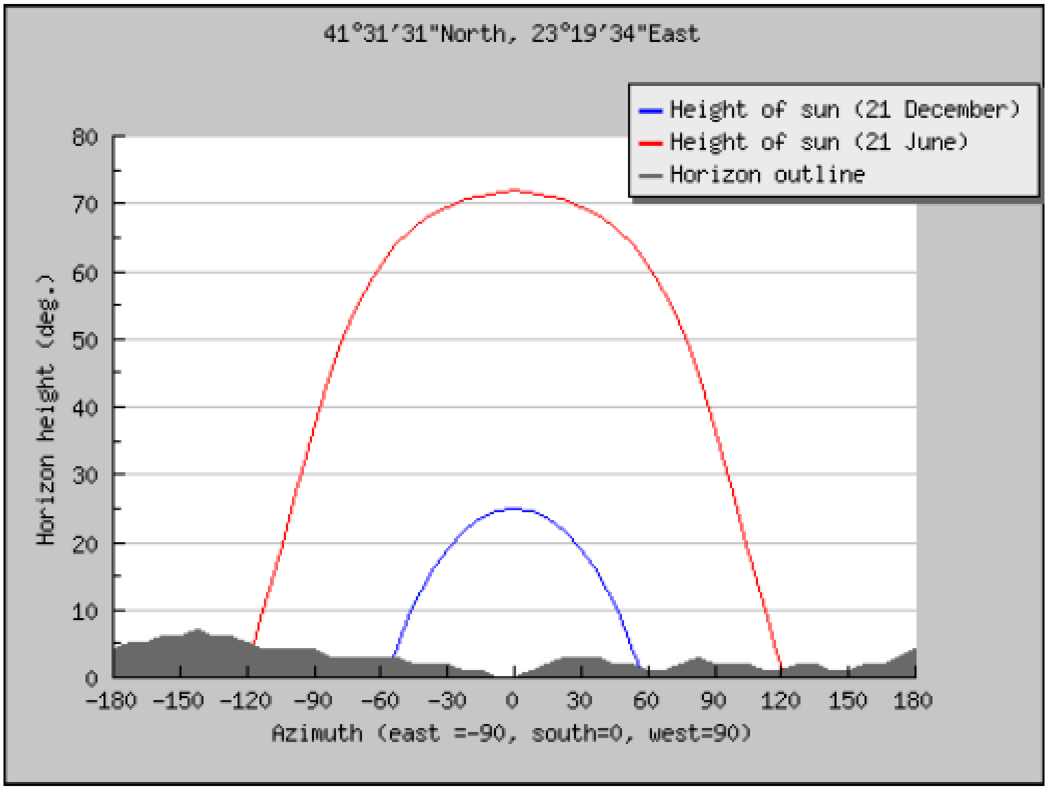


**Figure 2:Terrain topography and sun path diagram [2]**

The solar panels will be mounted on fixed steel frame on 34deg. angle, facing south. In table 1 the solar irradiation on 34deg. inclined plane is presented. To reach the power output of 900 kW, 3,750 PV panels with capacity of 240Wp are required. For example the ones that Suntech manufacture. The company is one of the largest Chinese PV producers and its polycrystalline PLUTO 240 –Wde[4] with efficiency of 14.6% could be the type of panel used in Sklave solar park. The total solar collector area for the whole PV park with such panels is estimated to be 6,186m$^2$. For that kind of system a substation is required. All the necessary controls, monitoring systems and the inverter will be located there.

The main losses that are expected to occur on the PV system are:

- Losses due to temperature and low irradiance = 9.0%
- Losses due to angular reflectance effects = 2.6%
- Losses due to the inverter = 2%
- Miscellaneous losses (cables, panels mismatch etc.) = 9%

**In total the combined PV system losses are22.6% of theyearly energy yield**

According to the expected losses the size of the inverter has been planned with power capacity of 850 kW and efficiency of 98%.

**Economic analysis:**

The starting expenses for the realization of the project include the costs for a detailed feasibility study, the administrative costs for obtaining the necessary permitting documents from the state and the municipal authorities, the local distribution company CEZ and the chief architect. Moreover, additional expenses should be covered when the development and the engineering of the solar park take place. One of the most significant initial costs – purchase of the land or renting the land is avoided due to the fact that the terrain already belongs to the municipality of Sandanski. Aforementioned costs comprise less than 2.8% of the total initial investment, which is expected to be around **954,291€**. More than 56.6% of the investment will go for purchasing the modules. The price per kilo Watt peak is expected to be 60 euro cents, including the shipping costs. The reset 40.6% of the total investment will cover the Inverter (0.16€/kWp), Balance of the system costs (spare parts, cables, mounting frames, storage) and the Miscellaneous cost (salaries, training and commissioning). During the lifetime of the project the costs for operation and maintenance were calculated, being 6,300€ per year. For the economical assessment of Sklave solar park a safety margin of 15% possible variation of the prices has been incorporated.

According to the Bulgarian legislation concerning renewable energy technology, the state guarantees 20 year contract for purchasing the generated electricity on a preferential price (fit-in tariff system). That price is fixed for the whole lifetime of the project and for the current one is 0.0901€ per kWh electrical energy fed into the grid. The initial energy production is shown in Table 2. A depreciation coefficient is also applied for the upcoming years, which reduced the energy yield by 0.3% per year due to expected drop in the modules efficiency.

| Month | Electricity exported to grid [MWh] | Income [€] |
|---|---|---|
| January | 68.08 | 6,134.01 |
| February | 83.58 | 7,530.56 |
| March | 113.15 | 10,194.82 |
| April | 119.81 | 10,794.88 |
| May | 130.74 | 11,779.67 |
| June | 135.49 | 12,207.65 |
| July | 142.38 | 12,828.44 |
| August | 140.65 | 12,672.57 |
| September | 115.68 | 10,422.77 |
| October | 98.99 | 89,19.00 |
| November | 73.21 | 6,596.22 |
| December | 62.83 | 5,660.98 |
| **Year** | **1,284.59** | **115,741.56** |

**Table 2: Electricity exported to the grid per month and the corresponding income per month**

For the detailed economic analysis the following parameters were derived:

- Fuel cost escalation rate = 3%
- Inflation rate = 5% (ten year average for Bulgaria [5])
- Discount rate = 4%
- Project lifetime = 20 years (Bulgarian RES Act)
- Depth ratio = 50% of the money will be lend from the bank
- Depth interest rate = 5% (average for large business credits in Bulgaria)
- Depth term = 10 years
- Depth payment per year = 61,793€
- Income tax = 10% (Corporate income tax determined by the Corporate Income Law)

The internal rate of return (IRR) after tax on equity and on assets is positive, being 8.7% and 2.1%. It is an indicator for the economic viability of the project, which in our case is expected to be profitable. The net present value (NPV) equals 289,562€. This value is related to the IRR and it is the value of all future cash flows, discounted at the discount rate, in today's currency [6]. The NPV is also an indicator for the financial feasibility of a project, if it is positive then the project is considered to be financially acceptable. Another important parameter is the Equity Payback Period, showing the break-even point. Around 11.4 years will be needed to cover the equity investments,the loanwill be completely paid after 10 years. The cumulative cash flows are shown on the figure below:

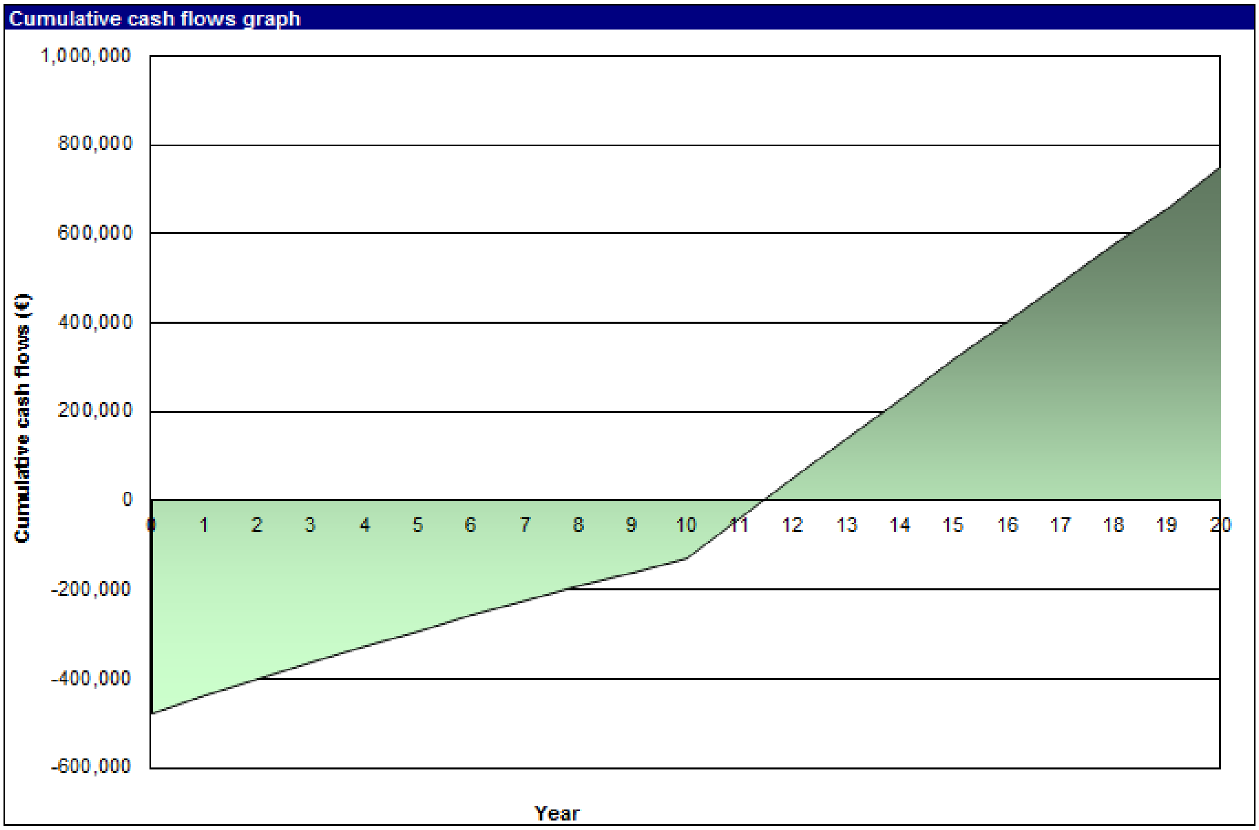


**Figure 3: Cumulative cash flows - 20 year period [7]**

**Expected Benefits:**

- If the municipality realizes the project, it could afford to offer the generated electricity to its citizens at price of 0.09€ per kWh, which is cheaper than to purchase it from the distribution company CEZ (0.11€/kWh).
- The exhausted open cast quarry will be rehabilitated and its solar potential will be utilized
- A project of such kind is expected to create up to 40 new jobs during the peak of construction
- Significant emission reductions of **817 tonnes of $CO_2$ per year** are expected, equivalent to 150 cars not being used
- The solar power plant could be used for educational purposes by the local schools and universities

**<u>Regulations on power establishment</u>**

For the realization of Sklave solar park project, the Bulgarian legal procedures have to be followed:

1. Registering a firm/company
2. Purchasing a land or renting a land. The terrain should have good solar conditions
3. Change in the designation of the acquired land and obtaining a legal right for PV installation
4. Estimation about the necessity for evaluation of the project impact on the environment;
5. Evaluation for compatibility under art. 31 of the Biodiversity Act – for projects or investment proposals which separately or by interacting with other projects or investment proposals, can negatively impact the protected areas
6. Preparing a detailed zoning plan (DZP)
7. Receiving a visa for engineering from the local municipality
8. Submitting a request to the Electricity System Operator (ESO) for investigation of the conditions for grid connection
9. Signing a "Preliminary contract for grid connection" with the local electricity distribution company
10. Performing a solar – energy audit of the selected site which includes the regulations in Ordinance 16 – 27 from 2008
11. Preparation of an investment project for the PV plant – it will be required for a building permit as well as for the final contract with the electricity distribution company. The calculations in the investment project will influence the offer for purchasing the PV equipment
12. Acquiring a building permit
13. Signing the final "Contract for grid connection" with the ESO
14. Preparation of the project documents – Business plan and applying for regulation 312
15. Application and signing a contract for financing of the project
16. Procurement, construction and mounting (72 hours probation tests + license for exploitation act 16) of the PV system
17. Signing a contract for " Grid access"
18. Signing a contract for "Purchasing of the generated electrical energy"

From the above mentioned stages for development of ground mounted PV installations, some are considered highly problematic for the project developers. The main reasons are the slow and complicated procedures along with the large number of institutions involved, responsible for issuing the relevant documents.

| Stage | Process | Barriers | Severity* |
|---|---|---|---|
| **3** | Administrative process | Complicated land use change procedure. Ban for designation of agricultural land on 40% of the Bulgarian territory | 🔴 |
| **4 & 5** | Administrative process | Slow and complicated procedure | 🟠 |
| **7 & 12** | Administrative process | Different set of documents in different municipalities | 🟠 |
| **13** | Acquiring Grid connection permit | Missing guarantees for grid access | 🔴 |
| **17** | Acquiring Grid connection permit | Rescheduling of grid connection | 🔴 |

**19. Table 3: Main barriers for realization of a PV project in Bulgaria [8]**

The most problematic stages during the commissioning of a ground mounted PV plant are marked in red 🔴, the stages associated with difficulties are in orange 🟠.

Moreover, the new Renewable Energy System Act from 10.04.2012 (determining the legal framework for renewables in Bulgaria) introduces additional barriers for PV:

1. An early interconnection fee is introduced - 13.000 EUR/MWp (PV projects up to 5 MWp) and 25.000 EUR/MWp (PV projects over 5 MWp). This fee applies for PV/RES only. If not paid, it makes all subsequent administrative procedures impossible.
2. A new legal-administrative procedure was introduced for grid access. RES projects need to accommodate grid availability and not vice versa. Maximum yearly capacity for interconnection of new PV/RES projects has to be announced every year by SCEWR by 01.07. The first annual decision of the commission presented **NO** available capacities for grid connection of new PV/RES. In addition, PV projects with signed preliminary grid connection contracts were rescheduled for grid connection after 2016.
3. Procedures for designating agricultural land for PV were removed in 2011. Thus, ground mounted systems are restricted on over 40% of Bulgaria's territory.
4. A recent transitional provision of the RES Act implements rescheduling of the grid connection of large and middle scale PV plants after 2016. It means that project with preliminary contracts should wait till 2016 to sign the final contract and electricity purchase agreement. According to the State Commission on Energy and Water Regulation (SCEWR) the measure was required due to grid stability issues. [8]

Also contributing to the decline of the photovoltaic investments in Bulgaria is the constant yearly reduction of the fit-in tariff by SCEWR. Besides, new ordinance was issued by the Regulator in the mid of

2012 stating that the fit-in tariffs would not only be changed on yearly basis, but whenever the SCEWR decides it is appropriate. With this last amendment the Regulator is bringing even more uncertainties and risks for the realization of renewable energy projects.

If all of the above stages are completed on time and the administrative procedures are correctly fulfilled by the institutions, it could take 35 weeks from the first application for building permit to the signing of the purchasing contract. In practice 48 to 56 weeks is the average time to accomplish a PV project from this segment. The reason is the long waiting period between the submission of the applications and the issuance of the relevant documents. On the figure below the main tasks as well as the corresponding time intervals in the best case scenario are shown:

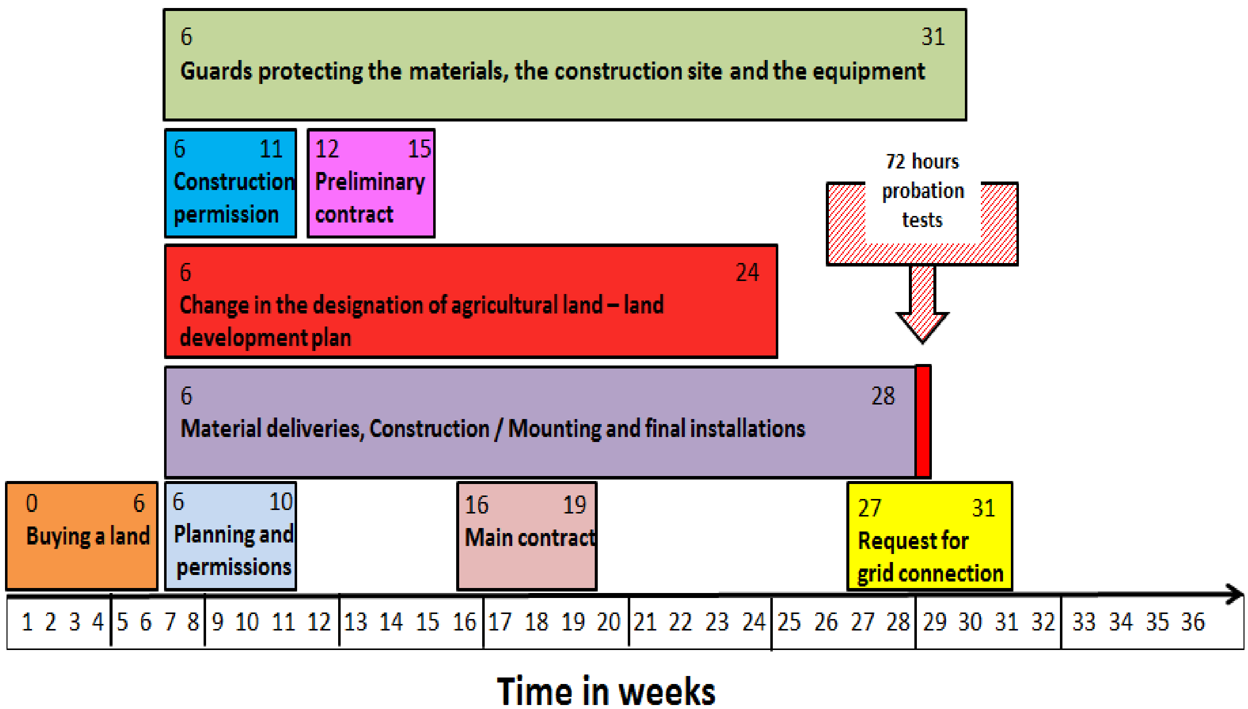


**Figure 4: Weekly steps for realization of a ground mounted PV project in Bulgaria[9]**

The tariffs are following an yearly decline as in many countries in Europe. Surprisingly here is steeper especially between 2011 and 2012. Most of the installed capacities in Bulgaria, approximately 600MWp out of 878 MWp (23.07.2013)[10] have been connected to the grid before 1st of July 2012, which means they are getting the highest FiT for PV shown in Table 4.

| Categories | FiT in BGN/MWh excluding VAT from July 1st 2011 until June 30th 2012 | FiT in BGN/MWh excluding VAT from July 1st 2012 until August 31st 2012 | FiT in BGN/MWh excluding VAT from September 1st 2012 until June 30th 2013 | FiT in BGN/MWh excluding VAT from July 1st 2013 till NOW |
|---|---|---|---|---|
| 1. PV up to 5kWp on rooftops and facades | 605.23 | 400.70 | 381.18 | 353.97 |
| 2. PV up to 30kWp on rooftops and facades | 605.23 | 400.70 | 289.96 | 284.18 |
| 3. PV above 30kWp up to 200kWp on rooftops and facedes | 596.50 | 369.08 | 226.87 | 211.40 |
| 4. PV above 200kWp up to 1,000kWp on rooftops and facades | 583.77 | 316.11 | 206.34 | 196.58 |
| 5. PV up to 5kWp | 576.5 | 268.68 | 193.42 | 196.58 |
| 6. PV above 5kWp up to 200kWp | 567.41 | 260.77 | 188.1 | 191.13 |
| 7. PV above 200kWp up to 10,000kWp | 485.60 | 237.05 | 171.37 | 176.26 |
| 8. PV above 10,000kWp | 485.60 | 236.26 | 169.85 | 160.20 |

**Table 4: Current fit-in tariff for PV and fit-in tariff change during the last two years[11]**

The prices in the table are in BGN per MWh fed into the electricity grid. To obtain the price in EUR per MWh the numbers should be multiplied by BGN to EUR exchange rates (1 BGN for 0.51 EUR, August 2013).

**Stakeholder analysis:**

The main stakeholders have been identified as well as their direct and indirect relations for the realization of the project. The main drivers for the completion of Sklave solar park are the ones that have the greatest interest. These are the local municipality and the project developers/installers. They will both benefit from the solar park in terms of money, additional benefits are expected for the municipality like job creation, economic development opportunities and rehabilitation of the problematic terrain. The stakeholders that act like a break are ESO (electricity system operator) and the local competitors. ESO has no need to connect additional capacities to the electricity network, because there is already an oversupply in Bulgaria. Another concern of ESO is the grid stability due to the fact that the transmission lines and the existing stations are old and partially overloaded.

| Stakeholder | Power | Influence | Needs | AIH* | LIH | HIH | MIH | Concerns |
|---|---|---|---|---|---|---|---|---|
| **Municipality** | Low | High | Strong | | — | → | | The financing and the grid connection has to succeed |
| **Investors/Installers** | Medium | Low | Strong | | | — | → | Worried about financing and grid connection |
| **Banks** | High | High | Weak | — | — | → | | Wants to have a guarantee |
| **EU Funds** | High to Medium | Low | Medium | | — | — | → | Concerned about the viability of the project |
| **Electricity System Operator (ESO)** | High | High to Medium | Weak | — | → | | | Does not want to connect additional capacities |
| **Consumers** | Low | Low | Strong | — | → | | | Negative public opinion regarding RE |
| **Local competitors** | Low | Low | Strong | → | | | | Wants to keep its leading supply role |

**Table 5: Stakeholder analysis**

*Key: AIH – Against it happening; LIH – Let it happen; HIH – Help it happen; MIH – Make it happen

In the case presented in Table 5 the investor and municipality are separate figures. Another possibility is the municipality to be the owner. In that scenario its power will be much greater, also the needs and its influence will be higher and it will be easier for it to get access to European funding and bank loans.

**SWOT analysis**

To ease the decision making process for the people responsible in the municipality and to do a preliminary estimation of the risks a SWOT analysis of Sklave solar park has been made. It evaluates the Strengths, Weaknesses, Opportunities and Treats involved in the project.

| Strengths | Weaknesses |
|---|---|
| • Ensure partial energy independence<br>• Political support on municipal and European level<br>• Funding support from the EU development funds<br>• Positive environmental impact<br>• Local job creation<br>• Providing low energy price for the end consumers | • The project is very complex<br>• Only one possible way for selling the energy<br>• Requires the construction of infrastructure<br>• Long payback time |
| **Opportunities** | **Threats** |
| • Positive impact on the local economy<br>• Usage for educational purposes<br>• Improved life standards of the local people<br>• Possibility for energy demanding industries to develop their production lines in the municipality due to the low energy prices | • Rejection of funding<br>• Possible time delays for the administrative procedures, the technical part and/or the financing<br>• Negative public opinion in Bulgaria regarding the renewable energy<br>• Instability of the Bulgarian legal framework concerning the renewables – unpredictable changes in the FiT tariff, introduction of varies fees (like the grid access fee), changes in the Renewable Energy System Act |

**Table 6: Project's SWOT analysis**

## References

[1] Cartography EOOD, Geographic and economic atlas of Bulgaria, Sofia, 2005.

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[6] RET Screen International, "NPV Definition," RET Screen International, 2012.

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[11] State Commision on Energy and Water Regulation, "Decision C-19," 28 June 2013. [Online]. Available: http://www.dker.bg/files/DOWNLOAD/res-c-19-28062013.pdf. [Accessed 1 July 2013].