Business-to-tenants energy projects – comparison and analysis of different types of operator models and implementation of an online payment system

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***Abstract*— In this practical project, different types of landlord-to-tenants or rather business-to-tenant energy projects will be compared and analyzed in terms of implementation and economic efficiency. As a result of this analyzation, there will be a formal recommendation for the solar company group ENTERIA from Wuppertal. With help of this recommendation, the decisions shall be simplified which type of business-to-tenant project should be chosen for future ventures. In addition, an online metering and payment system will be established to quicken and simplify the management of the solar systems or rather the virtual solar power plant of ENTERIA. Besides, this online system supports Mati Mati, a non-profit project which provides fresh water for people in Mozambique.**

1 Introduction

In today's world the climate change reached a critical status for future environment adjustments. The ENTERIA group of companies has the intention to fight these climate changes with help of business-to-tenant energy projects.

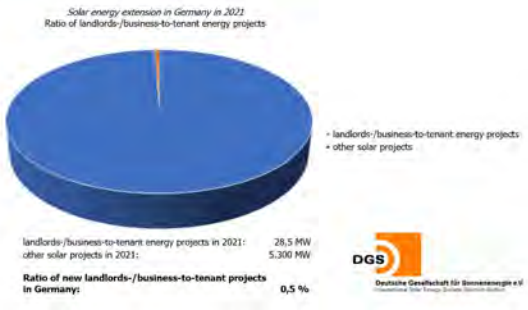

Figure 1: Ratio of landlord-/business-to-tenant energy projects in solar energy extension in Germany in 2021 [1]

Figure 1 shows that only 0.5 % of the solar energy extension in Germany in 2021 considered landlord-/business-to-tenant energy projects. To provide even landlords or tenants who are not able to install and use solar energy systems, ENTERIA wants to give them a chance to and wants to be part of the increase of advantages of renewable energy. This is the reason, why the management of ENTERIA has the interest to find a proper strategy to the groundwork of future energy projects to supply people with solar energy.

2 Theoretical Foundation

2.1 *ENTERIA group of companies*

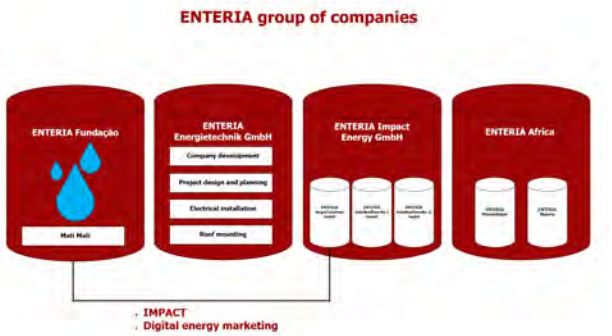

Figure 2: ENTERIA group of companies

As shown in Figure 2, the ENTERIA group of companies consists of four major parties. ENTERIA Fundacao is the foundation in Mozambique to contribute to worth living society with help of solar energy and provision of water. ENTERIA Energietechnik GmbH is the German company who operates for installation and distribution of solar energy systems. The ENTERIA Impact Energy GmbH has three subcompanies who run solar energy systems and sell the solar energy either to tenants or into the grid. ENTERIA Africa also operates for installation and distribution of solar energy systems in Mozambique and Nigeria. The author has the duty to design and plan solar energy systems in operation of the ENTERIA Energietechnik GmbH and to handle the disposal of solar energy for the ENTERIA RegioTalstrom GmbH.

2.2 *Business-to-tenant energy projects*

The idea of business-to-tenant energy project is to sell solar energy in the same location as the production without any utilization of the grid. For these kind of energy projects there are in general about seven parties who work together.

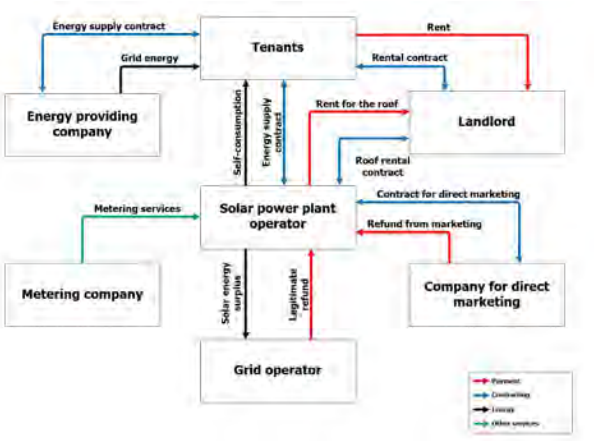

Figure 3: Parties of business-to-tenant energy projects

The solar power plant operator, in this case ENTERIA RegioTalstrom GmbH, has the most relations with the other parties. The scheme in figure 3 is targeting the concept of types which works with roof renting. This means, ENTERIA rents the roof of the landlord and installs the solar energy system on it. So that, ENTERIA can sell the produced solar energy to the tenants of the building. In the case of figure 3, the tenants must provide the additional grid energy by themselves. For that, the tenants can determine an energy providing company of their own choice [2]. The surplus of the solar energy system will be fed into the grid and can be dispensed by the grid operator. Either the solar power plant operator receives the legitimate refund or can commission a third party who is responsible for the direct marketing of the surplus solar energy. If the connected power of the solar systems is more than 100 kW, it is compulsory to work with direct marketing. The metering company installs and maintains the electrical meters.

2.3 Measuring concepts of the compared projects

In this practical project there are three different measuring concepts to consider.

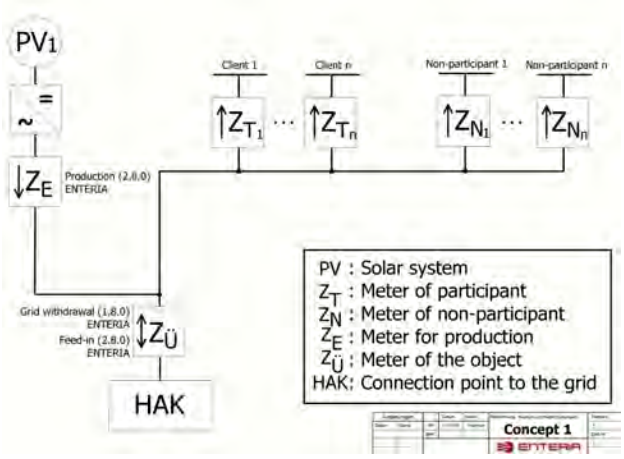

Figure 4: Measuring concept 1

The first measuring concept, shown in figure 4, focuses on the official definition of the BMWK about landlords-/business-to-tenant energy projects. It requires that the solar power plant operator supplies the tenants with solar and grid energy. Besides, this definition is meant for private energy clients and about 40 % of the object must be used as habitation. The prices for tenants must be lower than 90 % of the basic service prices. Based on EEG2023, if these demands are observed, there will be a public sponsorship for the self-consumption. Also, in this particular case the solar power plant operator supplies more than one tenant at the same time with solar energy.

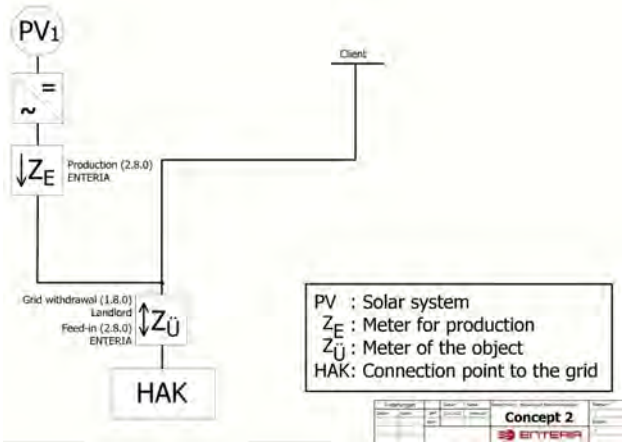

Figure 5: Measuring concept 2

Measuring concept 2 is about selling just the solar energy to the landlord or to one tenant. Because of this, any meters of potential subtenants are not drawn in figure 5. Only the meter for the solar energy production and the meter of the object is important for the accounting. According to this, the accounting and administration are much more uncomplicated than in case of measuring concept 3.

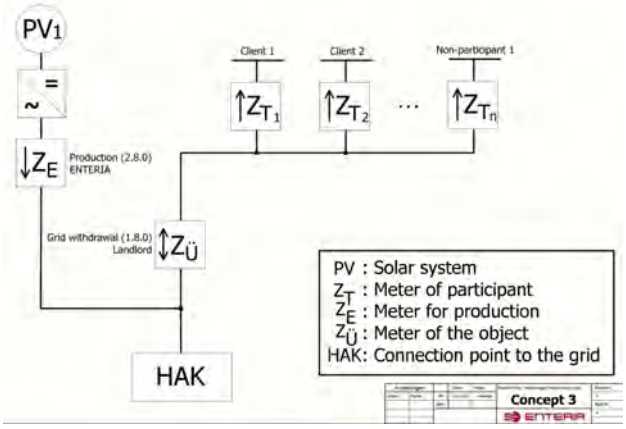

Figure 6: Measuring concept 3

The third measuring concept considers the energy supply chain. As shown in figure 6, the solar system is connected between the meter of the object and the grid. This kind of realization requires a collaboration with a

third company. In this scenario, ENTERIA worked on this energy supply chain with the direct marketing company WSW Energie & Wasser GmbH from Wuppertal. On the balance sheet, the solar system fully feeds into the grid. So, there will be a 100 % refund through the direct marketing. WSW closes an energy contract with the clients with two different prices. One price for the solar energy and one price for the grid energy. Because ENTERIA provides the solar energy, they are allowed to get a self-determined surcharge on the solar energy price. If you take a closer look at figure 6, there you can see that the clients are still using the solar energy immediately from the solar power plant. At this point, the rules of business-to-tenant energy projects described at the beginning of this subchapter can be observed.

3 Characterisation and Conditions of the Energy Projects

The business-to-tenant energy projects which are to be compared and analyzed are either already installed or in the phase of planning. In this practical project there will be four different types of ventures. The energy supply chain is a new and yet unknown marketing strategy for ENTERIA. By reason of this, every project will be compared between the classic local solar energy supply and the solar energy supply chain. The first impression of the energy supply chain is a comfortable way to market solar energy. ENTERIA only must close a contract with the owner of this property to rent the roof and with the WSW about the direct marketing and the supply of solar energy. The only risk to take is that the solar system could potentially fall out due to technical problems and would not generate yields. But for the own interest ENTERIA should maintain the solar power plant and keep it in a good condition.

Figure 7: Dasnöckel

The first project is Dasnöckel which follows measuring concept 1. In Dasnöckel there is a community of flat owners. This community includes ten similar apartment buildings here seen as one project. The solar power plant has a connected power of 353.6 kWp and 220.0 kVA. Dasnöckel might be the project with the most need of administration. The reason is a huge effort in agreements with the high number of landlords who all might have different ideas or requirements. Another reason is the high amount of energy clients and the providing of additional grid energy. Because of the dependence of the solvency of the clients and of the self-consumption of the solar system there is a high risk of financial damage. And if the solar system would not be able to produce e.g., because of technical reasons, ENTERIA must supply the clients fully with grid energy without making any yield. Direct marketing would not be economically worthwhile because the direct marketing operators do not see this project as one. Every object has their own connection point to the grid. So, there will be ten separate cases of direct marketing and as a result ten times charges for this service.

Figure 8: NeuDing

Project 2 is called NeuDing. This case applies measuring concept 2. The solar energy is sold to the landlord who passes the energy through to the tenant of this building. The connected power of the solar power plant is 197.02 kWp and 220.0 kVA. This case is more comfortable than the first project. There still will be more administration required than for the energy supply chain projects but with just one client, who also is the landlord, there is not a high risk for payment default. One disadvantage for this case is that there will be no public sponsorship on self-consumption.

Figure 9: DiGass

Figure 9 shows the solar system on the roof of DiGass. In this case the landlord is also the energy client at the same time. Because of the chance that their subtenant wants also to be part of this business-to-tenant project this scenario is split into two projects. With a connected power of 443.07 kWp and 368.0 kVA this location offers the largest solar energy system. For the scenario of classic local solar energy supply ENTERIA decided to run two solar systems parallel. There will be a full feed into the grid with the system on the large roof while there is a rather small system on the smaller roof for self-consumption. The reason is to get the higher refund for full feed into the grid and the ability to cover the consumption of the client. All other characteristics are similar to the second project of NeuDing.

4 Compared Viability of the Energy Projects

After the description of the characteristics and enumeration of potential risks and chances of the project, the viability the most impactful argument.

4.1 Viability of the projects

For the better understanding of table 2, the following table describes the numbers of the projects.

Table 1: Numbering of the projects

Number	Name
1	Dasnöckel: surplus feed-in
2	Dasnöckel: energy supply chain
3	NeuDing: surplus feed-in
4	NeuDing: energy supply chain
5	DiGass: surplus feed-in
6	DiGass: energy supply chain
7	DiGass incl. subtenant: surplus feed-in
8	DiGass incl. subtenant: energy supply chain

Table 2: Viability of the Energy Projects

Project / Numbers	1	2	3	4	5	6	7	8
Average grid consumption per year [kWh/a]	330.0		119.6		8.0		12.0	
Self-consumption rate	44.29 %		32.70 %		25.0 %	1.40 %	34.70 %	2.10 %
Investment per generator power [€/kWp]	958.40		1,138.61		962.50			
Legitimate/potential reward for feeding into the grid [ct/kWh]	5.98	10.00	12.38	14.69	14.10	14.29	14.13	14.29
Yield per year [€/a]	26,547.14	30,901.42	21,635.23	22,884.25	36,327.67	40,087.27	36,588.21	40,261.41
Rate of interest	4.68 %	6.51 %	7.19 %	7.93 %	5.67 %	6.90 %	5.76 %	6.96 %
Amortization	12.81 a	11.00 a	10.44 a	9.87 a	11.78 a	10.68 a	11.70 a	10.63 a

First, ENTERIA wants a maximum of energy price of 25 cents per kWh for the client. Consequently, the price for the local supplied energy is 25 cents per kWh. Because WSW takes 17.47 cents per kWh for their solar energy supply, ENTERIA takes a surcharge of 7.53 cents per kWh. At this point the energy clients would still have an energy price of 25 cents per kWh again. In table 2, there is an advantage for the energy projects working with the

energy supply chain. This is a result of the higher reward for feeding into the grid. Solar systems which fully feed its energy into the grid get much more reward per kWh. Furthermore, the self-consumption rate is in a lower level. The solar system feeds more energy into the grid than supplies it to the clients.

4.2 Viability of the project with a self-consumption of 100 %

TABLE 3: VIABILITY WITH 100 % SELF-CONSUMPTION

Project / Numbers	1	2	3	4	5	6	7	8
Average grid consumption per year [kWh/a]	330.0		119.6		8.0		12.0	
Self-consumption rate	100 %							
Investment per generator power [€/kWp]	958.40		1,138.61		962.50			
Reward for the solar energy [ct/kWh]	25.0	17.53	25.0	22.22	25.0 14.34	21.82	25.0 14.34	21.82
Yield per year [€/a]	66,441.21	42,409.77	35,509.10	31,160.31	38,342.14	40,293.18	38,342.14	40,570.29
Rate of interest	18.92 %	10.89 %	14.71 %	12.49 %	6.34 %	6.97 %	6.34 %	7.06 %
Amortization	5.12 a	8.02 a	6.36 a	7.25 a	11.16 a	10.62 a	11.16 a	10.55 a

Now, table 3 shows a scenario with a self-consumption rate with 100 % to analyze if there is a certain dependency of the self-consumption rate. In this case the situation switched, and the classic local energy supply shows a better result than the energy supply chain. The price for the solar energy supply is higher than the refund for feeding into the grid and the self-consumption rate is in a very high level. Thus, the yield per year is much higher than in table 2.

Apart from the projects of DiGass. There you can see almost no difference to table 2, because there are two solar systems at the same time. The sizing of the system is excessively higher in relation to the average grid withdrawal per year. So, the self-consumption rate of the smaller solar power plants do not have a deciding effect on the viability of the projects.

5 CONCLUSION AND RECOMMENDATION FOR ENTERIA

The characteristics of chapter 3 and the results of the viability lead to a conclusion. So first, there is to detect how many landlords are involved and if their decision-making about the coming project is complex in any way. The amount of energy clients is also an important aspect which has an impact of the risk of payment default. If there is just one client who also is the landlord or if there are many clients, the chances are rather low of money collection. The self-consumption rate plays a major significant role to the viability of the projects. In comparison of table 2 and table 3 the self-consumption concomitant with the amount of grid feed of the solar power plants is a very crucial factor for answering the question rather to decide between local energy supply or energy supply chain.
But to the date, only the WSW provides the energy supply chain and works only in Wuppertal and near surroundings. For now, it is difficult to find a direct marketing company who also offers this concept.
In conclusion there are six aspects to consider:

- Complexity through number of landlords or energy clients
- Potential risk of payment default
- Sizing of the solar power plant
- Average grid withdrawal by the client
- Self-consumption rate
- Availability of the energy supply chain

With this conclusion there should result a recommendation for ENTERIA to make the decision for the choice of realization of one business-to-tenant energy project much easier and quicker.

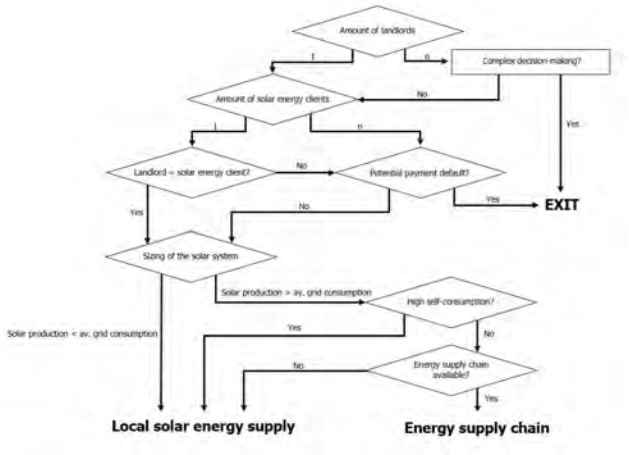

Figure 10: Decision-tree for future marketing strategies

The decision-tree in figure 10 serves as a guidance for ENTERIA to decide which marketing strategy they should focus on in the future. Starting at the top and working along the path should result to the right decision for each type of project.

To decide which measuring concept or rather type of energy client would be the most comfortable realization, you have to analyze the characteristics and tables of viability of the energy projects. Selling just solar energy to one client or better directly to the landlord is the concept with the lowest risk of financial damage and the lowest effort in supervision or accounting. And table 2 points out that this is the project with the lowest payback rate.
In the course of this ENTERIA can take with the decision-tree to decide if they want to work with local solar energy supply or the energy supply chain.

6 Excursion: Smart Energy Cloud

The knowledge and conclusion of the previous chapters should be implemented in the ENTERIA Smart Energy Cloud. This will be an online monitoring and payment system to illustrate and work with the virtual solar power plant of ENTERIA. The aim is to generate invoices automatically to simplify the administration and accounting of the solar energy supply. Besides, ENTERIA wants to realize donations for Mati Mati in Mozambique. Mati Mati is a water tower running with solar energy to provide fresh water for the people in Mozambique. The idea is that every energy client will get an extra water account on the new online platform besides their energy account working as a donation account. For every kilowatt-hour bought by the energy client, they will get an extra liter of water on their water account.

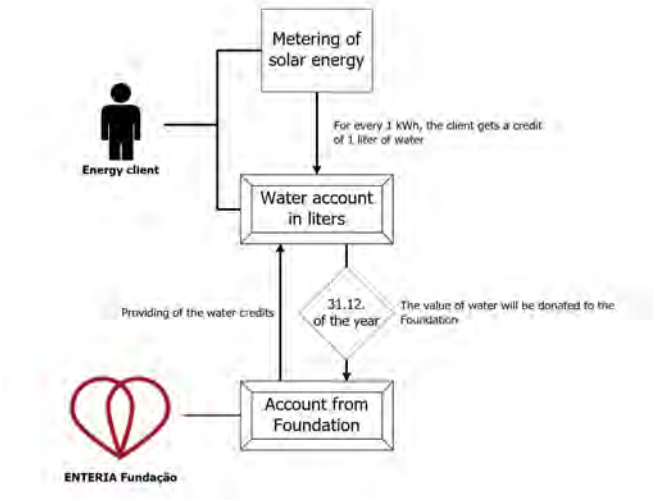

Figure 11: Procedure of donations

In theory, the clients are able to get water from the water tower in Mozambique. In fact, this is a very uncommon scenario. At the end of every year, the whole credit on the water account of the client will be donated automatically to the ENTERIA Fundacao.

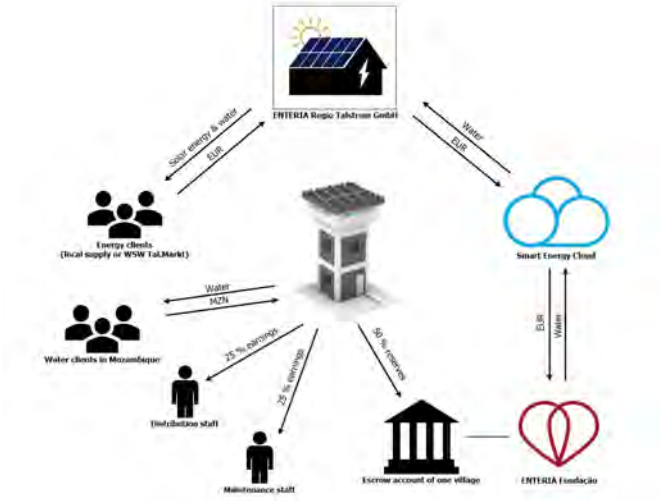

Figure 12: Process behind the donations

ENTERIA RegioTalstrom GmbH, the solar power plant operator of the business-to-tenant energy projects, buys water from the ENTERIA Fundacao to provide for the energy clients. ENTERIA Fundacao will use the donations to cover costs of maintenance and repairing of the water towers with help of escrow deposits in every village which has a water tower.
The main earnings of the water towers will still be the local disposal of water. The reason why the water is not free for the people in those villages is that this whole project should not collapse due to lack of donations. This descripted process arranges that it can stand on its own feet through the circle of distribution and donations.

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