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Business Plan for the use of photovoltaic on Cologne Trade Fair

Business Management
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presented by

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3 Conditions

3.1 Sun radiation map

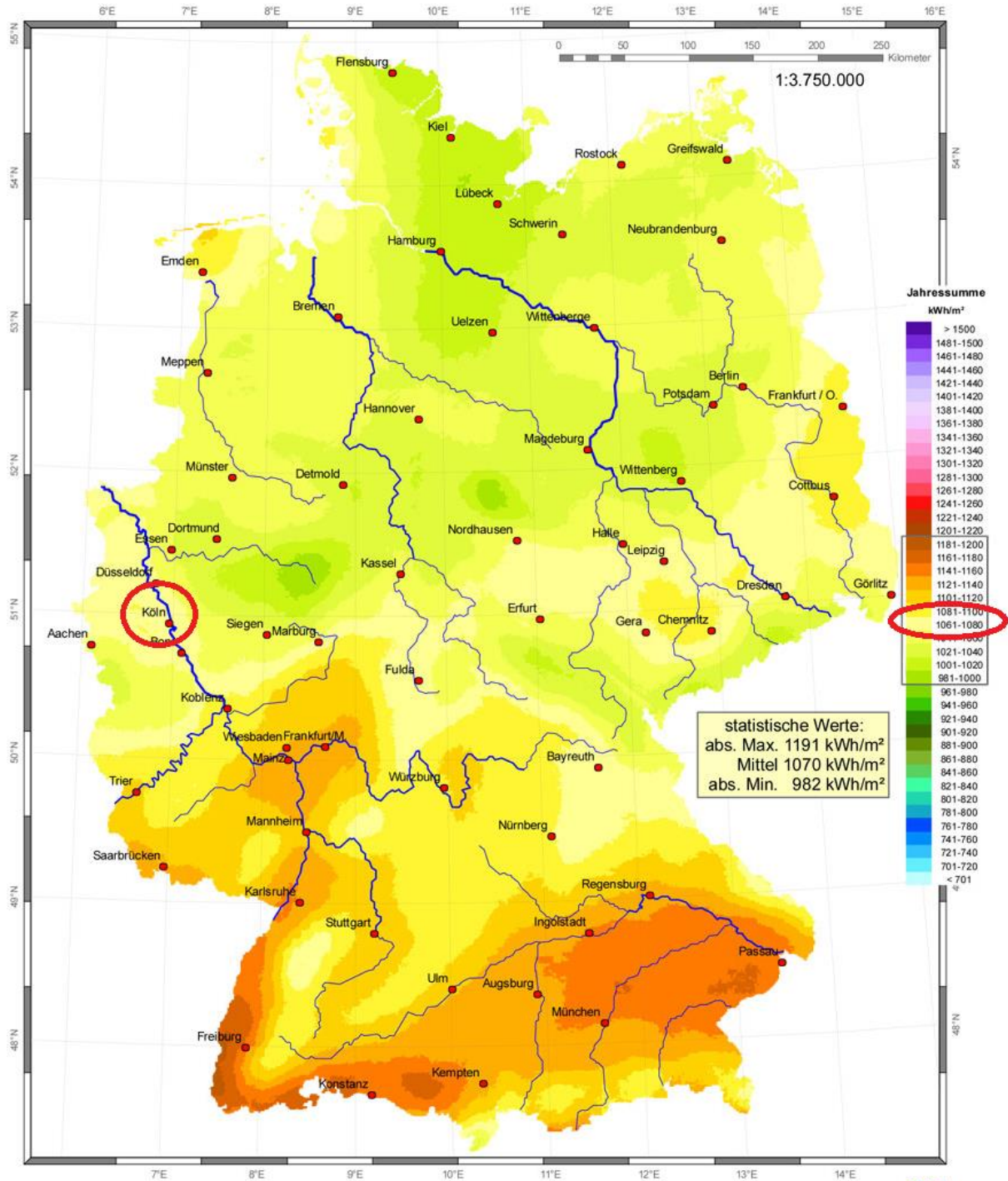


Figure 1: Sun Radiation Map [1]

Up to 1.200 kilowatt hours of solar energy can be earned in Germany per square metre yearly. Highly efficient solar power systems work effective and clean. You can gain high earnings even without direct sunshine. In Cologne we can earn a value of 1070 kilowatt hours per square metre.



3.2 Plant location

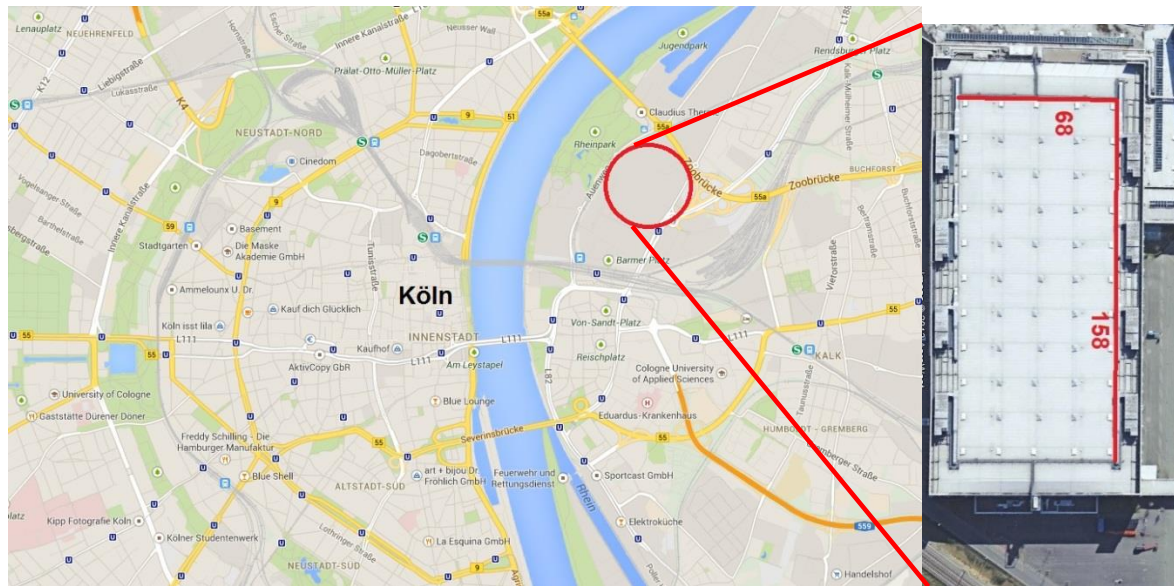


Figure 2: Location of the plant [2]

The Cologne Trade Fair is located on the east side of the Rhine in Deutz which belongs to the city center (see Figure 2). The selected roof of exhibition hall 8 has a usable area of 11.000 square metres.

3.3 Guaranteed market price based on the EEG

For photovoltaic plants > 40 kW and < 1MWp you get 11,58 ct/kWh over 20 years when the plant is built in January 2014. After this time the market price has an degradation of 1,4 % per month.

3.4 System design

In this chapter the system components are described and how they are mounted.

Table 1: System design

Total number of solar panels	3998
Peak performance	999,5 kWp
Total number of inverters	44



3.4.1 Assignment chart

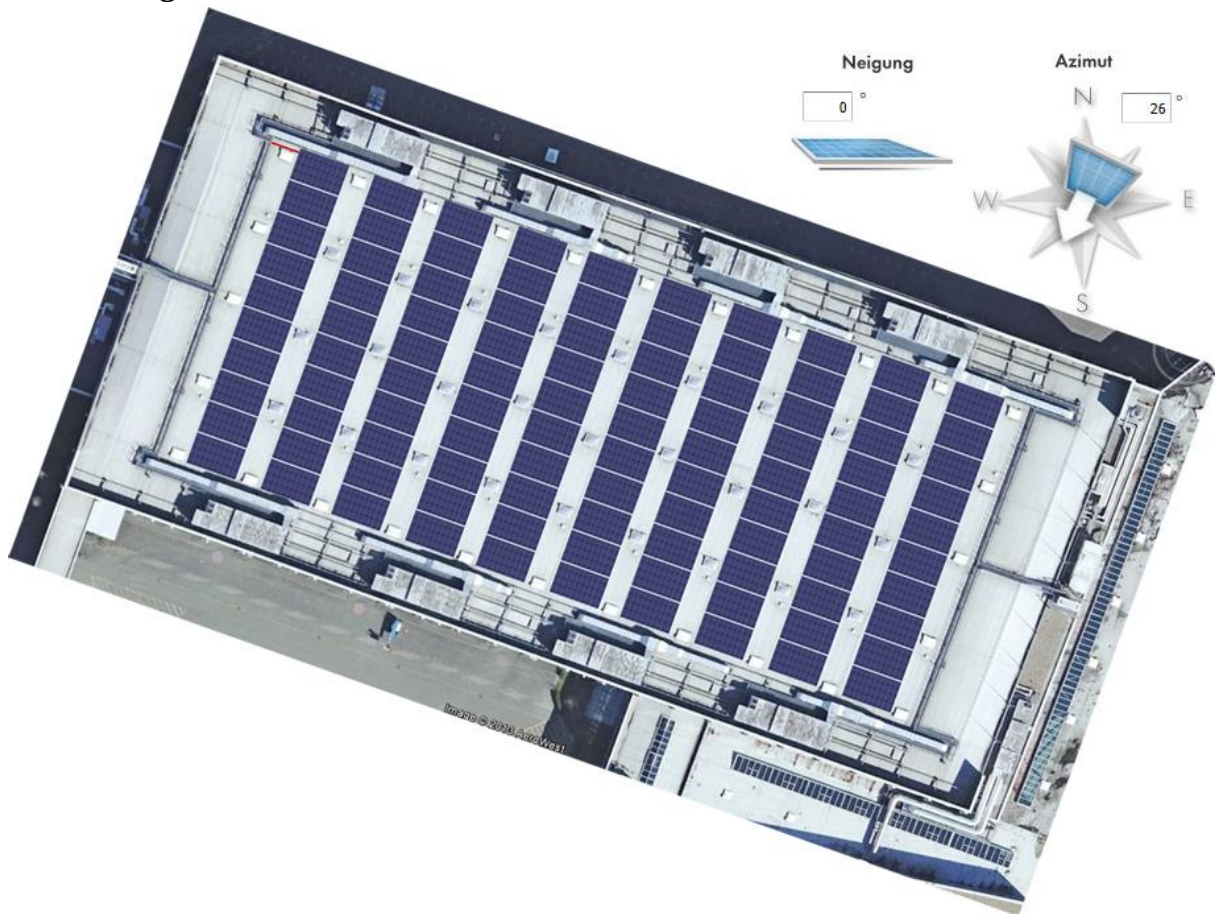


Figure 3: Assignment chart

In the bird's eye view you can see exhibition hall 8 with 3998 photovoltaic modules. This modules are aligned in azimuth angle of 26° south and are installed with an inclination angle of 0° .

3.4.2 Solar modul

The modul "sw 250 poly" consists of polycrystalline cells and is produced by SolarWorld AG which is a German company. It has a load of 250 W and an energy efficiency of 14,6 % (in the region of Cologne).



Figure 4: Solar panel [3]



3.4.3 Inverter

The used inverter is shown in Figure 5. This device changes direct current (DC) to alternating current (AC). Solar cells only produce direct current so that inverters are needed.

For our photovoltaic plant we select inverters from SMA. We need 43 times the inverter STP 20000 TLEE-10 and one time the inverter STP 10000 TL-10.



Figure 5: Inverter [4]

3.5 Simulation results

We install four strings and 23 modules in series per STP 20000 TLEE-10 inverter. At the single inverter STP 10000 TL-10 we install only two strings with 21 modules in series. The simulation is solved by the program SunnyDesign3 which uses actual weather data of the region for exact results.

Table 2: Gains of each year in kWh

1. Year	2. Year	3. Year	4. Year	5. Year	6. Year
785.040	777.190	769.418	761.724	754.106	746.565
7. Year	8. Year	9. Year	10. Year	11. Year	12. Year
739.100	731.709	724.391	717.148	709.976	702.876
13. Year	14. Year	15. Year	16. Year	17. Year	18. Year
695.848	688.889	682.000	675.180	668.428	661.744
19. Year	20. Year				
655.127	648.575				

In Table 2 the gain for the first 20 years is calculated by the power of the modules and a degradation of 1 % per year.

4 Cost Calculation

In the following chapter the different calculation are presented with the results in tables.



4.1 Calculation of the investments and depreciation costs

Table 3: Investment and depreciation costs

Description	Amounts of investment	Depreciation rate in years	Depreciation in €/article
Property (5 ha)	150.000,00 €	0	- €
additional expenses (5% taxes and 3% other costs)	12.000,00 €	0	- €
Sum of purchased land	162.000,00 €		- €
Exterior installations:			
installation	59.970,00 €	20	2.998,50 €
Total of exterior installations	59.970,00 €		2.998,50 €
Machinery:			
inverter (44)	153.245,00 €	20	7.662,25 €
solar module (3998)	1.044.117,00 €	20	52.205,85 €
Total of machinery	1.197.362,00 €		59.868,10 €
Engineering:			
expenditures/planning	20.000,00 €	10	2.000,00 €
Total of engineering	20.000,00 €		2.000,00 €

Table 4: Summary of fixed costs

Investment goods	Investment expenditures	Depreciation in years	Depreciation costs
Property	162.000,00 €	0	- €
Exterior installations	59.970,00 €	20	2.998,50 €
Machinery	1.197.362,00 €	20	59.868,10 €
Engineering	20.000,00 €	10	2.000,00 €
Unexpected	50.000,00 €	0	- €
Total Investment	1.489.332,00 €	Total depreciation costs	64.866,60 €

The amount of the investment for the roof is declared with 162.000 €. Furthermore there are calculated investments for Machinery, Installation and Engineering. Some of these investments have to be depreciated. The modules for example have depreciation rate of 20 years (see Table 3). The sums of investment costs and the depreciation costs are presented in Table 4.

4.2 Service costs

In some cases it is necessary to have an insurance to protect the solar cells. Maybe because of the risk of larceny and very bad weather conditions (e.g. lightning). In the cost calculation we planned to invest 2.000 € for insurance and another 500 € for maintenance to locate defected solar panels (see Table 5 and Figure 6).



Table 5: Calculation of service costs

Description	Costs
insurance	2.000,00 €
maintenance	500,00 €
Total of service costs	2.500,00 €



Figure 6: Defected solar panel [5]

4.3 Finances



Table 6: Total of investment and financing

Total investment	1.489.332,00 €
own capital funds (60%)	893.599,20 €
outside financing (40%)	595.732,80 €

Bank loan
1,36% interest
20 years running time

Number of investors	30
Investors equity	29.786,64 €

Table 7: Interest paid on debt

Years	Balance of dept	Interest rate (%)	Interest costs paid p.a.	Repayment
1	595.732,80 €	1,36	8.101,97 €	29.786,64 €
2	565.946,16 €	1,36	7.696,87 €	29.786,64 €
3	536.159,52 €	1,36	7.291,77 €	29.786,64 €
4	506.372,88 €	1,36	6.886,67 €	29.786,64 €
5	476.586,24 €	1,36	6.481,57 €	29.786,64 €
6	446.799,60 €	1,36	6.076,47 €	29.786,64 €
7	417.012,96 €	1,36	5.671,38 €	29.786,64 €
8	387.226,32 €	1,36	5.266,28 €	29.786,64 €
9	357.439,68 €	1,36	4.861,18 €	29.786,64 €
10	327.653,04 €	1,36	4.456,08 €	29.786,64 €
11	297.866,40 €	1,36	4.050,98 €	29.786,64 €
12	268.079,76 €	1,36	3.645,88 €	29.786,64 €
13	238.293,12 €	1,36	3.240,79 €	29.786,64 €
14	208.506,48 €	1,36	2.835,69 €	29.786,64 €
15	178.719,84 €	1,36	2.430,59 €	29.786,64 €
16	148.933,20 €	1,36	2.025,49 €	29.786,64 €
17	119.146,56 €	1,36	1.620,39 €	29.786,64 €
18	89.359,92 €	1,36	1.215,29 €	29.786,64 €
19	59.573,28 €	1,36	810,20 €	29.786,64 €
20	29.786,64 €	1,36	405,10 €	29.786,64 €
Total interest paid			84.665,55 €	
Total repayment				595.732,80 €

The total investment is split in own capital funds which are spent by 30 investors of the founded GbR and in outside financing. This is presented in Table 6 including the bank loan conditions. The outside financing or precisely the interest paid on debt is calculated in Table 7.

The following tables 8, 9, 10 contain information about the self-costs, the cash-flow calculation and the equity profitability.

Table 8: Self-costs

	1. Year/per kWh	1. Year	2. Year	3. Year	4. Year	5. Year	6. Year	7. Year	8. Year	9. Year	10. Year
Utilization of capacity (%)	100	100	100	100	100	100	100	100	100	100	100
Quantity produced kWh	785.040	785.040	777.190	769.418	761.724	754.106	746.565	739.100	731.709	724.391	717.148
Costs	cost per kWh	costs per year	costs per year	costs per year	costs per year	costs per year	costs per year	costs per year	costs per year	costs per year	costs per year
Depreciation costs	0,0826	64.866,60	64.866,60	64.866,60	64.866,60	64.866,60	64.866,60	64.866,60	64.866,60	64.866,60	64.866,60
Financing costs	0,0103	8.101,97	7.696,87	7.291,77	6.886,67	6.481,57	6.076,47	5.671,38	5.266,28	4.861,18	4.456,08
Service costs	0,0032	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00
Sum of costs		75.468,57	75.063,47	74.658,37	74.253,27	73.848,17	73.443,07	73.037,98	72.632,88	72.227,78	71.822,68
Self costs per kWh	0,0961	0,0961	0,0966	0,0970	0,0975	0,0979	0,0984	0,0988	0,0993	0,0997	0,1002

	11. Year	12. Year	13. Year	14. Year	15. Year	16. Year	17. Year	18. Year	19. Year	20. Year
Utilization of capacity (%)	100	100	100	100	100	100	100	100	100	100
Quantity produced kWh	709.976	702.876	695.848	688.889	682.000	675.180	668.428	661.744	655.127	648.575
Costs	costs per year	costs per year	costs per year	costs per year	costs per year	costs per year	costs per year	costs per year	costs per year	costs per year
Depreciation costs	62.867	62.867	62.867	62.867	62.867	62.867	62.867	62.867	62.867	62.867
Financing costs	4.050,98	3.645,88	3.240,79	2.835,69	2.430,59	2.025,49	1.620,39	1.215,29	810,20	405,10
Service costs	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00	2.500,00
Sum of costs	69.417,58	69.012,48	68.607,39	68.202,29	67.797,19	67.392,09	66.986,99	66.581,89	66.176,80	65.771,70
Self costs per kWh	0,0978	0,0982	0,0986	0,0990	0,0994	0,0998	0,1002	0,1006	0,1010	0,1014

Table 9: Cash Flow Calculation

	1. Year	2. Year	3. Year	4. Year	5. Year	6. Year	7. Year	8. Year	9. Year	10. Year
Revenue	90.908	90.908	89.999	89.099	88.208	87.326	86.452	85.588	84.732	83.885
Depreciation costs	64.867	64.867	64.867	64.867	64.867	64.867	64.867	64.867	64.867	64.867
Financing costs	8.102	7.697	7.292	6.887	6.482	6.076	5.671	5.266	4.861	4.456
Service costs	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Loss carried forward	-	-	-	-	-	-	-	-	-	-
Profit before taxes	15.439	15.844	15.340	14.845	14.359	13.882	13.414	12.955	12.504	12.062
Taxes (19%)	2.933	3.010	2.915	2.821	2.728	2.638	2.549	2.461	2.376	2.292
Profit after taxes	12.506	12.834	12.426	12.025	11.631	11.245	10.866	10.493	10.128	9.770
Cash-flow	77.372	77.700	77.292	76.891	76.498	76.111	75.732	75.360	74.995	74.637
Repayment credit	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €
Dividend	47.586 €	47.914 €	47.506 €	47.105 €	46.711 €	46.325 €	45.946 €	45.573 €	45.208 €	44.850 €

	11. Year	12. Year	13. Year	14. Year	15. Year	16. Year	17. Year	18. Year	19. Year	20. Year
Revenue	83.046	82.215	81.393	80.579	79.773	78.976	78.186	77.404	76.630	75.864
Depreciation costs	62.867	62.867	62.867	62.867	62.867	62.867	62.867	62.867	62.867	62.867
Financing costs	4.051	3.646	3.241	2.836	2.431	2.025	1.620	1.215	810	405
Service costs	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Loss carried forward	-	-	-	-	-	-	-	-	-	-
Profit before taxes	13.628	13.203	12.786	12.377	11.976	11.584	11.199	10.822	10.453	10.092
Taxes (19%)	2.589	2.509	2.429	2.352	2.275	2.201	2.128	2.056	1.986	1.917
Profit after taxes	11.039	10.694	10.356	10.025	9.701	9.383	9.071	8.766	8.467	8.174
Cash-flow	73.905	73.561	73.223	72.892	72.567	72.249	71.938	71.633	71.334	71.041
Repayment credit	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €	29.787 €
Dividend	44.119 €	43.774 €	43.436 €	43.105 €	42.781 €	42.463 €	42.151 €	41.846 €	41.547 €	41.254 €

Total dividend
891.199 €

Table 10: Equity Profitability

Equity profitability	1. Year	2. Year	3. Year	4. Year	5. Year	6. Year	7. Year	8. Year	9. Year	10. Year
Equity	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €
Profit after taxes	12.505,64 €	12.833,77 €	12.425,55 €	12.024,69 €	11.631,12 €	11.244,77 €	10.865,56 €	10.493,43 €	10.128,30 €	9.770,10 €
Dividend	47.585,60 €	47.913,73 €	47.505,51 €	47.104,65 €	46.711,08 €	46.324,73 €	45.945,52 €	45.573,39 €	45.208,26 €	44.850,06 €
Interest p.a.	5,33%	5,36%	5,32%	5,27%	5,23%	5,18%	5,14%	5,10%	5,06%	5,02%
Interest sum	5,33%	10,69%	16,00%	21,27%	26,50%	31,69%	36,83%	41,93%	46,99%	52,01%

Equity profitability	11. Year	12. Year	13. Year	14. Year	15. Year	16. Year	17. Year	18. Year	19. Year	20. Year
Equity	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €	893.599,20 €
Profit after taxes	11.038,77 €	10.694,23 €	10.356,41 €	10.025,26 €	9.700,70 €	9.382,66 €	9.071,09 €	8.765,91 €	8.467,07 €	8.174,50 €
Dividend	44.118,73 €	43.774,19 €	43.436,37 €	43.105,22 €	42.780,66 €	42.462,62 €	42.151,05 €	41.845,87 €	41.547,03 €	41.254,46 €
Interest p.a.	4,94%	4,90%	4,86%	4,82%	4,79%	4,75%	4,72%	4,68%	4,65%	4,62%
Interest sum	56,94%	61,84%	66,70%	71,53%	76,31%	81,07%	85,78%	90,47%	95,11%	99,73%

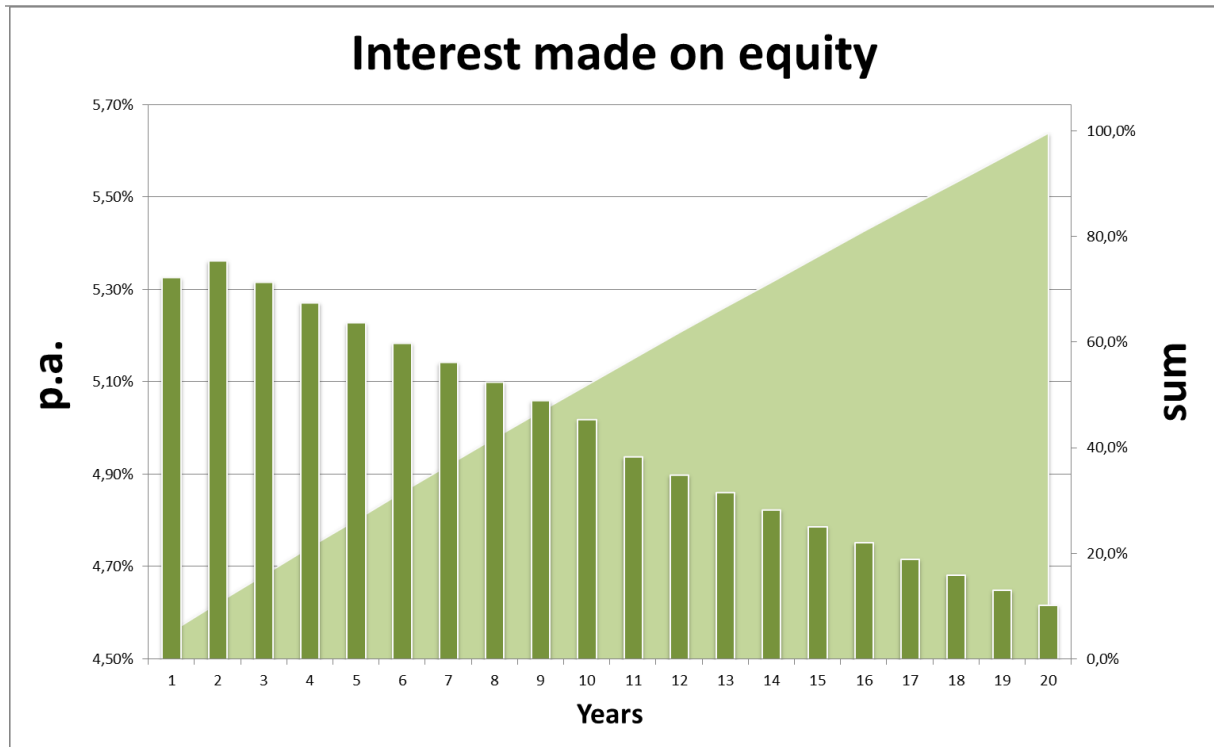


Figure 7: Interest made on equity

Over 20 years we have nearly constant revenues of 90.000 €. In each year the interest rate of the equity profitability come down from 5,3 % in the first year to 4,6 % in the 20th year (see Table 7). The sum of this interest rates is the quantity of the own capital funds. In Table 7 this quantity reaches 99,73 %.

The total dividend amounts 891.199 € after the calculation of costs and taxes.

5 Conclusion

At the beginning we spent 893.599 € own capital and 595.732 € outside financing. At the end of our calculation period (20 years) we have a total dividend of 891.199 € and the depreciation of 595.732 € (see Table 6).

Comparing these values results to a total loss of 2400 €.

In this case we decide not to invest in this project. However this investment is dependent on several items like the value of taxes to pay, the own capital, the interest rate of the bank etc.

