WIND TURBINES IN GERMAN AGRICULTURE - NO RISK, NO GAIN? CURRENT SITUATION AND ECONOMIC VIABILITY

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Abstract

Only a small number of German farmers invest into wind turbines on the land they own. In contrast to that they tend to rather lease land for that purpose to investors. An explorative qualitative study on the reasons for this investment pattern was conducted. Calculations of the economic efficiency (e.g. net present value, pay off) of wind turbines build the foundation of the study. In addition, farmers in the North-East Federal State Mecklenburg-Western Pomerania were interviewed for their motives of their capital expenditures. A considerable amount of equity capital is required for setting up a wind turbine. The capital invested frequently competes with the purchase of agricultural land.

Building wind turbines involves risks. In advance substantial financial means for a planning permission and other examinations precede the construction of a wind turbine. Only in the very end of these costly investigations a construction permit will be issued, facing a farmer with a high level of uncertainty during the whole process.

Fluctuations in wind yield and therefor volatile revenues confront farmers additionally with financial uncertainties. Risk taking behaviour of farmers was assessed normatively by the Hurwicz criterion. Results showed, that only farmers, with the necessary funds at their disposal and a high level of optimism were more likely to take the risk to set up a wind turbine on their land. They take this decision despite the fact that leasing once own land to other investors is of predictable profit and clearly less risky.

Keywords: Renewable energies, wind turbines, investment, leasing, profitability, risk

1 Introduction

Growing public concern has led governments worldwide, at the EU level and individual national governmental agencies, to set policies and a solid legislative framework to reduce emissions of Green House Gasses (Commission of the European Communities, 2007; EWEA, 2011). Since 1991, Germany has been promoting the production of renewable energies. The basis for this was first the Electricity Supply Act 1991[1] and from the year 2000 the Law for the Development of Renewable Energies (EEG). "The purpose of this law is to enable the sustainable development of energy supply, in particular in the interests of climate and environmental protection, to reduce the economic costs of energy supply by including long-term external effects, to conserve fossil energy resources and to develop technologies for the production of electric energy from Renewable Energies "(EEG 2017, §1 (1)). "The aim of this law is to increase the share of electricity generated from renewable energies in gross electricity consumption to ... 40 to 45 percent by 2025" (EEG 2017, § 1 (2)).

Gross electrical power generation in Germany of all, fossil and renewable energy sources together, has increased since the year 2000 from 576.6 TWh to 651.8 TWh by the year 2015. The share of renewable energy sources (from hydro power, wind, solar, biogas and other biomass) has risen from 6.5% to 32.6%. Wind power accounted for 9.5 TWh in 2000 (on-shore only), which was increased to 79.3 TWh on-shore and 8.7 TWh off-shore in 2015. The wind turbines thus produce the largest share of renewable energies, followed by biomass with 44.2 TWh and photovoltaic 38.4 TWh, each in 2015 (BDEW Energy Info 2016).

Significant investments have been done in the biogas sector, where up to about 10,000 units have been built in the past 20 years in Germany. But since 2015 the electricity prices for new biogas plants are significantly lower, so that investments in this sector of renewable energies came to a halt.

Since 2000, the number of wind turbines has risen from 9,359 to 28,675 in 2017 (Fig. 1). In order to achieve the politically predetermined goals of up to 80% share of renewable electricity by the year 2050, more wind turbines have to be built.

[1] Stromeinspeisungsgesetz 1991

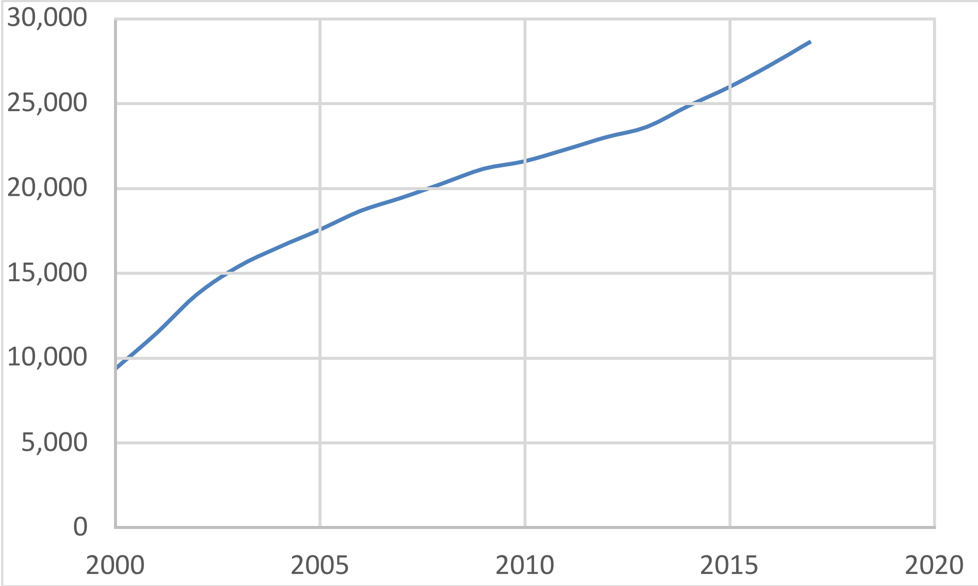


Figure 1: Development of the number of on-shore wind turbines in Germany in the years 2000 to 2017
Source: http://de.statista.com/statistik/daten/studie/20116/umfrage/anzahl-der-windkraftanlagen-in-deutschland-seit-1993 (22.08.2018)

2 Wind power increases while biogas stagnates

As described for Germany, the generation of renewable energies is steadily increasing in the federal state of Mecklenburg-Western Pomerania in the same way. Mecklenburg-Western Pomerania was selected as the site of our qualitative study. Here, the *economic efficiency* of an exemplary wind turbine was calculated and three farmers at wind park locations were interviewed (Marquardt, 2017). The strongest expansion is currently driven by the investments in wind energy (Fig. 2).

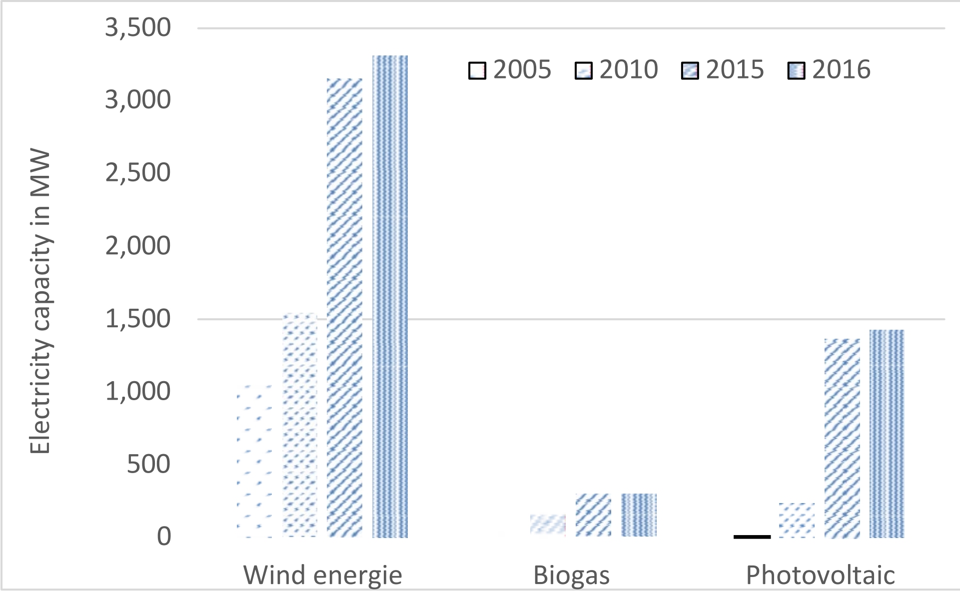


Figure 2: Development of electricity generation from renewable energies in the Federal state Mecklenburg-Western Pomerania
Source: Statistical Office Mecklenburg-Western Pomerania, Statistical Yearbook 2017, Tab. 19.2, p. 443.

The expansion of wind energy means a destruction of agricultural land and soil and therefor loss of income from plant production. On the other hand, income opportunities for the agricultural firms and also for the municipalities arise through wind energy production. Since farmers and agricultural companies are often owners of land, they have the opportunity for investments in their own wind turbines or to lease the location of wind turbines to investors outside of the agricultural sector.

As mentioned, farmers as landowners could design and build their own wind turbines in designated wind energy areas. However, the necessary investments for a modern wind turbine with the capacity of about 3 MW sums up to millions of Euro[2]. Even at the planning stage, considerable costs are incurred for appraisals and approvals amounting to approx. 7% of the total investment that would be lost in the event of non-approval.

Therefore, our hypothesis was, that farmers must be prepared to take special risks e.g. related to uncertain results of permit procedure, required equity or profitability of investment by planning of setting up at least of a single wind turbine. For more than one wind turbine, e.g. as part of a wind farm, the initial available equity would probably not be sufficient in most cases. Therefore, we assumed, that the lease of locations might usually be preferred. In contrast to that, for larger investors and for professional planning agencies of wind turbine parks, the risk of unapproved planning is spread over larger units and is also calculable on the basis of existing expertise.

[2] calculated with an investment of 1.500 EURO/kW

The regulations for constructing a wind turbine are an integral part of planning a wind farm or a single wind turbine, which bind a lot of capital in advance. The most important assessments and reports and the progress of the approval phase are briefly explained below. After that, the suitability for currently designated wind turbines for a location in Mecklenburg-Western Pomerania will be shown.

3 Methodology

After introducing to the overall political frame conditions and economic development in energy and related environmental protection, methodology of the article will be described. The study is based on the cost calculations of wind turbines in order to assess profitability and on farmer interviews to learn more about motivation for or against an investment in wind farms.

Deterministic calculation of total costs and breakeven analysis for a typical wind turbine currently constructed in North-Eastern Germany is needed to assess the economic situation and the chances in profitability of such an investment. Furthermore, in a stochastic simulation with triangle distribution of production of electrical power (median 3,200 hours p.a. and deviation of +/- 500 full load hours) the risk of fluctuating wind yields can be calculated. Additional a net present value comparison of own investment versus revenues from leasing a wind turbine site taking in account risk tolerance according to the Hurwicz criterion gives insight into the decision alternatives of own investment or leasing options. As in other countries (e.g. US, Sweden, Wales) observed (Bolinger et al. 2006, Munday 2011, Zdravkovic 2013) and for Germany already mentioned, framers are rarely owners of wind turbines or even wind parks. To learn more about the motivations, the benefits and the obstacles of own investments in wind turbines three farmers have been interviewed using a structured questionnaire developed by the authors.

4 Large approval effort

During the planning process of wind turbines and wind parks, operators are confronted with a multitude of laws and regulations. These exist at the federal, state and local level (Fig. 3).

• **Federal legislation** Federal Construction Act (BauGB) Air Traffic Act (LuftVG) Road using right Federal Nature Conservation Act (BNatSchG) Federal Emissions Control Act (BImSchG) Environmental Impact Assessment Act (UVPG)
o **Regulation of the federal states** Country construction order Height limit and distance regulations Spatial planning and Regional planning
▪ **Responsibility of the municipality** Designation of priority areas Creation of land use plans Examination of admissibility Granting of the building permit

Figure 3: Regulations for the approval of wind turbines
Source: Hau, 2014

Since 1998, wind turbines in rural areas have been considered privileged projects under the Federal Construction Act (BauGB). This amendment pushed the realization of wind power projects. Since then, planned projects in designated suitable wind energy areas can no longer be prevented by individuals.

The technical part of the required planning documents includes a ground survey, the course of the cable routes as well as the proof of ownership and lease conditions of the wind turbine location. For this purpose, a description of the location (geographical location and land use maps) is required, which includes information on crane movement, crane shelves, construction documents of the wind turbines and a mapping of the areas with the corresponding distance requirements (Hau, 2014).

The second component of the approval procedure is an environmental impact assessment according to the Federal Emissions Control Act (BImSchG). All basic requirements are regulated, but may vary from state to state or they are supplemented by the respective Federal Construction Act (BauGB) or Country construction order. A variety of environmental and regulatory relevant documents are necessary, in particular for occupational safety, air traffic control, a wind report, to turbulence, ice shedding, noise emission, the building materials used, waste treatment, visualization, plant safety, lightning and fire protection, landscape maintenance plan, possibly to archaeological features, the end of the operation, species protection, settlement structure, habitat compatibility, conservation, classification of flora and fauna, biotope structure, soil management, physical characterization, water management and soil sealing (Hau, 2014).

5 New designated areas for wind energy below 1% of the land area of Mecklenburg-Western Pomerania

On local levels there has been considerable public resistance against the declaration of new designated wind turbine park areas. The areas involved sum up less than one percent of the land area of Mecklenburg-Western Pomerania, as show for five larger sub regions in Mecklenburg-Western Pomerania [3]:

- The planning region Western Pomerania covers an area of 713.700 ha, whereby the administrative district Western Pomerania**-Greifswald (VG)** has an area of 393.000 ha and the district **Western Pomerania-Rügen (VR)** occupies an area of 320.700 ha. In the districts of VR and VG, an area of 6,258 ha was designated as a suitable wind energy area in the "Second Amendment to the Regional Spatial Development Program of Western Pomerania, 2015". The wind suitability areas thus comprise approximatively 0.87% of the area of the planning region Western Pomerania.
- In Germany's largest district, the **Mecklenburg Lake District** (Mecklenburgische Seenplatte - MSE), with an area of 547,000 ha, an area of 4,465 ha is designated as a suitable area for wind power plants[4]. This corresponds to 0.82% of the district MSE.
- For the district and the C**ity of Rostock**, suitable areas for wind energy production of approximatively 1% of the area of the planning region are indicated[5]. With an area of the planning region of 360,400 ha, this corresponds to an area of approximatively 3,500 ha. According to the Spatial Development Program **"Region Rostock"** wind turbines with a total output of 1,000 MW can be built. This compares to twice the output of the Rostock hard coal-fired power plant.
- For the planning region **Westmecklenburg**, an area of 6,473 ha is designated as a suitable area for wind energy production in the partial update of the regional spatial development program Westmecklenburg from the year 2016[6]. The planning region itself has an area of 700,200 ha, making it the largest of the four planning regions in Mecklenburg- Western Pomerania. The area share of the wind suitability areas here amounts to approximatively 0.92%.

[3] Mecklenburg-Vorpommern, SIS-Online, 2016
[4] Regionales Raumentwicklungsprogramm Mecklenburgische Seenplatte, Teilfortschreibung Kapitel 6.5 Energie, 2013
[5] Raumentwicklungsprogramm Region Rostock, Teilfortschreibung Kapitel 6.5 Energie, 2014
[6] Regionales Raumentwicklungsprogramm Westmecklenburg, Teilfortschreibung Kapitel 6.5 Energie, 2016

6 Lease income in comparison to the profitability of an own wind turbine

In this part of the article the construction of an own wind turbine is compared with the leasing of the site. By way of example, the construction of a wind turbine with a capacity of 2.300 MW is considered (Table 1). For this purpose, a full financing plan was drawn up and evaluated. The total investment is € 3,604,100, which includes a pro rata 7% planning and approval costs of € 252,287, which must be invested in advance, without any guarantee that the project may be carried out.

Table 1: Assumptions for the breakeven calculation of a wind turbine

Key figures	Unit	Amount
Size of the wind turbine	MW	2.300
total investment	€	3,604,100
from that: planning and approval costs	percentage / amount in €	7% / 252,287
Own funds of investor/farmer	€	570,615
Interest of loan	% p.a.	2.5
amortization period	Years	20
Feed-in-tariffs:		
- first five years	€/kWh	0.0890
- following years	€/kWh	0.0495
Capacity utilization	full-load hours per year	3,200

At the beginning, 15% own funds plus 30,000 € for the dismantling of the windmill at the end of the use have to be brought in for the investment, which add up to an equity amount of 570,615 € (Fig. 4). This is a substantial sum even for a larger agricultural enterprise, which then will not be available for other alternative investments, e.g. buying land or investments in buildings or machinery, which was also confirmed in the survey by the farmers.

The costs for the operation of the wind turbine are derived from depreciation, which is calculated for a use of 20 years, the interest of 2.5% for borrowed capital and 2% utilization costs for equity capital or the calculation of net present values, as well as other costs of € 56 per kW per year for operations management, insurance, reserves, maintenance and repair and others (Windguard 2015); the latter adds up to 128,800 € p.a. In addition, direct marketing costs of 0.20 €cent per kWh (approximately € 14,720 p.a.) must be taken into account.

When leasing the site for a wind turbine, 5.5% of the electricity revenue is initially recognized as lease costs or revenue, which in the first five years results in an average lease income of € 36,027 p.a. and in the remaining term 20,038 € p.a. Depending on the competitive situation, the rental share of electricity revenue can fluctuate considerably; in the following calculation a range of 4% to 8% is evaluated. In some cases, even values for the leasing share of up to 10% have been mentioned. Because of the lease payments, the equity capital of a third party investor (fund) is lower, compared to a farmer's equity capital, who operates a wind turbine on his own land (Fig. 4).

The difference in compensation over the useful life expectancy is also evident from the development of equity: The Law for the Development of Renewable Energies (EEG) guaranties for the first five years, a selling price of € 0.089 per kWh for the produced electricity and the following years at € 0.0495 per kWh (EEG 2014). It is currently not possible to estimate the remuneration that can be achieved under the EEG 2017, as new projects have to participate in the tenders and only then will the new allowances be determined. Capacity utilization is assumed to be 3,200 full-load hours per year, resulting in a capacity utilization of 37% p.a. equivalent. The revenues are then initially at 655,040 € p.a. and fall from the 6th year on 364.320 € p.a.

Calculated results in an average profit before taxes in the amount of approximately 76,000 € p.a. from which a payback period of 14 years can be derived. Including the equity capital, the possibility of special repayments and the higher initial remuneration, the investor could already be debt-free after 11 years (farmer with his own wind turbine) or 12 years (third-party investor – investment fund) (Fig. 4).

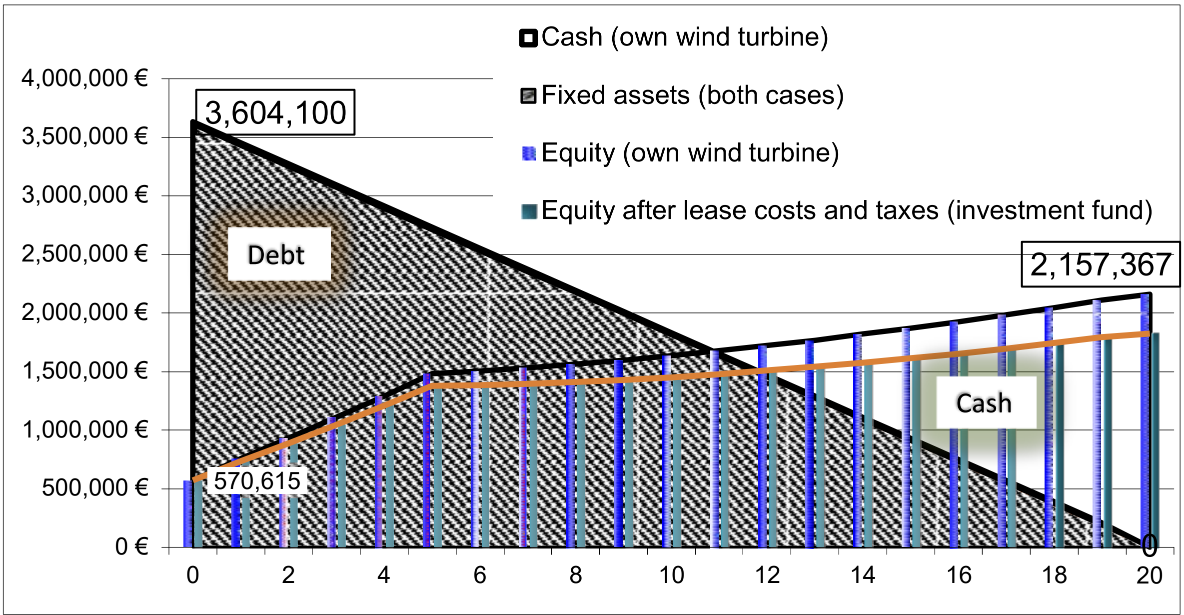


Figure 4: Amount of investment at the beginning and necessary equity capital and development of fixed assets and cash surplus for a wind turbine depending on the investor (farmer or external investor, example of lease share amounting to 5.5% of the electricity revenue)

All in all, in the case of an investment by a farmer an increase in equity (after taxes) can be expected to amount to around € 1.5 million and from external investors by as much as € 1.2 million. The investment of a wind turbine proves to be comparatively lucrative, as it comes to a return on equity of 6.9% for the investing farmer.

In the investment calculation, net present value is used for assessing profitability. The net present value is based on the start of the investment (t_0) and results from the discounted surpluses. With € 1.5 million equity growth over 20 years of operation, the (discounted) net present value is € 881,231 for t_0. This represents the value of the location of a windmill to the farmer. Potential risks, e.g. fluctuating wind yields or a refusal of approval will be discussed below. First of all, the effect of changed leases or lease shares of the revenue shall be considered.

The above assumed value of 5.5% lease shares of the electricity revenue is a well-known value in practice. Depending on the bargaining position and outcome, however, the range extends much further; In the calculations made here, the lease share is increased to a value at which the profit (after taxes) between investor and lessor would then be shared in half. For the wind turbine with 2.3 MW assumed here, a net present value of € 881,231 could be achieved with own investment, as already mentioned. For an investor who leases the location of the windmill, the net present value decreases. The net present value of the lease income for the lessor of the site increases to the same extent (Fig. 5). The value of € 592,514 for the external investor and € 288,718 for the lessor are shown in the chart for a lease share of 7% of the electricity revenue. At a lease height of slightly more than 10% of the electricity revenue of the wind turbine, funds investors and lessors would share the expected surpluses (after tax).

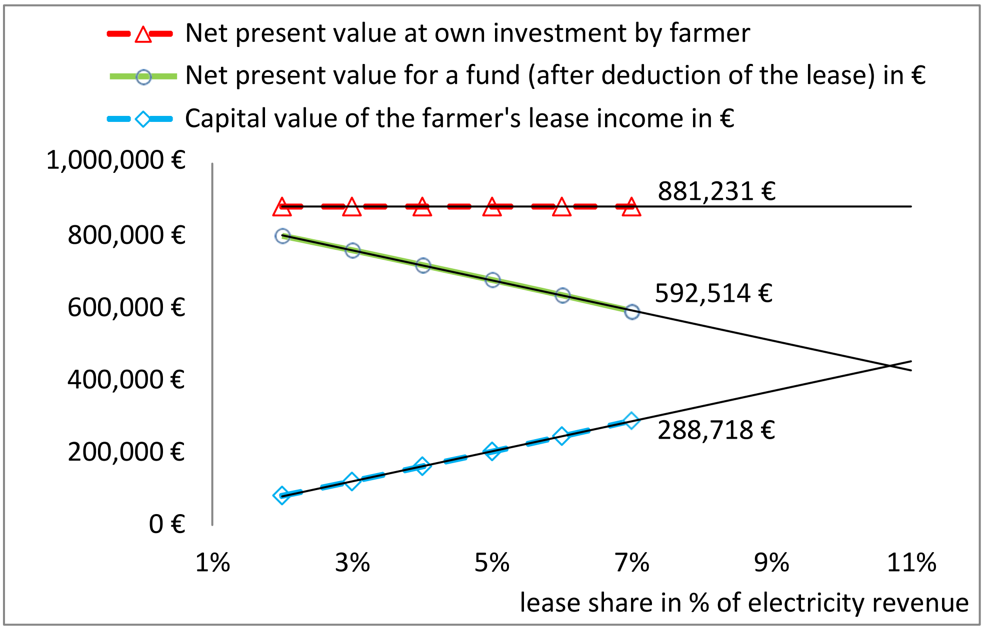


Figure 5: Net present values of the investment of a wind turbine in the case of own investment by a farmer or by an investment fund together with the net present value of the lease payments; latter depending on the lease share of the electrical revenues; all values after taxes

For all the calculations presented so far, it was assumed that sufficient equity would be available or could be procured from third parties through participations and no risk at all is considered. The most important risks to be taken into account here would be, firstly, a fluctuating wind yield and, secondly, the planning costs for a later refusal of the building permit. The willingness to take risks for your own investment certainly also depends on the expected rental income, because the higher the share of lease from in the electricity revenue, the less is the willingness of a farmer to invest himself. In addition, liquidity aspects in the agricultural company should also be taken into account.

7 Wind turbines pay off even with fluctuating wind yields

The assumption is made, that the utilization could vary by +/- 500 full load hours, or 15.6% off the average 3,200 hours, according to a triangular distribution. Hence, the probability that low performance of approximately 2,700 h as well as the high performance of up to 3,700 h rarely occur. The result shows that in 90% of cases a net present value of between € 763,000 and € 956,800 can be achieved (Fig. 6). Standard deviation is about € 60,000, which is comparable small. The minimum of net present value was determined at € 636.446. Despite fluctuating wind yields in individual years, investment in wind turbines remain lucrative. It should be noted here, that the revenue for a leased wind turbine location would fluctuate also according to the total revenue of the purchase of electricity. In the future, the risk of wind power will also be limited by the regulation of the remuneration according to the Law for the Development of Renewable Energies (EEG 2017, § 36h), according to which surcharge values for the electricity are to be applied in case of deviations from the reference location.

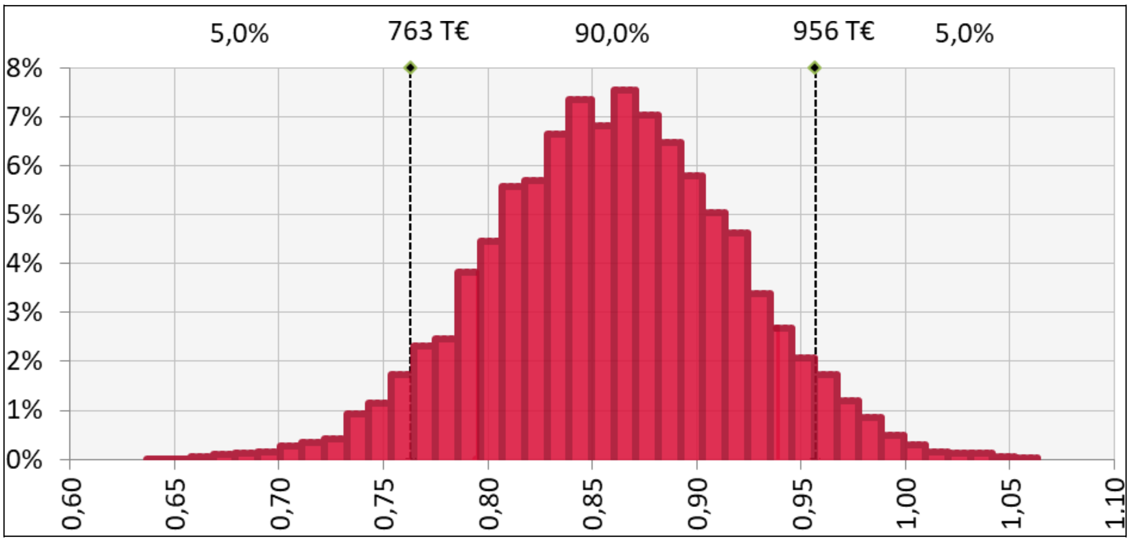


Figure 6: Distribution of net present value in million Euro of one wind turbine with fluctuating full load hours (3,200 h +/- 500 h as a triangular distribution, 10,000 simulations with @RISK)

But how to proceed in case of a new location to be developed and the planning phase of a wind turbine park is just at the beginning? In which cases should a single farmer take the risk of submitting an application?

8 Risks of approval must be included

For the following risk assessments, it is assumed that sufficient equity is available. In this case two factors are crucial: There is a risk, that only costs arise at a considerable amount, if the wind turbine is not approved. The second factor is, that lease payments may be offered from the external investor, the investment fund. Both factors are connected, because the lower the rental income would be, the more likely an investor would be willing to bear the risk of planning, while high contractually agreed and thus secure rental income would reduce the willingness to invest in a risky investment.

Thus, the expected results of the alternatives are known, but not the probability of occurrence. With the help of the Hurwicz criterion[7], also called optimism/pessimism rule, the (previously known) risk attitude of an investor can be taken into account in the decision. Conversely, e.g. for the decision "leasing the site" versus "building your own windmill" a recommendation depending on the risk attitude of the farmer can be given.

Table 2 shows again the values already shown in Fig. 5. In addition, the threshold for the farmer's risk adjustment is calculated, taking into account the maximum loss of € -252,287 for non-approval and the expected profit of € 881,231 (net present value), would be equal

[7] The paper in which the Hurwicz Criterion was originally stated is: “The Generalised Bayes Minimax Principle: A Criterion for Decision Making Under Uncertainty,” Cowles Commission Paper 355, February 8, 1951. 7p.

to the rental income. The necessary risk-taking is estimated using the optimism parameter lambda according to Hurwicz, where λ is between 0 for pessimists and 1 for optimists. For a given risk attitude, the net present value of the lease income should be equal to the surplus expected from investing in a wind turbine of its own (equation 1):

Net present value of lease income =	loss of planning costs $_{\text{worst-possible result}}$ * (1- λ) + Net present value's own wind turbine $_{\text{best possible result}}$ * λ	(equation 1)

The higher the income from the lease, the more confident (optimistic) the farmer would have to be, that he could beat the offer of a foreign investor (fund). Below an example of the iteratively determined value for λ is shown. For the 5% rent share of the electricity revenue the corresponding λ results of ~ 0.4, which is less than 0.5, and thus mirrows a slightly risk-averse setting (equation 2):

Net present value of lease income 202,870 € =	loss of planning costs of € -252,287 * (1- 0,4) + Net present value of an own wind turbine in the amount of € 881,231 * 0.4	(equation 2)

exact value for λ: 0,401543628790943

Table 2: Net present value of the investment of a wind turbine in case of own investment by a farmer (1) or by a third party investor (2) and the net present value of the leasing revenue (3) depending on the rent share of the electricity revenue after taxes and necessary risk tolerance for the investment in an own wind turbine (λ calculation according to Hurwicz)

(1) Net present value at own investment by farmer	**881.231 €**					
Maximum loss of planning costs in case of non-approval	**-252.287 €**					
Rental percentage in% of electricity revenue	0%	1%	3%	5%	7%	10%
(2) Net present value of the fund (after deduction of the lease) in €	881.231	842.146	760.529	678.361	592.514	451.272
Equity profitability (interest)	6,8%	6,7%	6,4%	6,0%	5,6%	5,0%
(3) Net present value of the farmer's lease income in € *	0 €	39.085	120.702	202.870	288.718	429.959
Risk setting: break-even with optimism parameter (λ)	0,22	0,26	0,33	0,40	0,48	0,60

* Note: the net present values after taxes take into account an income tax rate of approximately 45%; should the lease income be taxed at a lower tax rate, then their (net) amount increases!

From these calculations, it can be concluded, that in case of low leasing offers, due to the lack of outside investors (fund), even a little optimistic, but still rational acting farmer ($\lambda \sim 0.2$), would be willing to take the risk of an investment, due to the comparatively large expected returns! The higher the rent increases, the less will be the willingness of the farmers to bear the risk and will leave it to the outside investors. Risk neutral farmers ($\lambda \sim 0.5$) expect at least a share of 7% to 8% of the electricity revenue. Optimistic, risk-taking farmers, on the other hand, would reject the offer even with higher rent offers and prefer to invest themselves into a wind turbine on their own land (Fig. 7).

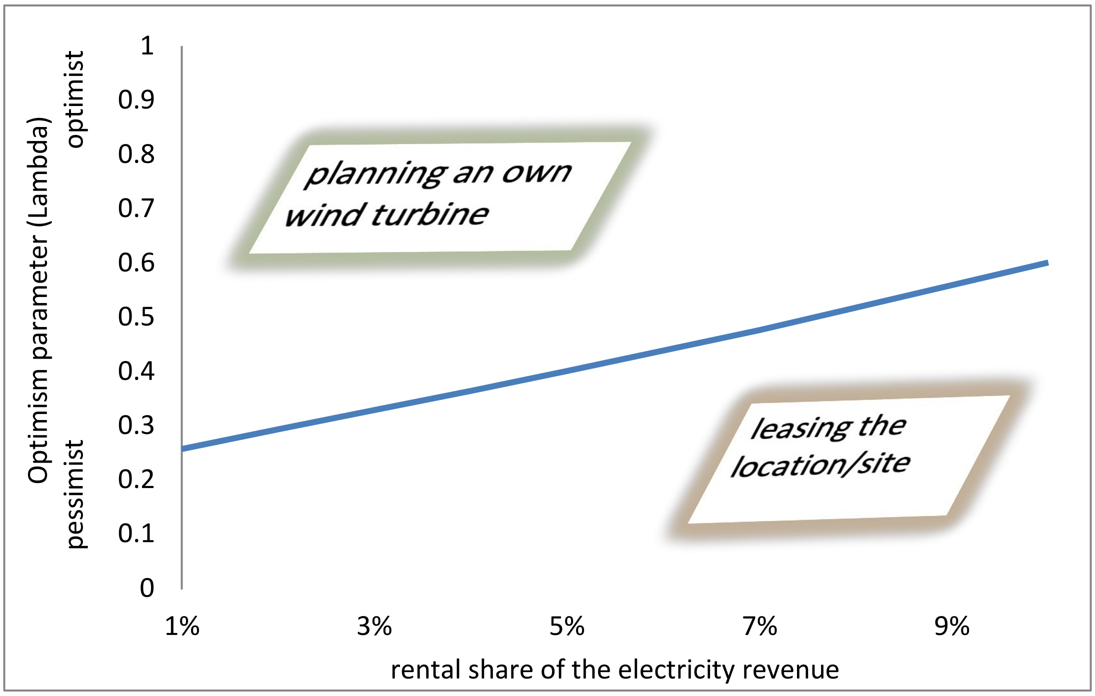


Figure 7: Decision to start planning a wind turbine with an uncertain outcome compared to leasing the site depending on the rental share of the electricity revenue and the investor's risk attitude

By the Law for the Development of Renewable Energies (EEG) granted feed-in-tariffs support the investment in wind turbines. The question therefore arises: Why do so few farmers invest in wind turbines? To find answers to this question, farmers were interviewed. The results of these interviews will be presented next.

9 Interviews with farmers

In the last chapter of this article, the different influencing factors and risks are now included and mirrored by the main factors and motivations in the decision making process of the farmers:

- risks of fluctuating wind yield,

- risks of failed building permits and approval,
- risk attitude of the investor and finally
- availability of equity.

The statements made so far make it clear that investing in wind turbines is relatively profitable, compared with returns that can be achieved in other farm businesses and rural areas. Three farmers with potential wind turbine sites were interviewed for this explorative study. The structured interview contained the following topics:

1. Number and size of wind turbines already built or still in a planning phase (year of construction, self-built and/or leased)
2. Reasons to build a wind turbine, reasons to lease the site (leasing conditions, economy)
3. Integration of municipalities and citizens in the construction of wind turbines
4. Electricity power marketing
5. Future plans

Two of the farmers have themselves set up wind turbines and additionally leased locations. The third farmer has leased all sites to an investor in the region. The wind turbines were built in the years 2000/2001, 2013/14, 2014/15 and 2016. The size of the wind turbines is between 2.3 and 3.45 MW and depend on the construction time of the wind turbines. The turbines constructed in 2000/2001 have an installed capacity of 2.3 MW. The two later built wind turbines have higher outputs.

As a reason for the lease of the location the third farmer argued about the high equity for the construction of an own wind turbine of necessary share of 10% of the total investment volume. The available capital was scarce at that time due to of purchase of farming land by the state own agency (Bodenverwaltungs- und -verwertungsgesellschaft, BVVG). After the reunification in 1989/1990, the specific political situation in Germany was responsible for the limited time window for investments in farming land, when privatization of former “socialistic state” owned land took place. In the years 2000/2001, the investment into farming land was more important than the construction of a wind turbine. In addition, the lease of the site seemed less risky than an own investment.

Farmers also acquired farming land from the BVVG in a first step and built wind turbines at a later date. The additional leasing of wind turbine locations suggests that the farmers thereby financially secure the investment of their additional own wind turbines. This, too, can be considered as a form of risk splitting.

Concerning the topic "Integration of municipalities and citizens in the construction of wind turbines", which is part of the policy in the federal state of Mecklenburg-Western Pomerania, none of the farmers directly involved municipalities or citizens economically in the construction of wind turbines. The farmers who built wind turbines themselves, provided funds to the communities, e.g. to support the renovation of a fire-fighting extinguishing pond and other equipment purchased for the fire department. One of the farmers provided the municipalities with financial means to develop their infrastructure. These payments consisted of one-time payments, which were negotiated during the approval phase. None of the farmers wanted to reveal the amount of these payments. Private individuals were not involved in the investments of wind turbines.

The entire electricity produced the wind turbines is marketed and not taken for own use. The reasons for this are the high production volumes and the low (own) on-farm consumption of electrical power. The entire produced electricity is fed into the transmission grid after deduction of the own electricity consumption of the wind turbines and sold according to conditions of the EEG. Furthermore, no electricity is directly marketed to surrounding industrial and craft businesses.

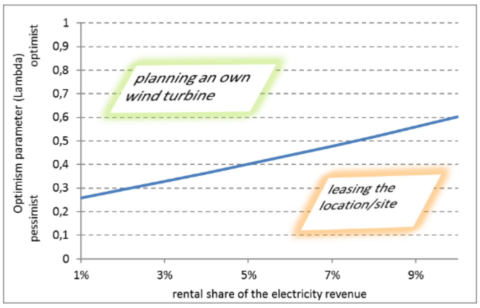
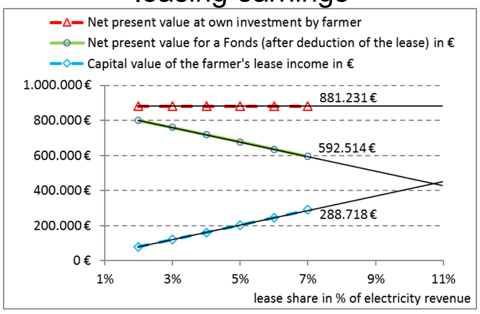
One of the farmers, who has land in a newly designated wind energy area is thinking of building even more wind turbines. Furthermore, he also negotiates with investors about the lease of the sites. At the present time he can imagine a repowering of older wind turbines. The farmer, who has built only one wind turbine and leases more sites, wants to decide after a market analysis and the condition of the wind turbines after 20 years between the alternative repowering or further operation of his wind turbine. The farmer, who has leased all sites, has already agreed clauses in the lease agreement for the extension of the lease period. These can be extended by five years for the first construction phase, starting in 2000/2001 and five years in the second construction phase. The other two farmers must renegotiate with the investors at the end of their leases or renew existing contracts.

10 Conclusions

In summary, it can be stated that besides the cost-effectiveness and profitability of wind turbines, other factors also play a key role. The land purchase competes very strongly with the construction of wind turbines. Often, the high equity ratio of 10% to 15% of the investment volume deters from the construction of a wind turbine. The farmers interviewed did not build their own wind turbines at all designated sites, but in addition to their own wind power plants leased additional sites. The risk can be reduced in this way, so that the decision to build their own wind turbine is easier. The explorative survey has also shown that so far neither citizens nor communities are directly involved in the construction of wind turbines. Depending on their negotiating skills, communities could benefit from the construction of wind turbines in the district.

When considering investment in a wind turbine, it should first be considered whether sufficient equity is available or whether additional investors are needed. Furthermore, it must be checked whether a building permit is granted. The assessment of risk attitudes of the farmer measured according Hurwicz criterion, moderates the decision making process. In the case of uncertain planning projects and at the same time relatively high lease payments from the electricity revenue, the alternative "leasing of the location" is gaining in importance (overview 1).

Overview 1: Recommendations for the investment decision or lease of wind turbine sites depending on the state of the approval, the availability of equity capital, the risk adjustment and the possible lease revenue

Availability of equity capital	State of the approval	
	Site unsure – not jet approved	Exists, e.g. expansion of an existing wind park
Own equity missing	waiting; keep option for leasing	Search for investor / leasing the location
Own equity available	Test risk attitudes, then decide  Decision to start planning a wind turbine with an uncertain outcome compared to leasing the site depending on the rental share of the electricity revenue and the investor's risk attitude	Own investment; profits higher than leasing earnings  Net present values of the investment of a wind turbine in the case of own investment by a farmer or by an investment fund together with the net present value of the lease payments; latter depending on the lease share of the electrical revenues; all values after taxes

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