The Social Complexity of Renewable Energy Production in the Countryside

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Introduction

An increasing number of studies and scholars agree that the era of cheap oil and abundant fossil energy[1] is coming to an end (IEA, 2009; Scheer, 2009; Energy Watch Group, 2006;Energy Watch Group, 2007; Heineberg, 2007; Hirsch et al., 2005). Thus the way is made for a shift to renewable energy production. Even if political foresight and ecological responsibility cannot initiate a major change in energy politics, resource scarcity and roaming prices will likely be the drivers towards this transformation. Without conscious decisions, however, the transition will come at higher ecological costs (Henseling, 2008).

A decisive characteristic of renewable energy sources is their consumption of horizontal space; energy no longer comes from oil rigs that penetrate the vertical level (Altvater, 2008, p. 78).[2] Instead, it consumes space directly (e.g. solar power plants), or indirectly as agricultural production sites for substrate (e.g. corn for bio-gas digesters). As space is re-established as a primary source of producing energy (UNEP, 2009, p. 20), social research ought to focus on the countryside where space is abundant.

The popular as well as scientific discourse on renewable energy in Europe emphasizes the potential to emancipate the countryside from its often peripheral economic situation (Wuppertal Institute, 2010). Many villages and rural cities in Europe suffer from a continuous decline in population. The selective emigration of the young and skilled often leaves these regions with economic difficulties. Renewable energy production as a new economic branch may be a coping-strategy, as demonstrated by the case example of Güssing. Renewable energy production may contribute to a local economy in three different ways: by creating jobs, by creating local tax-income from sold-off energy, and by lowering energy costs (Busch, 2010, p. 29). All three factors contribute to regional value creation as a lower proportion of capital leaves the municipality´s borders to import energy. Such a surplus of capital can potentially be reinvested in the region, creating more jobs. Regional value creation is defined as "a measure for productive economic activity. It is made up by the difference of the value of a unit of production minus the value of the consumed pre-product" (Wuppertal Institute, 2010, p.23).

A few pioneer regions in Europe began to invest in renewable energy production in the early 1990s. The often corresponding creation of regional value and positive economic development gave an encouraging example to mayors across Europe. Many local politicians are drawing an example from those early birds. In 2009 approximately 100 municipalities in Germany declared the political goal of satisfying the complete local consumption of energy in the near future from local, renewable sources.[3] Amongst Swiss, Germans, and Austrians those *best practice*

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[1] Fossil resources comprise oil, gas, coal, and - not always agreed upon- uranium that will likely also be depleted during this century (Meadows et al. 2004).

[2] Though late fossilism consumes large areas as well, to exploit tar-sands, uranium, and off-shore oil drilling has proven to be no less space intensive, if pollution is taken into account.

[3] Exhibition „100% Erneuerbar" in Kassel, Germany 2009.

cases, which are serving as a point of reference, became known as “Energy-Villages” (*Energiedorf) ,* “Energy-Regions” (Wehnert & Nolting, 2010), or “energy autarkic” regions. For this study the termin “energy autarkic region” is used. It is defined in line with the definitions given by publications from Wehnert & Nolting (2010) and Ruppert et al. (2008), and extended to include a concept of “sustainability” (not identical with “renewability”) and “participation”.

A region, village, or city is called “energy autarkic” if it covers the main part of its demand for heat and electricity from locally produced renewable energy (wind, sun, water, biomass/gas). Furthermore this production is “sustainable” in the sense of the Our Common Future / Brundtland Report by the United Nations (1987) only if energy production does not result in any significant reduction of food production, by creating a concurrence for agricultural space. The form of organising the necessary technical infrastructure is “participative” to the extent that local consumers take a share in property relations of the production and distribution facilities and engage in relevant decisions.

The blue print of *energy regions*: Güssing

The small Austrian city Güssing has played a major role in coining the popular terms “energy autarky”, “energy autonomy”, “energy region”, and “energy-village”. In the early 1990s it was characterised by demographic downturn and unemployment, when it decided to establish an energy system based on renewable sources. Güssing chose that development path with commitment as a possible solution to demographic and economic decline. Its goal of satisfying the complete demand for electricity and heat from local sources, mainly wood, was achieved in 2005. By 2010 Güssing even became a net exporter of energy. As a result the sum of 35 million Euro that would have been spent annually to import energy (electricity, heath, gasoline), stayed in the region.[4] This money added to the available capital stock and created new jobs as it was locally re-invested, increasing tax incomes and attracting young people who left in times of high unemployment. The end of demographic downturn seems to be one of the most important results in Güssing´s own perception.[5] Being a pioneer in certain techniques of refining wood into heat, gas, electricity and even gasoline, the city enjoyed substantial subsidies from the European Union and Austrian Government, putting in question if the development might be repeated without that support. Nevertheless, the promise of using a cutting edge technology to give a halt to common economic and demographic problems made Güssing famous in a growing scene of mayors and municipal stakeholders across Europe. Around 40.000 of them flock to the city annually to see the success story with their own eyes.[6] The gap between interest and practice as demonstrated by the small number of approximately 100 German municipalities[7] that have made a serious attempt on becoming “energy autarkic” regions, is obvious. Keeping in mind that renewable energy production has reached a state of technological maturity, and that Güssing and other cases have shown its economic and financial feasibility, the premise for this study is to uncovered social hindrances which restrict the renewable resource path of development.

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[4] All information about Güssing has been provided by the Cities internet presentation <www.guessing.net> in 2009. In 2010 the content on the energy topic was deleted from the page. Additional information was given by a standardised powerpoint presentation to visiting majors. One of those majors was interviewed in Germany during the field research.

[5] ibid.

[6] Ibid.

[7] Exhibition „100% Erneuerbar“ in Kassel, Germany 2009.

Research objective

This paper aims to expand the scientific discussion about rural renewable energy projects by conducting case studies in one German county, Brandenburg. This federal state has shown impressive progress in the field of renewable energies in the last years. The state-funded Agency for Renewable Energies (*Agentur für Erneuerbare Energien*) awarded Brandenburg the "Lead-star 2008" (Leitstern, 2008)[8] for its development. Most of the research on renewable energy in rural areas has focussed on technical or economic aspects. The social dynamic of the transition from non-renewable to renewable energy in a micro-sociological context has attracted little attention so far.[9] Based on the first findings of this grounded-theory approach, the following research questions were developed: How can different technical solutions be categorized according to the social complexity of the respective projects? What are the typical social obstacles in the development towards local energy autarky?

Methodology

As only few studies were found concerning social obstacles toward energy autarky, *grounded theory* was chosen instead of a quantitative approach (Glaser & Strauss, 1998; Charmaz, 2006; Flick, 2008). The research was carried out between early 2009 and mid 2010. Study sites were villages and rural small cities that were planning or had begun to become a renewable energy region/village. Interviews were made with relevant stakeholders such as professional and non-professional majors, heads of administrations (*Amtsverwaltung*), small and medium business owners (*Mittelstand*), and non-formal opinion leaders. The latter were mostly heads of social associations and sports clubs (*Vereine*), and in some cases well respected families or individuals. Experts were selected mainly by the snowball method granting the interviewer a certain trust bonus, as a familiar third person could be named as a reference. Cooperation with a local governmental support program yielded important insights and contacts.[10] The snowball method - supplemented by internet research - eventually yielded seven villages and small cities that promised to develop a participatory and local approach towards renewable energy.[11] The geographical boundaries where set by the borders of the Federal State of Brandenburg in eastern Germany. From February 2009 to August 2010, 41 expert face-to-face interviews were conducted. Interviews were narrative and open in the beginning; later on an interview guide was used. Six face-to-face street interview sessions with lay people (n=47) were conducted in July and December 2009. 22 scheduled pre-structured telephone expert interviews with heads of social associations and sports clubs (*Vereinsvorstände)* were realised in July 2009. The researcher visited 16 meetings and public discussions on the topic using participatory observation as a mean to gather data. The majority of material was documented with notes, since audio recording had shown to cause a very cautious behaviour of

8 The "Leitstern" is a ranking of all German Federal States. The evaluation of the performances is made on the basis of a "scientific analysis" of the general conditions in the Federal States. This includes the actual installed facilities, state policy instruments, educational efforts, and the performance of the private sector (Busch, 2010, p. 10).

9 Exceptions are the case of Samsø in Denmark (Torrs Silva, 2008) or the Swedish studies by McCormick (2005) and Mårtensson and Westerberg (2007).

10 This was Mr. Ralf Ullrich with his project „*Lausitz Spreewald sucht den Zukunftsort*" of the agency „*Regionale Planungsgemeinschaft Lausitz Spreewald*" in Cottbus.

11 Two regions were dropped because they did not promise any new insight. The seven selected regions were: Drehnow, Feldheim, Schipkau, Uebigau-Wahrenbrück, Licherfeld-Schacksdorf, Spreewald, and Altdöbern. The project in Spreewald failed during research, so it is not mentioned in the chapter ideal-types.

interviewees, holding back crucial information.[12] A few interviews were carried out by students at Technical University Cottbus in winter 2009 and summer 2010, though the majority was done by the lead author.

Ideal types of technology application

This chapter explains and sorts the different possible applications of renewable energy production in the countryside according to their social complexity. Social complexity refers to the sum of necessary efforts for organisers to convince locals to participate, propagate popular acceptance of a technology, take care of fund raising and legal permissions, and to convince local opinion leaders and small businesses of the technology´s benefits. Those proposed categories are necessarily a proposal for *ideal types.*[13] What is agreed upon as being *typical* depends on particular premises. This study emphasise the chances of renewable energy to emancipate the countryside from its marginalized position in economic structures. This perspective results in a focus on public rather than private, and political rather than economic forms of organisation. As Güssing has shown, it is complex energy structures with a high degree of local ownership that are evenly distributed (and not concentrated within one company), which contribute to regional value chains and a positive economic outcome. Such a level of complexity, in regard to technical as well as social characteristics, means that a project is necessarily a public and political task, not a purely private or economic enterprise.[14]

The following categories were derived from the seven empirical case studies. In many regions more than one technology was applied. That means in some cases several case studies can serve as an empirical basis for one ideal type. Types with high complexity are less frequent so only one case study serves as a reference. The precise locations of field research underlying each ideal type is indicated in a footnote of each caption. The following list is ordered by complexity, beginning with forms of low complexity that are easy to implement towards those that are highly complex and consequently seldom and difficult to realise.

1) Solar Panels to supply a single public building with electricity[15]

Upgrading existing municipal-owned buildings like offices, kindergartens, schools, gyms etc. with solar panels for electricity production is maybe the easiest and most common form of public renewable energy in the countryside. The technology has reached maturity, and is well known amongst electricians and other craftsmen – maybe even more important - also among banks and lawyers, so loans are quickly accessible at low costs. This in particular is valid for Germany and Austria since governmental feed-in tariffs guarantee repayment.[16] The produced

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[12] Most projects were in their critical stage during the interviews, and positions, jobs, contracts, and honor were at stake, making it difficult to gain precise information and even more so if the tape recorder was running.

[13] Referring to Weber´s *ideal types* the multitude of possible applications is sorted by *typical* social features of each form.

[14] See the definition of “participatory” in the introduction.

[15] The corresponding case studies are Uebigau, Wahrenbrück, Schipkau and Drehnow.

[16] At least at the time the study was conducted, the faith in the stability of these tariffs under a special law called Erneuerbare Energien Einspeise Gesetz (EEG) was unbroken. One mayor reported that people would stand in line for long term investments in solar panels. EEG guarantees fixed prices for a twenty year period, which made it a popular form of long term investments. Since the summer of 2010, however, sincerity in the stability of these tariffs has had to bear the continuous attacks from the Merkel- government. The coalition favours the interests of Germany´s four energy monopolists E-on, RWE, EnBw, and Vattenfall, who would appreciate seeing the EEG modified in their interest, possibly hindering existing renewable producers from feeding in the grid at times of energy “over production”, leaving the market for conventional coal and nuclear power.

energy may be both consumed by those buildings themselves,[17] lowering their energy bill, or sold by feeding into the national grid, generating an income for the municipality.

1.1) Solar panels to supply a single public building with heat[18]

Slightly less common are solar panels for heat production. They reduce the consumption of heating-fuel by pre-heating water of a central heating unit. Since new water pipes must be installed to connect the roof and heat grid, this form is slightly more complex than electricity production. On the other hand, the whole system is usually cheaper. Its independence from feed-in tariffs may be both an advantage and a hurdle depending on the investor's faith in the long term stability of these tariffs.[19]

1.2) Combined heat and power production to supply a single public building with heat and electricity

A bio-fuel operated *combined heat and power plant* (*Blockheizkraftwerk, BHKW*) may relatively easy be installed in a public building to replace a fossil oil heating unit. Like photo-thermal systems, this reduces heating costs, but only as long as market prices for mineral oil are well above those for rape seed oil or other bio-fuels.[20] Most of these units may produce both heat and electricity, which is sold and fed-in the national grid generating an income with feed-in tariffs similar to 1). All three forms are easy to organise as they are known amongst experts and already used by private home owners. Besides unproblematic financing, they require little administrative effort for permissions and regulations. A well working municipal administration (*Amtsverwaltung*) can take care of everything within a few weeks without much consultation with other political or administrative bodies. In particular solar systems are often financed by locals, or by people related to a building: for example parents might invest in solar installations at their children´s school. Those participatory models (*Bürgerbeteiligungsmodelle)* are charming due to their democratic financing which results in a broad distribution of profits during the common 20-year period of operation. Nevertheless, the effort of educating and convincing a sufficient number of people in the countryside may be high. In the investigated cases villagers were observed to be very sceptical of any investment different from a bank account. For municipalities under a budget freeze (*Haushaltssperre*) however, this is often the only possible way of financing as they are not allowed to take bank loans, nor do they possess adequate financial means themselves.

2) Supplying a public building with electricity from a small-scale wind turbine[21]

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[17] German law on renewable energy Erneuerbare Energien Einspeisegesetz (EEG) supports the self-consumption of produced renewable energy by paying for each consumed kilo watt hour. Thus it is equally economically feasible to consume solar-energy instead of selling it to the grid.

[18] The corresponding case studies are Schipkau and Wahrenbrück.

[19] Investing in renewable energy on the expectation that repayment is guaranteed by the feed-in-tariffs requires a certain trust that the tariffs won´t be changed or abolished for the 20 year working period. In some villages, people worry that coming governments will change those tariffs, although that would be an expropriation not seen for 60 years in Western-Germany, and contradict the feed-in-tariff-law. From a juridical point of view it is therefore rather unlikely, but public discussions on the topic were often very emotional, and due to a general lack of information, villagers voiced a couple of unqualified concerns that were driven partially by the uncertainty caused during the financial crisis.

[20] The current level of above 70$ per barrel of crude oil are high enough to make many bio-fuel applications an economically feasible investment.

[21] The corresponding case study is the village Lettewitz (near Schipkau). A small scale wind turbine was erected without any complaints from neighbours, as it was put in a place not visible from the village. It produces enough electricity to supply the offices in the small town hall.

Small-scale wind turbines may be set up in backyards, gardens, and on roofs, with little or no legal procedures. They usually can supply a few offices or a small kindergarten with electricity. The main difference from solar and combined heat and power production units is that wind turbines not only rotate, but do so in public, often clearly visible to neighbours. For the case of Germany many incidents can be found where neighbours would prevent the installation of wind turbines by initiating law suits.[22] The Sight-axes of small scale wind turbines may be exactly calculated in advance, meaning on the one hand that affected persons are precisely identified well before, giving them a strong incentive for resistance. On the other hand, it means those people are isolated, and limited in number as anyone else can be sure not to be affected. This may be an advantage or hindrance, depending on the affected household's opinion of wind turbines. While the process is transparent and honest, it is time-intensive enough to open a window of opportunity for people to take legal action against wind parks. Of course, the optimal solution is if no one is affected. In that case there is little more effort necessary than described under point 1).

3) Constructing new buildings equipped with renewable energy feeding into the national grid[23]

From a technical point of view, it is often even cheaper and easier to equip new houses with renewable energy sources, for example by making the roof completely from solar panels, instead of upgrading it later. The difficulty is rather in organisational complexity. Financing, planning, and permitting new public buildings brings many small municipalities to the limits of their economic and administrative capacity. Discussions on financing, building grounds, and contracting firms all require a great deal of time and effort and often hold potential for conflict. If municipal parliaments have to be consulted, the whole process of getting building permission and funding may be slowed down even more by conflicts between political fractions. Such situations may put stress on stakeholders and organisations. All this can result in renewable energy being perceived as an extra hurdle or luxury that in some cases is dropped if at least the rest of the project can be saved , as was observed in one case.

4) Biomass or Biogas plants for electricity and heat production[24]

Biogas plants use manure and energy crops (for example corn) to produce both heat and electricity. The same is done by biomass plants, with the difference that they do not run on biogas but biological waste or wood. One problematic aspect of biogas is the possible occurrence of odour. Once the public is aware, acceptance of a new plant is difficult to achieve, especially in the countryside where people might feel that they are already suffering enough from manure odours.[25] In contrast to mini wind turbines, the group of affected

[22] The initiative "Rettet die Uckermark" (save the Uckermark [region in North-Western Brandenburg]) can be seen as one manifestation of this phenomenon. The initiative tries to prevent the erection of any further wind turbines in Brandenburg (http://www.rettet-die-uckermark.de/ accessed Feb 24th 2011).

[23] The corresponding case studies are the small city Altdöbern and the village Schipkau. The municipality of Altdöbern was overstrained with the whole task and dropped the idea to implement renewable energy , in order to save the construction project itself.

[24] The corresponding case studies are Uebigau, Wahrenbrück, Feldheim, Schipkau.

[25] Experts claim that the odour animal excrements emit when brought out on a field are significantly reduced if these faeces are used in a biogas plant prior. But this is a very rational consideration, and difficult to communicate to an emotionally stirred up public, and was thus not taken into consideration by locals in one case study.

households can hardly be predicted; there is no clear "odour-axis". All households within a certain area are potentially affected. This can lead to broad opposition since everyone might be victim to nuisance.

Energy from biomass is for justified reasons burdened with the *plate - fuel tank* dilemma (*Teller-Tank-Problem*). Agricultural fields either produce food or energy, and one cannot be maximised without minimising the other (Sieferle, 1982).[26] Awareness about the problem was observed to be high amongst local farmers who perceived themselves primarily as food-producers, before being energy producers. This poses the task of gaining legitimacy for biomass plants that start with this handicap (food vs. energy). One solution is turning to superfluous wood from local parks and forests,[27] which was a solution in one case studied. An entirely space-neutral solution is the use of organic household waste, however, that would require a complex recycling scheme.[28] Besides odour, increased noise from lorries that deliver biomass on a daily basis was a common fear in local opinion.

A lack of knowledge, pre-judgements, difficult ecological legitimacy due to space concurrence, and feared odour and noise all raise the stakes for this energy producer. Beyond that, both plant types require long term contracts with suppliers, usually local farmers, forest owners, or the waste collection, which require bargaining and consultation of political bodies. Nevertheless biomass/gas plants were often perceived as being worth the difficulties. Interviewees argued that they are economically the best solution. Income from heat generation in combination with feed-in-tariffs for the electricity produced is a strong incentive. To transport heat to a nearby house, a simple pipe is placed, that bears the potential to become the corner stone of a whole heat grid. It may later on be expanded to supply more houses when more people are convinced of the central-heating, once the system has proven to be working efficiently.[29]

5) Constructing single, new off-grid self-sustaining buildings[30]

The so called *off-grid* (*Insellösung*) allows the erection of new energy systems in remote locations without investing in laying new electricity lines and heat pipes. Costs are reduced in the very construction process as long distances of cables and pipes become obsolete. In the long run, annual energy costs are reduced or completely avoided, depending on the chosen type of renewable source. "Wind and Sun won´t send an energy bill" as a proverb puts it. If a local sewage water treatment and drinking water purification unit is included, connection to drainage and culvert are also unnecessary, lowering construction costs even more.[31]

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26 Many scholars argue that the world food-crisis of 2007 has - at least partly – been due to the massive expansion of US bio-fuel production.

27 What can be considered superfluous should be calculated by forestry experts. Local stakeholders have shown, however, to be quick in their judgements that a certain amount of wood may be extracted from forests over a long period without harming its reproduction capacity. Consultations of experts did not take place.

28 This case could unfortunately not be observed.

29 This was the Scenario observed in the village Feldheim.

30 This was observed in two case studies, Altdöbern and Lichterfeld-Schacksdorf. Both failed on the idea of setting up an island-grid.

31 A typical application in Brandenburg is at small tourist infrastructures at far off lake-sides.

With a combination of several energy producers like solar, small-scale wind turbines, and combined heat and power production units, one or several houses might satisfy their entire electricity and heat demand. However this poses both a technical and judicial challenge, since small scale electricity storage techniques are still in their pioneering stage and missing knowledge and experiences slows down all administrative processes. Furthermore, it was observed that the local monopolist of fossil energy production[32] was able to mobilise enough political influence to prevent off-grid solutions from happening. It is thus defending a comfortable market position since the wide adoption of island systems pose a long term threat to its monopoly. A well determined municipality might not be distracted from such attempts, but since installing and running the whole technology is still an organisational pioneering act, such external influences can tip the scales.

6) Setting up large wind turbines[33]

An alternative to the common model of huge wind parks financed by external investors is financial participation of locals in one or a few turbines, referred to as *citizen-wind-turbine* (*Bürgerwindrad*). Since the required capital is high - one turbine costs approximately 2 million € - that is a rare model in Eastern Germany where family savings are lower than in the western part of the country. Concerning the regionalisation of profits, however, this was the optimal model. The only observed case with such a *citizen-wind-turbine* is the village Feldheim, the only case study site with a high level of popular acceptance of wind turbines (they are highly unpopular in many parts of the federal state).[34] Feldheim adds evidence to the notion of a general link between acceptance and ownership of wind turbines (Warren&McFadyen, 2010). External financing is however the common model, and despite being less attractive regarding benefits for the local economy, it still offers some prospects as taxes stay partially local[35] and land owners[36] have a chance of gaining high revenues from lending or selling their land away for the turbines.[37] In one case study (Drehnow) seven wind turbines generate enough tax revenue to allow for a balanced municipal budget and above that even for a well financed kindergarten, a new fire brigade house, and renovation of the village's roads.

Popular opposition is nevertheless very likely, as some families do not benefit financially from land-lease either due to a lack of land, unwillingness, or since their property was not necessary for the wind park. In Brandenburg no example was found where people were unwilling to lease or sell land, so the financial motive has proven to be dominant.[38] If people cannot, for one of these reasons, gain a "piece of the cake", they still have to bear the social cost. The acoustic and optical impact of a wind park is usually evenly distributed to the side of a village facing in its direction, indiscriminately to peoples financial gains from it. So cost and profits

32 In Brandenburg, as in all of eastern Germany, the company Vattenfall and its subsidiary Envia-M hold a monopoly on the electricity grid.

33 The corresponding case studies are the villages Drehnow, Feldheim, Uebigau and Schipkau.

34 Again, the initiative "Rettet die Uckermark" can be named as an example.

35 Regulations on the local tax income from renewable energies can be found in Gewerbesteuergestz (business tax law) §29 (2) in its 2009 Version.

36 Land ownership is still in many regions characterised by small family held land plots.

37 In many cases the dirt-roads necessary to transport the turbines´ building parts to the construction sites require more space and generate higher land revenues than the turbines themselves.

38 Two informants gave the number of approximately 10.000-12.000 € paid per annum for land lease per turbine to land owners.

diverge, and no notion of legitimacy can arise. The share a local gains from a wind park depends mostly on law and regulations,[39] and on contracts with the company running the wind park. Some villages managed to reach favourable terms with contractors, for example letter-box offices of the project company are often set up in villages, so a higher tax share stays local. Two villages signed additional contracts[40] with companies, obliging them to a lump sum payment and long term shares to the municipality.[41] In some cases informal arrangements were reached, where the company donated a fixed sum to a local sports club for new flood-lighting for the football field. There are plenty of possibilities as long as a village stands united behind its major so he/she can bargain a favourable agreement. The village´s token is often the threat of law suits (that usually slow down a wind park) and collective denial to offer the necessary land.[42] It might also agree internally on minimum prices to establish a pricing agreement. Many villages in Brandenburg fail on that task, since it requires a high level of homogeneity in acting to stand together. The attractiveness of defective behaviour lies in the lure of an immediate income for quickly selling the land, instead of waiting to rent it away for an agreed minimum price with a long term contract. Though the wind park is constructed in both cases, the difference for a village is with what financial terms it is accompanied.

A wind park thus offers at least a chance for local profits. However tough conflicts about the question if gains outweigh costs, and how they ought to be distributed might arise. Often these conflicts lead to a complex combination of uneven distributed costs (depending on one´s house location, the sight axis, and wind directions) and profits (depending on local land owning patterns). To evade a situation of asymmetrical distribution of benefits, a suitable compensation may be direct investments in collective goods, such as renovation of the respective village's roads or donations to the local football club. The wise investment of local taxes from renewable energy production often plays a decisive role in the management of these conflicts. A finding of this research is therefore that public support for wind parks may only be established if collective benefits pacify individual worries. Because this bargaining process is more complex and holds more potential for conflict than most other forms of renewable energy, large wind turbines are considered a complicated task for local politics and a village's consensus.

7) Supplying a street or a part of a village with local renewable electricity[43]

In nearly all villages the local electricity grid is not managed by the municipality, but the local grid-monopolist. In Brandenburg that is the company Vattenfall. Transporting locally produced energy from wind, sun, or water powered units to households requires the grid owner to agree, which is rare for the same reason *island-grids* (*Insellösung)* are hindered. It would seriously threaten the energy monopolists' dominant market position if this model became

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[39] Till 2010 the main share of taxes of wind parks was paid in the region where the company in charge was located. Since 2010 a reform of that law gives the main share to the municipality where the wind turbines stand (Gewerbesteuergestz (business tax law) §29 (2) in its 2009 Version).

[40] The village Feldheim even signed an urban development contract with the project company (*städtebaulicher Vertrag*).

[41] In the two cases of Feldheim and Drenow an urban development contract was signed in order to make this agreement legally binding.

[42] Till 2003 villages were completely in charge of giving or denying permission to a wind park, which gave them an excellent bargaining position. A reform (*Gemeindereform)* in Brandenburg´s law in 2003 shifted responsibility to a central administrative body, leaving villages with fewer options to resist and bargain. The quoted positive examples all derive from deals before 2003.

[43] The corresponding case study is the village Feldheim.

common practice. The village Feldheim bargained for a couple of months without reaching any agreement, so there was only one way left: constructing a new grid parallel to the existing one.[44] Such a new grid is only operated at reasonable costs per household if most or all households in a street or part of a village participate. The fixed costs for digging and putting power lines in the ground are the largest part of the total costs, and do not decrease with a lower number of participants. Financing may be done by a combination of a loan,[45] state subsidies,[46] and contributions by the households. In Feldheim every household paid a single amount of 1500 € to get connected to the grid, and got a 10 year price guarantee in exchange.

The combination of renewable power sources to supply such a local grid may take different combinations. In Feldheim the main energy source is a close by wind-park, besides minor energy shares from solar panels and a biogas plant. The law on feed-in-tariffs obliges grid owners to buy renewable energy at all times, except the grid would break down from oversupply.[47] Since there are many wind turbines in eastern Germany, that is increasingly happening (Morris, 2011). In periods when wind turbines produce a lot of energy during a stormy day or night time with very low consumer demand, oversupply can occur. At these times wind turbines are often turned off, even if there is wind. For their owner this means wasting money as the profit return rate drops in face of a fixed twenty year operating licence. As a single standard, a two megawatt turbine easily powers a whole village, and its owner is still better off selling a part of its electricity at very low prices to locals than not selling it at all. So a win-win situation occurs with villagers receiving cheap energy. The community owned grid supplies local households for 16.6 euro-cent per kilowatt hour with local wind-generated electricity. For comparison, the German average price for electricity is around 22 euro-cents[48] with a rising tendency.

For all its advantages, an energy grid is a complex social task for a village. Local politics (supported by experts and other stakeholders) are not used to rallying for the necessary active financial support of their voters. They are rather used to top-down decisions and often act helpless when being faced with the task of raising bottom-up support, lacking experience, knowledge, and pre-concepts. Such financial involvement is necessary to finance a community owned grid. Further commitment is needed to make a decision and sign a contract to receive electricity for a long period (in Feldheim for 10 years). As the example has proven, such active and wide support of a major part of residents is possible. Its main prerequisite is trust. Locals will only invest if they are adequately convinced of the whole concept. That requires knowledge on technical, juridical, and financial aspects which can only be received from experts who seldom happen to live in such villages.

As extensively described in literature, trust is a necessary condition for cooperation in contemporary society with its high dependency on experts (Giddens, 1992; Putnam, 2004).

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44 Additionally, a large battery capable of supplying the village for two days was installed. This was quite a technological novelty but not a serious task compared to installing the grid. In that scenario, the old grid stayed operational in case it was needed. It may still deliver energy and receive energy from local renewable producers.

45 In Feldheim - and probably in most villages – these were granted by the governmental credit bank *Kreditanstalt für Wiederaufbau (KFW).*

46 In the federal state of Brandenburg the local governmental bank *Investitionsbank* supports the heat and electricity grid with loans. In most other cases the European Union or National Government supports financing.

47 As regulated by the Erneuerbare Energien Gesetz § 11 (1) in its 2008 version.

48 Eurostat 2010 in: www.tarif-verzeichnis.de http://www.tarife-verzeichnis.de/nachrichten/3652-eu-vergleich-der-strompreise-deutschland-zahlt-mit-am-hoechsten.html 27.7.2010

Renewable energy projects are no exception to that. In Feldheim the development of a renewable energy system started with a few wind turbines in 1994, growing to many wind turbines, solar panels, and a biomass facility, and culminating in 2010 with the construction of a community owned heat and electricity grid that connects a variety of different power generators with local consumers. During those 16 years villagers became familiar with all aspects of the technology, including its financial gains for families that leased away land, as well as its technical and juridical aspects. This knowledge however is unevenly distributed. There are a few villagers that are each expert on *one* topic. In Feldheim, an insurance broker checked the contract for juridical details before locals signed it, the head of the agricultural cooperative had an eye on financial gains and costs for the village, some technicians would question the construction company in charge how far the heat grid would function reliably and how quick it could be repaired in winter. Each of these local experts checked one aspect of the project and made it understandable. Thus the project became trustworthy to locals. On the other hand, they communicated worries, critique, and crucial information from the village to external experts via their own local experts.[49] These people formed the crucial link between local lay language and an external technical discourse.
The process of bargaining and getting informed took the village one and a half year. Despite potential for conflict, it ended in a compromise that the majority could agree upon. During the 16 year project, the village significantly developed its social institutions for conflict solving (Ostrom, 2005, p. 251). Dates and places to meet, rituals on how to behave in meetings, and how to discuss and avoid dissent were trained and improved. The energy project was not perceived as a mere technical topic but embedded in the village´s identity. Without these strengthened social institutions, the unavoidable conflicts that accompany the expansion of wind parks or the grid projects would not have been transformed into a broad consensus.

Most villages in Brandenburg are lacking a tradition of public participation since political responsibility has been delegated to the priest or mayor. Examples like Feldheim prove, however, that such high levels of participation are necessary and achievable for complex technical solutions. A precondition is a high level of social capital that enables a village to form a broad consensus generating trust in common decisions as well as exert peer pressure on possible free-riders. A participatory local energy grid will thus only be achieved in villages rich in social capital and social cohesion (Franzen & Freitag, 2007).

8) Supplying a street or a part of a village with heat from biomass/biogas facilities[50]

Since nearly no village and only a few small cities have a heating grid, supplying with locally produced heat requires construction of a new heat grid. All the characteristics of the electricity grid apply here with the exception that agriculture for biomass production is necessary rather than a wind park. Renewable heat energy is usually produced in biomass or biogas facilities.[51] In contrast to electricity contracts that can easily be cancelled, getting connected to central

[49] In a "ritual" of giving and receiving information, villagers informed external experts before the construction process started about hidden obstacles in the ground that would have hindered construction. In the particular case they passed on the information of a massive and hidden turnaround-loop the Soviet Army had constructed for tanks close to the village during the Socialist Era.

[50] The corresponding case studies are Wahrenbrück, Uebigau, Schipkau, and Feldheim.

[51] A technologically feasible solution would be to save wind energy in times of wind peaks by transforming energy. The electricity could be transformed into heat that can be saved in well-insulated oil tanks. This energy could later on be used in the local heat grid. However German energy laws prohibit this solution. Organizers of Feldheim´s heat grid complained that this law was tailored to suit the interests of energy monopolists, hindering competition by medium size companies that run most wind parks. Thus the most economic technology to safe wind energy in times of heavy oversupply is ruled out.

heating grid requires families to take the decision of giving up their old heating system; sustaining it as a reserve system would economically not be sound due to maintenance costs.[52] Giving up such personal independence and putting ones fate in terms of a warm home in winter in the hands of a citizen-owned company that requires democratic consensus[53] is a delicate decision in the countryside. While people are used to being connected to a central electricity grid, heating in the countryside is still a domain of proud independence. This makes using renewable energy in this form a challenging endeavour. Due to the fact that most families in eastern Germany invested in oil-heating after unification in the early 1990´s, many of those systems are breaking down now. This makes an expensive renovation or investment into a new system necessary. Thus a window of opportunity will open in the coming few years, before families purchase new oil heating units, which will contradict any attempt to introduce a central, renewable system.

The main motive for families to invest in a central heating system is usually a lower energy bill, for example Feldheim guaranteed low prices (7,5c / Kilowatt hour) for the next 10 years. Currently oil heating systems operate at higher costs and will surely do so in the future. This convinced the majority of villagers to give up independence and even agree to take a part of financing the grid construction by paying a lump sum of 1500€ per household. In exchange the grid will entirely become the property of its users (local households), once the loans are paid off as scheduled for 2020.

9) Supplying an entire village[54]

From a technical point of view there is little difference if a street or a whole village is supplied with locally produced energy. Sociological theory, however, expects much more difficulties, as more people are involved. The larger a group the more likely is free riding and therefore conflict (Olson, 1968, p. 33). The potential for conflicts is inherent in projects involving community ownership due to their feature of setting up *common goods* (ibid.). A collectively owned central heating often can lower long term costs for *all* involved families in a village,[55] so an affirmative attitude towards it is regarded as one’s moral duty. Nevertheless, the fieldwork for this study has clearly shown that there are always some families and individuals that are sceptical, passive, ignorant, and sometimes directly opposing a project. In some cases it did not matter how much the project follows economic and ecological aims; even behaviour that contradicted personal economic benefits was observed. The reason behind that phenomenon is no extraordinary feature of renewable energy; when people gather to jointly participate in the organisation of a heat or electricity grid, neighbours and relatives have to cooperate. People might hold resentments towards certain other parties, thus hindering a project with jealousy, mistrust, and dislike no matter how good the project itself might be from a rational point of view. In Feldheim this was overcome by social behaviour very common in the countryside: peer pressure. Once the majority and opinion leaders of village life support a project, the social costs for defective behaviour are raised to an extent adequate to oppress

[52] Oil heating requires a regular approval by German Boiler Code (*TÜV*) which requires repairs, so permanent operating costs would be unavoidable.

[53] Feldheim´s heating grid is owned by a joint company that unites all participating families, the local agriculture-cooperative, and the project company as owners with shares and each one has a voice in decisions taken by majority rule.

[54] Only observed in Feldheim

[55] As explained earlier, a high rate of participation is necessary in any grid project to make it economically feasible, since fixed costs form a large part of the total sum to be invested. With higher participation quotas the per capita costs decrease. So without a certain minimum participation many projects cannot be realised in an economically sound way.

individual antipathies (Elias & Scottson, 1994). This was one of the main reasons for Feldheim´s successful development.

9.1) Supplying a whole village with renewable electricity *and* heat[56]

With technical complexity of a project, the challenges for its social organisation also rise. So setting up a community owned electricity *and* heat grid simultaneously is more daring than setting up just one grid.
One scale effect is nevertheless possible. Marginal costs fall as more grids are built at a time, both for social and technical reasons. The ground must be excavated only once no matter how many grids are installed. And people have to meet, discuss, and agree anyway when setting up *one* grid. Efforts can be smaller if meetings are used to discuss the installation of two or more grids compared to starting from scratch for every new negotiation process.

Most grid related social questions are alike: dependency, trust, long time horizon, financing, personal resentments et cetera. So if successful strategies for one problematic *social* aspect are established they may be applied to all technical projects involved. From a theoretical point of view it may be argued, that the level of trust and social capital is rising in the long term in villages that have successfully accomplished such tasks (Franzen & Freitag, 2007). Feldheim used the opportunity to combine a heat and electricity grid proving that both may be planned and organised simultaneously. Additionally new pipes for fresh water and fast internet connections were placed. The latter particularly motivated some people to support the whole grid-idea as they could only get the internet connection in a package with renewable energy.

A question of complexity

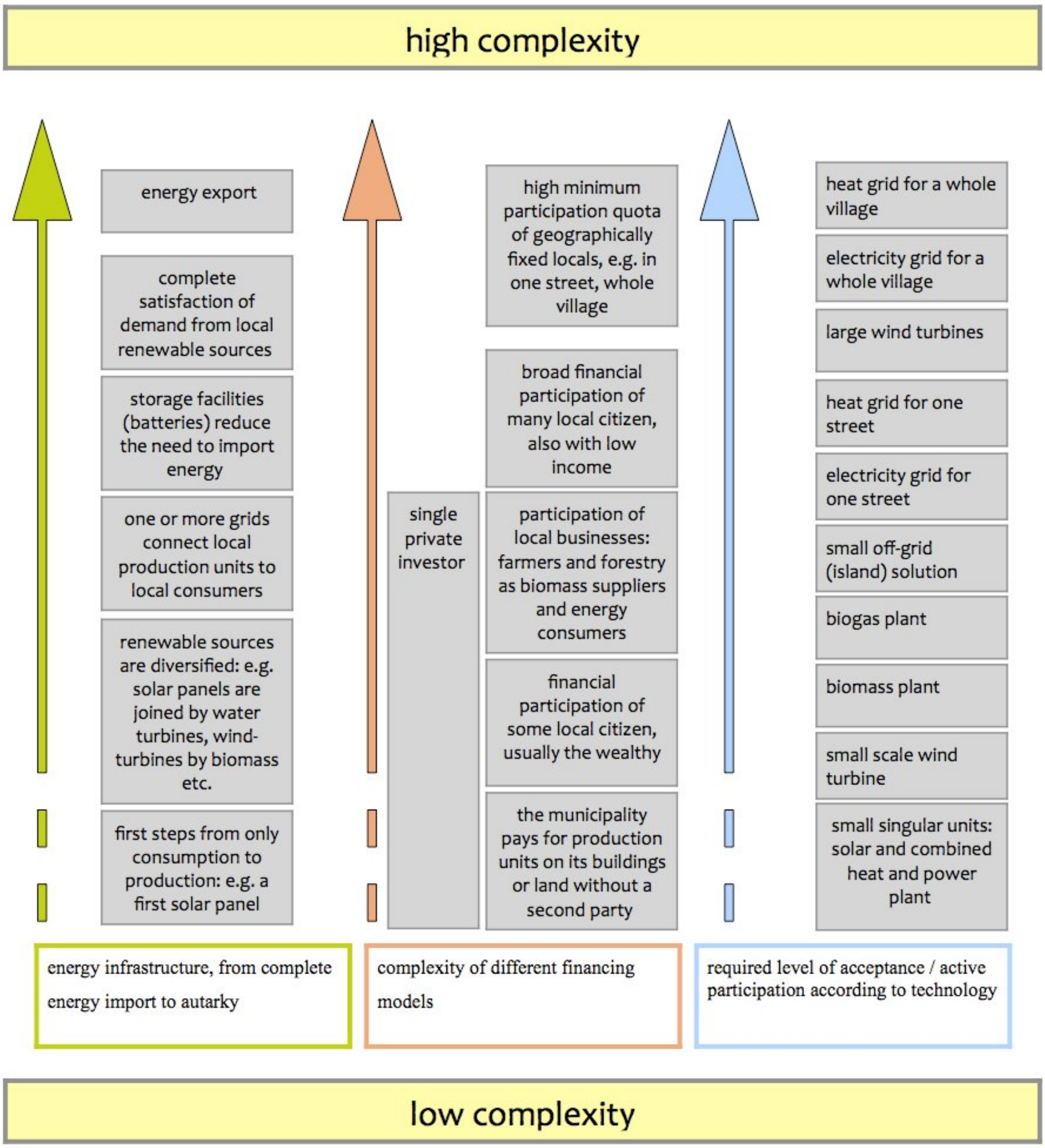
The described nine *ideal types* categorize different forms of renewable energy. As shown, they hold the potential to produce both private goods like lower energy bills for consumers, as well as common economic benefits by reducing capital flows out of a region since spending for fossil energy imports are reduced. The technology of the highest social complexity is a local grid, which combines several renewable local producers (wind-turbines, solar panels, water-turbines, biomass, and biogas) and bypasses intermediaries like the big grid monopolies by linking production directly to consumption. A local grid is typically the last piece of the puzzle for an autarkic renewable energy supply.

However the generated surplus will not stay local and not provide any positive economic impact, if the ownership of production facilities and grids is not at least partially distributed amongst households and businesses in the village or region (Hirschl et al., 2009). As collective ownership requires broad participation of villagers, convincing a large number of residents is often a difficult task. The observed *best case,* the village Feldheim, has shown that communities may realise such complex projects if they have successfully achieved simpler technologies before without breaking the villagers' goodwill and consensus. As several projects with low complexity are realised, communities' social institutions and social capital become potent enough to realise more complex projects. This study argues that for a village to reach energy autarky social causes are much more relevant than technical or pure economical features. Experience from Brandenburg has however shown that stakeholders are still not well aware of that point. In consequence they spent often too much attention on technical and

56 This was only observed in Feldheim. Besides the Danish island Samsø and the village Güssing there are only a few cases in Europe which have reached such a level of local autarky in energy production.

financial questions instead of realising the social task of consensus building for each specific technology.

The graph number 1 gives an overview of the three relevant dimensions of local energy projects: the requirements of each technology concerning approval and active involvement of citizens, organisational complexity concerning local and democratic financing, and the steps towards an autarkic energy infrastructure. The box on the middle axis called “broad financial participation of many local citizens, also with low income” refers to the fact that participation often means that only a few households engage in making a long term investment. These people are often well off anyway since they do own the spare capital. Reaching a broader audience requires much more time to inform and convince people, so that eventually even families with small savings have enough confidence to engage and invest at least small amounts. The box “high minimum participation quota of geographically fixed locals” refers to the increased difficulty of convincing not a few people living at different locations in a village, but precisely those in a single street or even the whole village. This procedure prevents all cherry picking but means that even the sceptical ones need to be integrated. The box “single private investor” equals three other boxes meaning that the difficulty for local politicians to bargain with one private investor varies strongly depending on the technology and the investor. It is nevertheless still easier to bargain with a single investor than convincing a large part of the population to join in for financing a technology. The difficulty of public participation in financing was observed repeatedly. The box “wind turbines” is put just before “supplying a whole village with a new grid” because acceptance for a new wind park is usually difficult to achieve. Acceptance for wind-parks is well researched and depends on varying factors. This technology might therefore take a different rank in a differing cultural or economic context. When discussing wind-turbines it has to be noted that wind-parks with unfavourable financial conditions for locals come *without any* participation of local citizen or politics. The described complexity therefore lies not in getting a wind park but in achieving a favourable financial agreement for the community close by, which usually requires consensus and acceptance. Research in Brandenburg has shown that a wind-park may have very different consequences for a community, ranging from zero profit to strong financial support for public services.



Graph 1: Technical, financial and social complexity forms - three dimensions that determine the effort necessary for each technological application

Conclusion

Renewable energy production is a possible development path for the countryside in the present and future. How much a region can profit (financially, environmentally, but also socially) from the chances that open up with the possibility of renewable energy production depends on its ability for collective action and consensus building. Renewable energy is therefore not a purely technical topic, but very much one for the social sciences. The research on seven bottom-up case studies has shown that every possible technical application corresponds to a certain level of social capital. The article proposes a categorisation system of 10 ideal types to predict *how much* social capital is necessary for each form of renewable energy, from simple solar panels to socially and technically highly complex grids in autarkic villages. It became obvious that some projects are likely to cause social conflicts; if however technical aspirations are adapted to a village´s social capabilities its consensus may not only prevail, but even be elevated by successful collective action, allowing for more complex projects later on. The development towards a renewable local energy regime should therefore not be regarded as a dichotomy but as a continuous process with consecutive single steps. The accumulation of technical and social institutions may eventually elevate a region to a state defined in this study as "energy autarky", in which it covers its complete demand of energy by local, renewable sources.

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