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Article

Energy Transition: Missed Opportunities and Emerging Challenges for Landscape Planning and Designing

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Abstract: Making the shift from fossil fuels to renewable energy seems inevitable. Because energy transition poses new challenges and opportunities to the discipline of landscape architecture, the questions addressed in this paper are: (1) what landscape architects can learn from successful energy transitions in Güssing, Jühnde and Samsø; and (2) to what extent landscape architecture (or other spatial disciplines) contributed to energy transition in the aforementioned cases. An exploratory, comparative case study was conducted to identify differences and similarities among the cases, to answer the research questions, and to formulate recommendations for further research and practice. The comparison indicated that the realized renewable energy systems are context-dependent and, therefore, specifically designed to meet the respective energy demand, making use of the available potentials for renewable energy generation and efficiency. Further success factors seemed to be the presence of (local) frontrunners and a certain degree of citizen participation. The relatively smooth implementation of renewable energy technologies in Jühnde and on Samsø may indicate the importance of careful and (partly) institutionalized consideration of landscape impact, siting and design. Comparing the cases against the literature demonstrated that landscape architects were not as involved as they, theoretically, could have been. However, particularly when the aim is sustainable development, rather than "merely" renewable energy provision, the integrative concept of "sustainable energy landscapes" can be the arena where landscape architecture and other disciplines meet to pursue global sustainability goals, while empowering local communities and safeguarding landscape quality.

Keywords: renewable energy; sustainable energy landscapes; landscape architecture; operational design; strategic design; climate change mitigation; transition management; Güssing; Jühnde; Samsø

1. Introduction

Making the shift from fossil fuels to renewable energy (commonly referred to as sustainable energy transition, renewable energy transition or, simply, energy transition) seems inevitable [1]. Important drivers are the adverse effects of the use of fossil fuels on the environment, geopolitical tensions and the security and affordability of energy in the long run (see [2–5]). For the European Union, it has been agreed that, by 2020, the share of renewable energy should be 20% of the total energy provision. In 2011, the share was at 13% [6]. Energy transition has the potential to contribute to sustainable development [4,5,7] when, among other conditions, "equitable availability of energy services to all people and the preservation of the Earth for future generations" is met [4] (p. xix). Since aspiring sustainable development is worthwhile beyond fulfilling international commitments, there is broad consensus that the implementation of renewable energy requires paramount attention.

According to ECLAS, the European Council of Landscape Architecture Schools, landscape architecture is "the discipline concerned with mankind's conscious shaping of his external environment. It involves planning, design and management of the landscape to create, maintain, protect and enhance places so as to be both functional, beautiful and sustainable (in every sense of the word), and appropriate to diverse human and ecological needs." [8]. Energy transition is relevant to landscape architecture, because it is in line with the discipline's striving for sustainability and, because changes take place in the physical landscape, its material object of work. Similar to, but more intensively than conventional energy provision, renewable energy technologies occupy land and influence the environment around the world.

Landscape architects have been involved in energy transition, for instance by planning and designing renewable energy technologies in the landscape. Beyond that, increasingly, there is a belief among landscape architects that the spatial domain can (and should) contribute more strategically to energy transition. This could be done, for instance, by energy-conscious spatial organization of land use functions, enabling energy savings and facilitating renewable energy provision (see [9–12]). The new challenges that energy transition poses to landscape architects, among others, are specified by Radzi and Droege [13] (p. 238) as follows: "Globally, the ground is shifting for local planning organizations and their tools. Mapping renewable energy capacity, understanding energy flows, realizing which roof and open space assets are available for renewable electricity and thermal energy conversion: such knowledge forms the basis for achieving renewable energy independence in an efficiently structured and purposeful manner." Yet, within landscape architecture, energy transition processes and sustainable energy systems are still relatively new topics [14]. As in other fields, case study research is seen as an important way to advance the discipline [15,16]. However, studies on the interface between landscape architecture and energy transition, whether theory building or focusing on design and planning methods, tend to revolve around hypothetical projects and/or projects in the initial phase, rather than implemented cases (see [9,17–19]). Many of the publications about realized energy transitions take an interdisciplinary, a spatial planning or a governance perspective (see [12,13,20]). Studies that focus on what landscape architecture can learn from implemented energy transition cases seem to be absent so far.

The purpose of this paper is to add to the small, but growing, body of literature on energy transition from a landscape architecture perspective. This is done by conducting an exploratory, comparative case study (see [21]) of three successful, realized energy transitions in Europe. By describing the transitions in the municipalities of Güssing (Austria), Jühnde (Germany) and Samsø (Denmark), the paper focuses on four aspects (A–D). First, the paper discusses the transition processes (A) and the renewable energy systems that have been realized (B). Then, how landscape impact was considered in the process of siting and designing renewable energy installations (C) is described, as well as to what extent experts from the spatial domain, such as landscape architects, planners, designers and architects, were involved in the transition (D). By comparing the cases with each other and against the literature, a number of lessons can be learned.

The paper commences by accounting for the selection of cases and the methodology in Section 2, followed by a brief introduction into energy transition processes and renewable energy systems in Section 3. Thereafter, in Section 4, the literature regarding energy transition and landscape architecture is discussed, followed by a presentation of the cases in Sections 5–7. In Section 8, the cases are compared with each other and against the literature, while the final section contains the conclusion.

2. Studying Three Renewable Energy Municipalities

Over the past century or two, a number of territories in Europe have shifted to renewable energy. For the study presented in this paper, the municipalities of Güssing, Jühnde and Samsø have been selected, because they represented realized and well-documented examples of energy transition in Europe. They were among the few examples that went beyond the scale of the neighborhood and that used two or more renewable energy sources and technologies, which means that the transitions have certain spatial dimensions and complexity. The cases differed in geographical, socio-economic and planning context, which is why it is expected that they offer a wide range of insights and experiences, which suits the explorative nature of this study. Although, due to their context dependency, transition processes can hardly be transferred to other places, it is reported that all three cases inspired other regions inside and outside of Europe [22–25].

The study was structured according to case study research in landscape architecture [15]. Francis provides a systematic format for data collection and reporting, to cover a number of aspects relevant in a case description. Because the purpose of this study is to explore realized energy transitions from a landscape architecture perspective, the literature on transition management, renewable energy and landscape architecture was used to structure and frame the study. The multiple case design allowed for systematic comparison of the three cases [26] on the four aspects (A–D) central to the study.

The research drew from scientific and professional literature about the cases and information on the cases' websites. Further, Güssing, Jühnde and Samsø were visited several times between 2010 and 2012 for data collection. During the fieldwork, guided tours were attended to study the energy installations, their location and design in the landscape. In Güssing and Samsø, three people were interviewed; and four in Jühnde. Because of the limited number of interviewees, the interview results were triangulated with the available literature and fieldwork. The interviewees were key persons in the transition process and/or work(ed) for the local authorities, for instance as a project manager, an architect, a researcher or the mayor [27]. The interviews were semi-structured, conducted face-to-face and varied in length between 35 and 120 minutes. In Austria and Germany, the interviews were conducted in German. In Denmark, they were conducted in English. All interviews were transcribed in English. The interviews were coded to structure the data according to the four central aspects, A–D, which have their origin in the literature. A grounded approach is used to explore what was said about each of the aspects. Excerpts from the interviews presented in the case descriptions refer to the interviewees as G1–G3 for Güssing, J1–J4 for Jühnde and S1–S3 for Samsø.

3. Energy Transition and Renewable Energy Systems

Energy transition has been (and continues to be) a particular subject for transition research (see [28–32]). In this context, transitions are defined as "large-scale transformations within society or important subsystems, during which the structure of the societal system fundamentally changes" [31] (p. 295). Energy transitions are long-term processes, triggered by multiple problems, containing multiple social and technological components and concerning multiple (scale) levels, phases and stakeholders [31]. Energy transition, therefore, goes far beyond mere interventions, such as the installation of wind parks or solar panels [11]. While it is agreed that insights from transition management apply to guiding energy transition, Grin, Rotmans and Schot [30] (p. 325) pointed out that "The spatial turn in many of the social sciences, which brought a new sensitivity to the importance of locating change in specific spaces beyond the national, and to the importance of the circulation of things, people and ideas between local, national, regional and global spaces, still needs to be incorporated into transitions theory"; a critique shared by Coenen *et al.*[33]. Although this paper's perspective is landscape architecture and not transition theory, it may shed light on how landscape architecture can bridge this gap, by approaching energy transition from the integrative nature of planning and design and of the concept of landscape itself (see [34,35]).

For realizing energy transition, increasing both energy efficiency and renewable energy provision are the key strategies (see [4,5]). According to the 'Trias Energetica' concept by Lysen [36], energy efficiency should be addressed first, then renewables should replace fossil fuels, and if fossil fuels remain to be used, this should be done in the most environmental-friendly way. Energy efficiency is improved when more services are delivered with the same input of energy or the same services are delivered with less input of energy [37]. Typical examples are the insulation of buildings and the use of energy-saving devices. Renewable energy is defined as "energy obtained from natural and persistent flows of energy occurring in the immediate environment" [5] (p. 7). It can be harvested from renewable sources by conversion technologies, such as solar boilers, geothermal power plants, hydroelectric stations, photovoltaic cells (PV), wind turbines, biogas plants, and so on. It is expected that, in the long run, a balanced mix of renewable energy sources and technologies will be able to substitute the current energy system based on fossil resources. Beyond renewable energy generation, energy transition also implies adjusting current ways of energy distribution and storage [4,5,11]. For a more exhaustive discussion of the characteristics of (regional) renewable energy systems and the challenges of their design, see de Waal, Stremke, van Hoorn and van den Brink [14].

4. Energy Transition and Landscape Architecture

With regard to the way(s) in which landscape architects discuss and take part in energy transition, the familiar distinction between operational and strategic activities is considered helpful (see [38,39]). In transition management, too, a multilevel framework, including the strategic, tactical and operational level, is used [31].

First, landscape architects work on the siting and design of renewable energy technologies in the landscape, mainly, but not exclusively, wind turbines [40–43]. In landscape architecture practice, these activities mostly concern operational projects. Operational projects take place on lower spatial scale levels within limited time frames. Designs and plans serve as the input for implementation, aiming for landscape transformation [44]; the emphasis is on the product rather than the process [38,45]. In line with this, landscape architects are involved with environmental impact assessment (EIA) studies. An environmental impact assessment is an examination of the possible environmental consequences of the implementation of projects, programs and policies [46]. With regard to renewable energy, an environmental impact assessment may be required, for instance, for the construction of wind farms and hydroelectric power plants [47]. Especially in carrying out landscape and visual (cumulative) impact assessments, as a preparation for or as a part of the environmental impact assessment, landscape architects use their expertise on (visual) landscape quality, ecology, *etc.* [40,48].

Second, landscape architects can contribute to energy transition by means of strategic landscape planning and design. Strategic planning and design is employed to explore possible (far) futures, addressing landscape developments on various scale levels. Multiple actors, interests and issues are at stake in strategic projects [38,49]. The typical contributions of landscape architects include problem analyses, spatially explicit scenarios, long-term visions and visual representations of the proposed changes (see [49–51]). When landscape architects get involved at an early stage, they can add to agenda-building and/or influence the design and planning processes [38,44,52]. At times, they become project managers in strategic planning and design processes (see [53]). In the case of energy transition, the strategic contributions of landscape architects can be illustrated by the example of the recent book *Landscape and Energy, Designing Transition* [1]. There, it is visualized what the spatial requirements and impacts are of generating a certain amount of energy on the basis of different renewable and non-renewable sources. Further, landscape architects focus on developing diversified energy landscapes by means of spatially explicit energy potential mapping (EPM). In EPM studies, the physical potentials and limitations for renewable energy are mapped, for instance in GIS, to identify suitable locations for renewable energy technologies [54]. Similarly, Austrian examples are provided by Stoeglehner and Narodoslawsky, who discussed the tools of energy zone mapping (EZM) and the Energetic Long-Term Analysis of Settlement Structures (ELAS) calculator for identifying energy demand and saving potentials in (urban) settlements [55]. Whereas EZM focuses on energy-saving potentials for room heating, hot water production and district heating, the ELAS-calculator is a more holistic tool. Next to providing insight into the energy demand of settlements, it aims to determine the environmental and socio-economic impacts of interventions, as well. Mapping studies, suitability studies and modelling tools such as these can spark and inform the debate on sustainable energy transition in the initial phase and precede and support the making of spatial scenarios and strategic visioning, as has been done, for instance, in Switzerland [17] and Canada [18].

Going beyond technical analyses and modeling, some landscape architects have turned to ecology, thermodynamics and system science to develop principles and concepts for so-called energy-conscious landscape planning and design, which aim to foster energy transition by spatial (re)organization and (re)design of the existing physical environment [56,57]. Stremke and Koh [57], for example, present a number of design strategies to address periodic fluctuations in energy supply, low energy densities and the limited utilization of available energy; constraints that are associated with renewables and commonly found to inhibit sustainable energy transition. To explicate, three strategies for strategic energy-conscious landscape planning and design are summarized here:

- The environment holds potentials for storing thermal, chemical or other forms of energy, e.g., in aquifers or abandoned mines. Mapping and using these storage potentials aids the use of renewable energy sources that tend to fluctuate, such as wind and solar energy.
- The low energy density of many renewable energy carriers, compared to fossil fuels, makes the transport of energy over a long distance less favorable. A principle, such as (re)locating energy sinks and sources in proximity of each other, aids the efficient use of renewable energy.
- When energy quality is also taken into account in the process of (re)locating energy sources and sinks, energy cascades can be created. A heat cascade, for instance, makes use of residual heat from heavy industry in areas with lower quality heat demand, such as greenhouses.

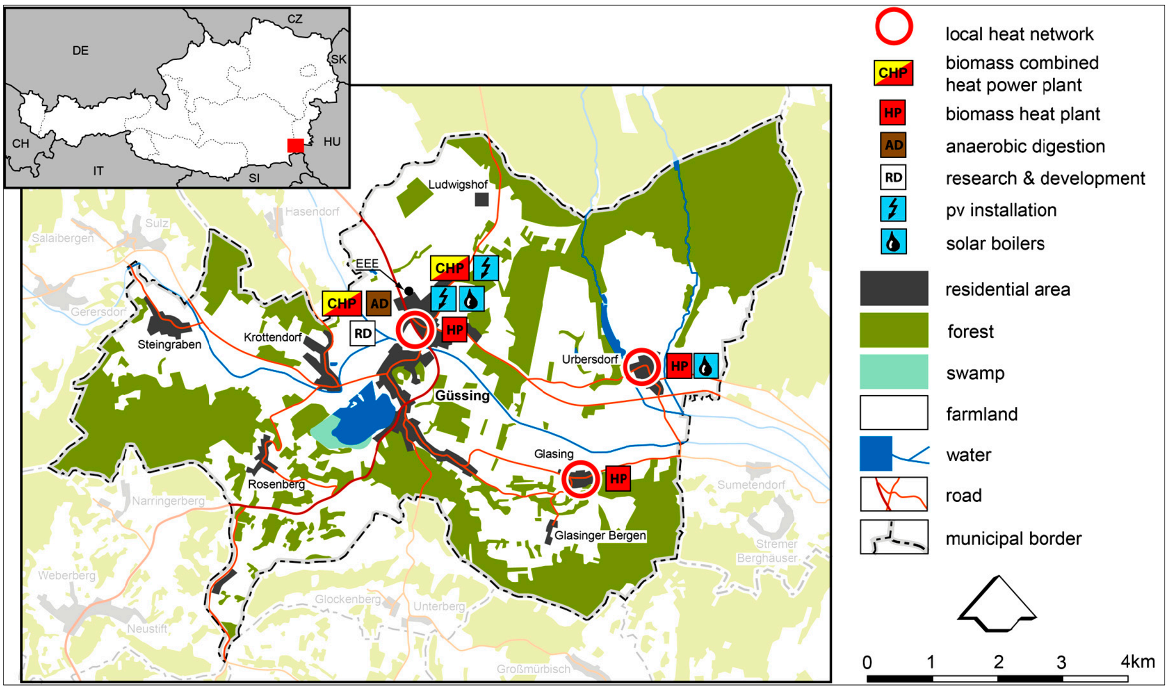
These and other design strategies have been applied in strategic planning and design projects, for example in the south of the Netherlands. In order to envision sustainable energy landscapes, a methodological framework was employed by the landscape experts and other experts. This framework comprises the following five steps: analyses (of the present conditions and near future developments), scenario-making (identification of possible far futures by concretizing existing context scenario's), development of integrated spatial visions (development of desired far futures) and identification of energy-conscious spatial interventions [19,50]. The study showed, next to the description of the methodological framework, that it is possible for that region to achieve a sustainable and self-sufficient energy system, based on existing technologies.

Based on the above publications, it is safe to state that a growing number of landscape architects, both from practice and academia, focus on the transition to sustainable energy. Landscape architects already contribute to the transition by means of operational activities, such as siting, the design of technologies and environmental impact assessments. Moreover, it is outlined how landscape architects could, more strategically, contribute to the development of a built environment that makes better use of locally available, renewable energy sources by means of strategic landscape planning and design. In addition to the question about what landscape architects can learn from the successful, realized energy transitions in Güssing and Samsø, a second question emerges based on this literature discussion: whether and to what extent operational and strategic activities of landscape architects have been employed in the realization of sustainable energy transition in the three cases.

5. Energy Self-Sufficient Güssing

Güssing is a town in the Burgenland region of Austria (see Figure 1) that is well known for its historic castle. For three decades, the region suffered from close proximity to the Iron Curtain and poor connections to the other parts of Austria, which made it unattractive for industries. A lack of local employment forced many inhabitants to work elsewhere, to commute long distances or to move away. Forest is the largest land use in Güssing, followed by farmland and residential areas [58,59]. The municipality comprises 45 km^2 and has 4500 inhabitants, resulting in a population density of 100 inhabitants/ km^2 [23].

Figure 1. Map of Güssing: location in Austria, land uses, infrastructure and renewable energy technologies.



5.1. The Transition Process

The combination of a poor economy, low employment and large amounts of money that were spent for energy imports provided the context in which change was instigated in Güssing [23,58]. At the end of the 1980s, Peter Vadasz, a member of the municipal council, and Reinhard Koch, a local technical engineer, recognized the potential of local wood as a renewable energy source and energy transition as a way to improve the economy and employment in Güssing. In 1990, Vadasz, Koch and some other experts developed a strategy to provide heat, electricity and fuel for Güssing, all on the basis of local wood [58]. When the plan was presented to the municipal council, it was accepted by an absolute majority, whereby the expected spinoff for the local economy and employment was an important motivation [23].

The transition really took off in 1992, when Vadasz was elected mayor. He appointed Koch as manager to the energy transition [23]. Together, they became frontrunners [60] and succeeded to raise public support (G2, G3). Implementation started with interventions in the town of Güssing and gradually involved the larger municipality and the district [23,59]. In 1996, the European Centre for Renewable Energy (EEE) was founded, coordinating the energy transition and spin-offs, such as eco-energy tourism. The EEE also stimulates research activities and disseminates the so-called Güssing Model [61] nationally and internationally. In 2001, energy self-sufficiency was realized for the municipality. Hereafter, the transition was expanded to the district and combined with research and development on renewable transport fuels [58,62].

Typical for transition processes, the energy transition in Güssing addressed multiple issues in multiple domains. It took place at various scale levels, namely individual buildings, the town, the municipality and, currently, the district. The transition occurred in phases, in which both strategic thinking and operational implementation intertwined. The government was involved: first as the instigator and later as the consolidator, whereby the later role has been taken over by the EEE in recent years. Especially in the initial phase, it was important that the transition be supported by the inhabitants. According to interviewee G2: "A critical mass should be cooperative, and in fact, also a mix of future consumers must be interested; not only the users in winter, but also consumers that need heat in the summer. For that sake, we involved private consumers from the beginning by organizing information sessions." However, citizen participation became less important during the course of the transition and remained limited to the development of the heat network. According to interviewee G2, the current, less active role of citizens is a pity in light of continuing the transition to renewable transport fuels and other goals of the EEE, such as extending the eco-energy tourism concept.

5.2. The Renewable Energy System

Energy efficiency was addressed by insulating public buildings, resulting in a 40%–50% savings [23,24]. To provide renewable energy, a number of technologies were installed (see Figure 1). Biomass heat plants and heat networks were constructed in the villages of Glasing, Urbersdorf and in the town of Güssing, along with two combined heat and power plants (CHPs). Güssing also has a small PV plant, and its grammar school has PV panels and solar boilers on the roof. More recently, an aerobic digestion plant was erected, where poultry manure and corn silage is used to produce biogas [63]. Table 1 presents an overview of the renewable energy provision in Güssing.

Local authorities in Güssing speak of 100% energy self-sufficiency, because the renewable energy provision exceeds their energy use [58]. In reality, transportation still relies on fossil fuels. Starting in 1991, biodiesel was produced from locally-grown rapeseed, but due to a change in the EU biofuel policy, the plant was outcompeted and had to close in 2005 [23]. Currently, the generation of fuel gas, synthetic gas, petrol, diesel, methanol and hydrogen from wood is being developed, in an experimental setting near the newest CHP plant.

Another drawback is that energy provision relies heavily on local (waste) wood [24]. A more balanced mix of sources would enhance energy security (see [57]). The potential for wind energy is indeed low. The small share of solar energy, however, could be increased, especially since Güssing is located in one of the sunniest regions of Austria.

Table 1. Renewable energy provision in Güssing [58,64].

Facility	Location	Energy source	Capacity
CHP (combined heat and power plant); steam turbine with heat network	Güssing	Saw dust	8.6 MW fuel capacity, 1.7 MW electrical capacity and 3.5 MW thermal capacity
CHP; wood gasification, R&D, heat network	Güssing	Wood chips	8 MW fuel capacity, 2 MW electrical capacity and 4.5 MW thermal capacity
Heat plant with heat network	Güssing	Wood chips, waste wood	17 MW (only heat)
PV (photovoltaic cells) installation + solar boilers	Güssing (grammar school)	Solar	10 kW peak electrical capacity and 40m² solar thermal panels
PV installation	Güssing	Solar	27.9 kW peak electrical capacity
Heat plant + solar boilers with heat network	Urbersdorf	Wood chips, solar	650 kW + 320 m² solar thermal panels (only heat)
Heat plant with heat network	Glasing	Wood chips	300 kW (only heat)

5.3. Considerations on Landscape Impact, Siting and the Design of Renewable Energy Technologies

According to interviewees G2 and G3, in Güssing, the impact of renewable energy technologies on the landscape was not considered until problems arose. Soon after the opening of the heat plant and the heat network in Güssing (see Figure 2), the chipping of the wood caused a noise and dust nuisance for the neighboring school, which led to a "massive protest" according to interviewee G2. However, according to the same interviewee: "That has been ended very quickly by the municipality. The operators of the district heat plant and the school management agreed that the chipping should take place in the forest instead of the plant."

When the newest CHP, with anaerobic digestion and research and development facilities, was planned along the main road to Güssing (see Figure 3), the inhabitants of Ludwigshof (see Figure 1) protested, because they feared noise and dust nuisance (G2, G3). In spite of the protests, the plant has been built at the intended location. There, the plant also significantly affects the view from the regional road to Güssing's historic castle. Remarkably, the inhabitants did not complain about the visual impact of the installation. Interviewee G2 commented on that as follows: "Personally I regret that. It is a general thing that the aesthetics of the buildings, whatever their function, is not really taken care of in this region. In the western states, such as Tirol, Vorarlberg, that is much better; industrial buildings can be wonderful over there, but they also have significantly more money to spend. When a carpenter builds his firm over there, he has the ambition that his building should look great, and that is different over here. Here, they prioritize having the plant in the first place."

With regard to the forests, it was said by interviewee G2 that the harvesting had so far no negative impact, neither on sustainability nor on visual quality. The forest organization manages the forest in a sustainable way to safeguard the wood potential for the future, which is possible with the current and near-future energy demand. The visual quality of the wood actually improved due to the energy transition in Güssing because the forest management is now much better (G2).

Figure 2. Heat plant in Güssing.

Figure 3. The CHP (with research and development center) as seen from the regional road located at the edge of an industrial area and in the view of the historic castle.

5.4. Involvement of Landscape Architects

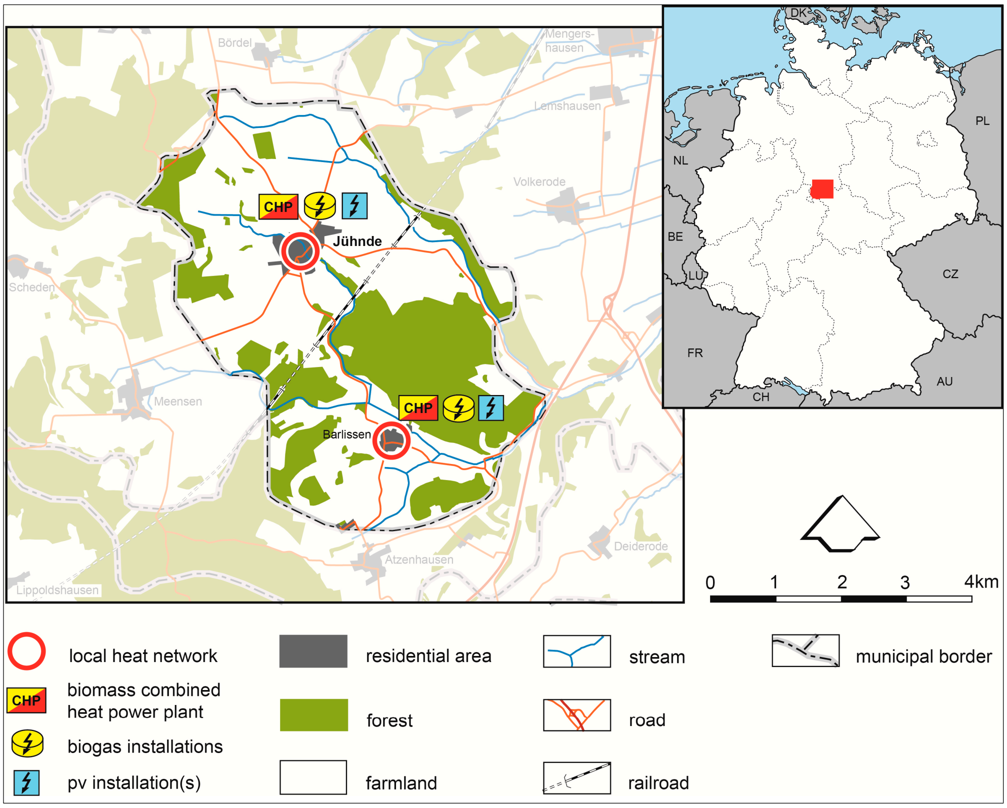
In Güssing, clearly, the focus was foremost on the economic, the technical and, to a limited extent, the social dimensions of energy transition. The contribution of energy transition to overall sustainable development became a motivation only later in the process (G2). Landscape planning and design were not part of the transition process, which, in some instances, resulted in opposition during the implementation of energy technologies. Interviewee G2 regretted that and considered it even problematic. When asked whether the municipality of Güssing employs planners or designers, the same interviewee replied that this is, in general, much weaker in Austria than in Germany, where it is better institutionalized. According to him, there are also differences in this respect within Austria. In Oberösterreich and Salzburg, for instance, planning is also better institutionalized.

Beyond the implementation of the renewable energy technologies in Güssing, a landscape planner working for the Burgenland state government was involved in the design of a cycling route, as part of developing the eco-tourism concept (G3).

6. Jühnde Bio-Energy Village

Jühnde is a village in the south of Lower Saxony, Germany, and forms, together with Barlissen, the municipality of Jühnde. The population density is 44 inhabitants/ km^2. The area is characterized by large-scale farmland and forest areas (see Figure 4), and the closest city is Göttingen. Following Jühnde's successful implementation of energy transition, Barlissen adopted a similar plan. In this case, the focus of the description will be on Jühnde, because this was the first village in Germany to adopt the bio-energy village (*Bioenergiedorf* in German) concept [20].

Figure 4. Map of Jühnde: location in Germany, land uses, infrastructure and renewable energy technologies.



6.1. The Transition Process

In Jühnde, the energy transition started in 2001. At that time, researchers from the Interdisziplinäre Zentrum für Nachhaltige Entwicklung (IZNE; Interdisciplinary Centre for Sustainable Development) of the University of Göttingen initiated an action research, to study energy transition as a strategy for enhancing sustainability and societal and economical welfare in rural areas [25]. Among the researchers were geoscientists, agricultural scientists, social scientists and economists. The research team selected one of initially 23 villages that wanted to become Germany's first bio-energy village by means of a feasibility study and a number of additional criteria (J3, J4). Jühnde's application for this project was carefully prepared by the village community, and its selection was enthusiastically received by the villagers [25] (J1). In Jühnde, becoming independent of fossil fuels by using local renewable sources was perceived to save money, stabilize local energy prices and support the local economy by creating employment in the rural area. Indeed, becoming a bio-energy village was supported by the farmers, because they could enter into long-term contracts to provide biomass, which meant increased income stability [25]. One full-time and five part-time jobs were created to operate the biogas installation and to deal with the 7,000 tourists that now visit Jühnde each year [25] (J1, J2). Moreover, the villagers pay significantly less money for their energy than before, when they heated with LPG (liquefied petroleum gas), oil or electrical systems (J1, J3).

From the beginning until realization in 2005, IZNE was involved in the transition process by sharing knowledge, motivating the community and progress monitoring [24,25]. Community participation is a part of the bio-energy village concept [25] and also deliberately stimulated by local frontrunners. Important in this respect were the mayor and a local physician, who later became an operational manager of the biogas installation (J1, J2). The two of them organized information meetings for the villagers, visited people at home, organized excursions to reference projects in Germany and abroad and acted as intermediaries between the researchers and the inhabitants. According to three interviewees, this was essential to the success of the project (J1–J3). Villagers were consulted, cooperated in working groups, contributed financially and were involved in the construction and managing of the heat network and the biogas installation, either unpaid or commissioned.

In 2004, the cooperative partnership, Bioenergiedorf Jühnde eG, was founded as the future operating company and owner of the biogas installation, as well as the CHP and the local heat network [25] (J2). Within the cooperative, every heat consumer is a member having a voting right. Over 70% of the households are now connected to the local heat network, allowing the system to operate effectively. Today, the project is actively disseminated in the region and (inter)nationally [20,65], inspiring other bio-energy villages and beyond. The interviewees, J2 and J3, mentioned e-mobility as the next step to enhance CO_2 reduction, to go beyond the achieved energy self-sufficiency (see also [65]).

6.2. The Renewable Energy System

As was the case in Güssing, the locally-available renewable sources and the energy demand influenced the decision on the different technologies and their capacities. The cooperative partnership in Jühnde operates a biogas installation and a CHP, complete with a heat plant running on wood chips to serve peak demands (see Figure 4). Biomass from 250–300 ha is delivered by six farmers in Jühnde, together with manure from 800 cows and 1400 pigs [24]. Yearly, 350 tons of wood chips from the regional forest are used, which is 10% of the annual growth [24]. The biogas installation generates two and half-times the electricity demand and fulfils the entire heat demand of the village. Heat is transported to about 145 households via the newly constructed, 5.5-km heat network ([24,25]. The generated electricity is transmitted via the existing grid.

Next, there are PV panels on the roof of the nursery school, the community house, individual houses and stables and at the site of the biogas installation. They are owned by another cooperative, private households and a private firm, respectively (J3). Table 2 provides an overview of the renewable energy provision in Jühnde. Because Barlissen is part of the municipality of Jühnde and adopted a similar renewable energy system, we included the information on Barlissen in Table 2. Energy efficiency was not explicitly addressed in Jühnde, and no achievements in this regard have been reported.

Table 2. Renewable energy provision in the municipality of Jühnde [25,65].

Facility	Location	Energy source	Capacity
Biogas installation (CHP) with heat network	Jühnde	Manure, energy crops	700 kW
Heat plant	Jühnde	Wood chips	550 kW
PV installations	Jühnde	Solar	(unknown)
Biogas installation (CHP) with heat network	Barlissen	Manure, energy crops	250 kW
Heat plant	Barlissen	Biomass	500 kW
PV installation	Barlissen	Solar	30 kW

6.3. Considerations on Landscape Impact, Siting and Design of Renewable Energy Technologies

Jühnde concentrated the energy installations at a site in the north of the village. In the siting process, several factors played a role (J1–J4). It had to be in proximity of the village in order to minimize the length of the heat network. Building on municipal land would be practical and economical. The installation could not be built close to the historic country estate, which is a monument. Among the villagers, the visibility of the installation was not perceived as problematic (J1–J3).

Initially, villagers did worry about odor nuisance, but there is little or no odor from the biomass that is stored before fermentation or from the biogas emerging from fermentation. The fertilizer that remains after fermentation is used on the fields instead of liquid manure; it is of outstanding quality and does not have the pungent smell [25]. Yet, the facility was located in the north of the village, so that the prevailing westerly wind would blow odor, if any, away from the village (J1–J3). To prevent noise nuisance, the heat plant is well insulated (J3). At the chosen location, north of the village, the installation is visible from the edge of the village, but not from the center nor in combination with the estate. From a walking trail and local road near Jühnde, the installation seems well embedded within the rolling landscape (see Figure 5).

Figure 5. The biogas installation is embedded in the landscape, as seen from the local road.

To get the permits for building the installation, an environmental impact assessment was conducted, and for that, a landscape maintenance plan was drawn up. This plan specified the plantations, envisioned the future landscape image and fitted the installation in the surroundings (J3). To mitigate the impact on ecology and the landscape image, the authorities required compensation. This was proposed in the form of an orchard, which is situated on the fields next to the installation (J2, J3).

Where the finances and technical requirements allowed it, the aesthetic design of the biogas installation site was addressed (J2, J3). Overall, the chosen strategy was to embed the installation within the existing landscape, rather than letting it stand out. The fire water pond and the staff building, for instance, have a natural look, and the inclination of the roof of the storage building is exactly that of the surrounding landscape (J3). Further, plantings were used to blend the installation in with its surroundings (J2).

To conclude, the university took the aesthetic value of the landscape into account when advising the farmers about energy crops, preventing monocultures from coming into existence. It was advised to vary and rotate crops and to allow for certain weeds to grow in between the crops, which enhances the attractiveness of the agricultural landscape and biodiversity [25] (see Figure 6).

Figure 6. The landscape around Jühnde with a variety of (energy) crops.

6.4. Involvement of Landscape Architects

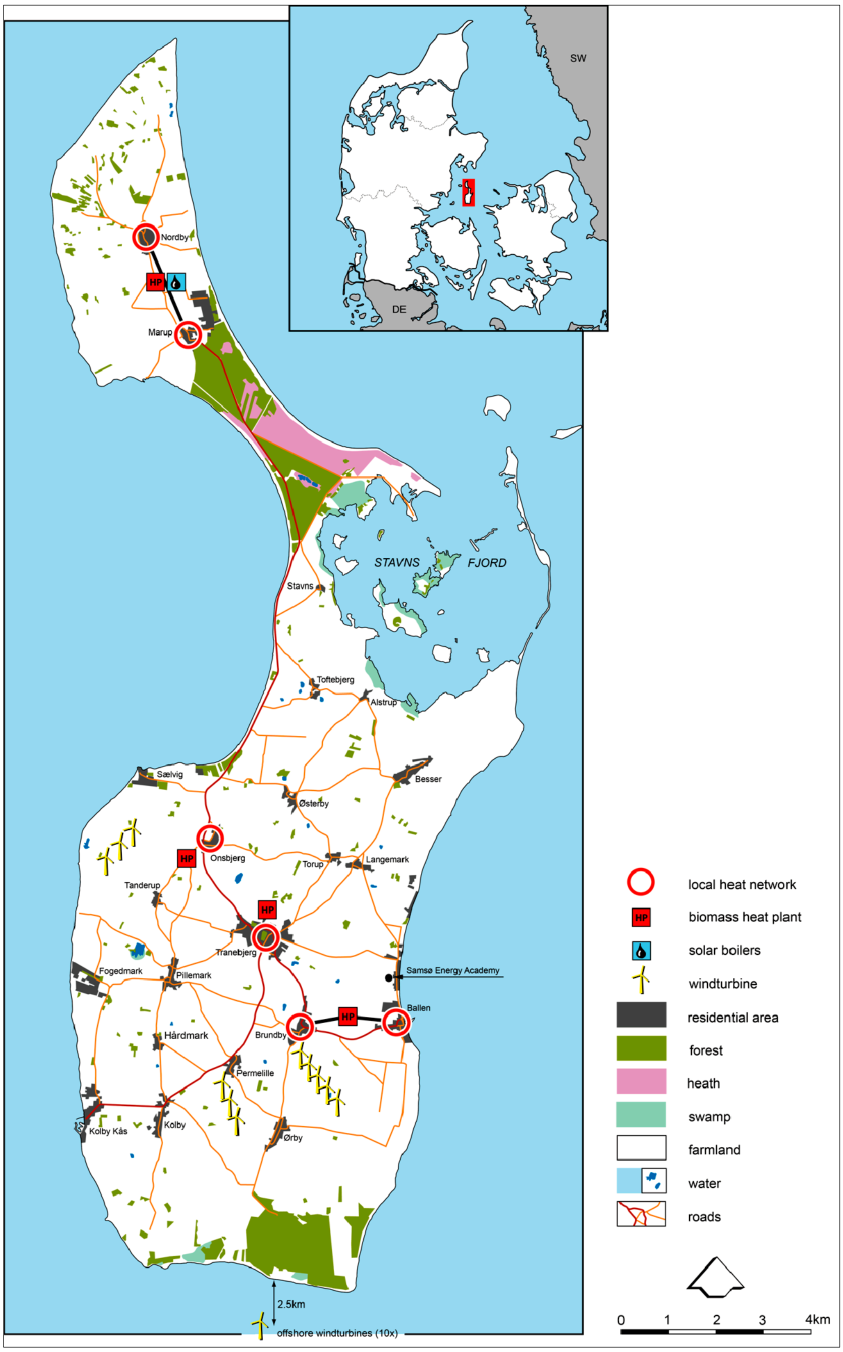
In the case of the biogas installation in Jühnde, several formal procedures had to be followed with regard to the landscape image and ecological values. Because the village community had little experience with that, the cooperative commissioned an engineering firm for the project management and for dealing with the formal procedures (J2, J3). For creating the landscape management plan, the engineering firm hired a landscape planner, as is required in Germany (J2, J3).

Towards the implementation of the biogas installation, the landscape management plan needed to be further specified to allocate and design the buildings and green spaces on the site. A number of guidelines and legal requirements were applied to the construction of buildings and installations. For this stage, a local construction architect was commissioned. Although he had few experiences with landscape, he also did the green space design of the installation (J3).

7. Samsø Renewable Energy Island

The municipality of Samsø encompasses an island of 114 km^2 in the Danish Kattegat, east of the mainland. Samsø is linked by car ferry to Hou (Jutland) and to Kalundborg (Zealand). The largest settlement is the town of Tranebjerg with 829 inhabitants, and there are several smaller villages and parishes (see Figure 7). The landscape is varied, featuring rolling hills, forest, heathland and beaches. The predominant land use on Samsø is agriculture. The island has 4,120 inhabitants, resulting in a population density of 37 inhabitants/km^2. The population has been decreasing for the last two decades, primarily due to a lack of employment for young people [66].

Figure 7. Map of Samsø: Location in Denmark, land uses, infrastructure and renewable energy technologies.



7.1. The Transition Process

In 1997, the Danish Ministry of Energy and Environment organized a competition for municipalities to submit the most realistic plan for energy transition. According to the announcement, the plan should be realized within ten years and without additional subsidies, while making use of local resources and proven technologies. The participation of Samsø in the competition was instigated by the engineering firm, PlanEnergi, in consultation with the municipal administration. Samsø won the competition with the plan created by PlanEnergi [66].

Whereas the competition was motivated by the sustainable development goals of the national government, the local decision to initiate the energy transition was more economically driven. As was the case in Güssing, the start of renewable energy transition on Samsø coincided with unfavorable economic conditions in the municipality. In 1998, the slaughterhouse was closed, a major employer on the island. About 100 people needed to find a new job, and energy transition was seen as a potential to create jobs and boost the economy (S1, S2). Interviewee S2 stressed that "In the making of the 10-year report ([66]), they interviewed a number of people about their motivation for entering the project. Number 1 was to 'help the local economy and independency of other sources', and Number 5 was 'CO_2-neutrality'. That means, this island isn't green at all!"

After revising and concretizing the initial plan, financed by the national government, the involvement of the community and other stakeholders became of crucial importance to the success of the transition. A frontrunner in the process was project leader Søren Hermansen who, being from Samsø himself, succeeded in actively involving many people. From the start of the implementation, Samsingers participated financially, in working groups and in the construction and management of local heat networks and other technologies. For the realization of heat networks, similar to Güssing, support from a large part of the inhabitants was necessary. This largely succeeded, however, for "one or two villages, it didn't work out in the end" (S3). Farmers participated by providing the heat plants with straw, investing in wind turbines and by experimenting with renewable transport fuels. The fact that inhabitants and farmers participated financially was important to the success of the transition, especially because of the fact that, as part of the competition, the goal was to achieve energy transition without subsidies, other than those normally available (S2, S3).

In the beginning three organizations were involved in realizing energy transition on the island, which later merged into the Samsø Energy Academy. Hermansen eventually became director of this institution, and the Academy is still guiding the developments today [67]. The local trade organization advocates renewable energy, because of the economic activity that the transition stimulates—among others, an increase in tourism. The municipality of Samsø was involved (but not leading) from the beginning, and in the final, crucial stage for realizing energy self-sufficiency within ten years, they provided finances for realizing the offshore wind turbines (S2).

The phasing of the transition on Samsø revolved around different interventions of increasing complexity and size; it started with smaller (domestic) renewable energy projects, followed by the heat plants and networks, the land-based wind turbines and, eventually, by the offshore wind turbines (S3). Samsø reached energy self-sufficiency within ten years [66], which is short for such a complex transition. Hereafter, the transition scope was expanded by starting a new program: Fossil Free Island. The island now aims to phase out the use of fossil fuels completely towards 2030 [67]. Similar to

Güssing and Jühnde, multiple issues in multiple domains were the reason for, and the focus point of, energy transition. Again, a multi-phased and multi-scalar approach was developed, ranging from the individual households to the entire municipality in the end.

7.2. The Renewable Energy System

On Samsø, the renewable energy system is based on the abundant potential for wind energy, solar energy and available agricultural (waste) products on the island. The wind turbines on Samsø produce more than 100% of the electricity consumption, and biomass sources cover 70% of the heat demand [66]. In Tranebjerg, Onsbjerg and Ballen-Brundby, heating is provided by plants that run on straw, a waste product from wheat and rye cultivation on the island. The Nordby-Mårup plant uses wood chips from the Brattingsborg estate in the south of the island (80%) and solar energy via boilers (20%). Local heat networks distribute heat to the consumers in the towns and villages. Owners of the more than 2000 residences and summerhouses outside the settlements are supported to replace their oil-fuelled furnaces with alternative installations, such as heat pumps and solar boilers. For an overview of the renewable energy sources and technologies on Samsø, see Table 3.

Furthermore, on Samsø, some drawbacks occurred during the transition to a renewable energy system. Despite several campaigns, the efforts of energy advisers and implemented efficiency measures, the household electricity consumption is increasing; a rebound-effect that has been observed across Europe [68]. Similar to Güssing and Jühnde, the use of fossil fuels for transportation is compensated for by the export of renewable electricity. The great potential of biogas to provide electricity and heating is unused so far, but studies on the feasibility of biogas production on the island are being conducted currently.

Table 3. Renewable energy provision on Samsø [66,69].

Facility	Location	Energy source	Capacity
5 land-based wind turbines	Brundby	Wind	1 MW each (electricity)
3 land-based turbines	Permelille	Wind	1 MW each (electricity)
3 land-based turbines	Tanderup	Wind	1 MW each (electricity)
10 offshore wind turbines	South of the island Samsø	Wind	2.5 MW each (electricity)
Heat plant with heat network	Tranebjerg	Straw	3 MW (heat)
Heat plant with heat network	Onsbjerg	Straw	0.8 MW (heat)
Heat plant with heat network	Brundby-Ballen	Straw	1.6 MW (heat)
Heat plant + solar boilers with heat network	Nordby-Mårup	Wood chips and solar	1.6 MW (heat) (2500 m^2)

7.3. Considerations on Landscape Impact, Siting and Design of Renewable Energy Technologies

According to the interviewees, S1 and S2, while siting the first set of turbines on land, their height and visibility were discussed with a wide range of stakeholders. This process was initiated by the Samsø Energy Company, one of the predecessors of Samsø Energy Academy. This process was also the preparation for the formal environmental impact assessment that had to be conducted. As a result of this process, the turbines are located in three groups: three turbines near Tanderup, three near Permelille and five near Brundby (see Figure 8). It was decided that all turbines that would be visible from one location should have identical designs. Studies revealed that all three clusters of wind turbines are visible from some locations; hence, eleven identical turbines were installed. Further, it was decided to use the same tower heights (instead of custom made ones), so that the turbines would reflect the landscape contours. For energy reasons, it was determined that the turbines should have a capacity of 1 MW (50-m tower height, 54-m diameter, 77-m total height). Interestingly, interviewee S3 acknowledges that the process of wind turbine siting went relatively smooth compared to other regions in Denmark and that the small number and size of the turbines on the island contributed to that. Next to the visual and energy considerations, land ownership was vital in the process of siting the turbines and managing resistance among the inhabitants. By locating some of the turbines on private land and others on public land, the ownership of all turbines could be organized in a way that the Samsingers could agree on it (S2). Interviewee S2 explained further that, normally, for each of the three groups of turbines, a separate, environmental impact assessment should have been conducted. However, because the Samsingers considered it important that the groups were designed and developed as a unity, similar to the rationale behind cumulative impact studies, they managed to have the three groups assessed in one study. In this formal assessment procedure, landscape planners and other experts were involved (S2). The off-shore turbines were sited in one, curved line, so that they least spoil the view from the island. Fortunately, they also receive the most wind in this spatial constellation.

For siting the heat plants, visibility, as well as potential noise and dust nuisance played a role. Locations were proposed, for example, by the Samsø Energy Company and then discussed with the inhabitants and other stakeholders, such as the municipality. By organizing an open planning process, similar to the turbines, consensus was reached without having to compromise restricted areas, such as the nature area in the north of the island or areas that have many (summer) houses.

A local architect designed the heat plants and their immediate surroundings. Interviewee S2 gave the following account on the considerations around the siting and design process of the heat plants. In the case of the Ballen-Brundby plant, the excessive technical costs resulted in a merely functional design. In spite of these circumstances, the physical appearance was judged positively by inhabitants and other stakeholders. For the Nordby-Mårup heat plant, it was proposed to locate solar boilers along the road in order to make a statement. The inhabitants uniformly rejected that: they found the boilers ‘ugly’ and wanted them to be hidden behind the plant. Although the boilers ended up in front of the plant, they are partly hidden by shrubs. Instead of designing with the boilers, the architect gave the building a notable appearance (see Figure 9). In Onsbjerg, locals feared that the view of the church would be dominated or even blocked by the heat plant. The architect therefore placed the chimney eccentrically on one side of the building and placed the plant well between the nearby buildings.

7.4. Involvement of Landscape Architects

On Samsø, generally speaking, the impact of energy technologies on the landscape received much attention. This study has shown that, similar to Güssing, some interventions were opposed, due to landscape concerns. On Samsø, however, this was handled during the planning process rather than afterwards. Almost all interventions were sited and designed consciously, and formal planning procedures were more prominent. Landscape architects were among the experts on the environmental impact assessment committee in the county. During the preparation of the formal procedures, discussions on the siting and design of technologies took place, but without the participation of landscape architects. Occasionally, a (local) architect was involved. Upon the question of whether more involvement of experts, such as landscape architects, would have been beneficial to the transition, the interviewee, S1, stated that the process at Samsø was "one of the people" instead of experts. Participation, in his view, would enhance the commitment of inhabitants, which, in turn, was considered essential for the long-term success of the transition.

Figure 8. Land-based wind turbines near Tanderup.

Figure 9. The Nordby-Mårup heat plant, which runs on wood chips and solar boilers. The solar boilers are screened with vegetation to hide the view from the road.

8. Case Study Comparison

Because energy transition poses new challenges and opportunities to the discipline of landscape architecture, the main question addressed in this paper was what landscape architects can learn from the transitions in Güssing, Jühnde and Samsø. After discussing the literature, a second question was raised, namely whether and to what extent the identified operational and strategic activities of landscape architects have been employed in the realization of the aforementioned cases. This study described for each case (A) the transition process, (B) the renewable energy systems, (C) the consideration of landscape impact, siting and design of renewable energy technologies and (D) the involvement of landscape architects (or other professionals from the spatial domain) in the transitions. In this section, the cases are compared with each other to demonstrate differences and similarities. Table 4 provides an overview of the three cases, structured according to the four central aspects of this study.

Table 4. Overview of the cases of Güssing, Jühnde and Samsø.

Aspect	**Güssing (Austria)**	**Jühnde (Germany)**	**Samsø (Denmark)**
Transition period	1992–2001	2001–2005	1997–2007
Geographic entity	Municipality and town	Municipality and village	Municipality and island
Population density	100 inhabitants/km^2	44 inhabitants/km^2	37 inhabitants/km^2
A. The transition process			
Context and motivations for renewable energy transition	The context and motivations in Güssing were a combination of the poor economy, low employment and the large amount of the municipal budget spent on energy imports.	The immediate cause was an action research by the University of Göttingen, to develop Germany's first bio-energy village. The concept is seen as a way to enhance sustainability and socio-economic welfare in rural areas. The community was motivated by socio-economic reasons.	The immediate cause was winning a national competition for becoming the first renewable energy municipality in Denmark. Participation was instigated by an engineering firm from outside. Continuation of this process was, at least partly, motivated by economic and demographic reasons.
Typical characteristics of transitions	Multiple issues were addressed in multiple domains. The transition took place in phases that each addressed the next scale level. Continuation focuses on renewable transport fuels and development of eco-tourism.	The village of Jühnde is a small territory for a transition. However, also here, multiple issues in multiple domains were addressed. The process was multi-phased and continues with e-mobility in the future.	Multiple issues were addressed in multiple domains. The transition took place on multiple scale levels The process was multi-phased and continues with the Fossil Free Island program.
Frontrunners	Local frontrunners were vital for conceiving and initiating the transition. From 1996, the European Centre for Renewable Energy (EEE) took over the task of implementing and continuing the developments.	Local frontrunners were vital for communicating and mediating the bio-energy village concept between the university and the village community. The cooperative partnership Bioenergiedorf Jühnde eG has operated the biogas installation since 2004, of which one of the frontrunners is now the manager.	Local frontrunners were vital for implementing the transition. In the beginning, three organizations were important for organizing the developments, which later became one, the Samsø Energy Academy, of which, frontrunner Hermansen became director.
Government involvement	The municipality was an important stakeholder, especially in the beginning of the process, when political support was needed to start the transition.	The mayor acted as a frontrunner in the transition himself. The municipality was important as the landowner when siting the biogas installation.	The municipality was involved from the beginning, but not leading; they participated financially in the crucial, final stage of the transition.

Table 4. *Cont.*

Aspect	Güssing (Austria)	Jühnde (Germany)	Samsø (Denmark)
Citizen participation	Inhabitants were involved in the beginning, because their support and cooperation were needed for implementing the heat network; after that, inhabitants got less involved.	Inhabitants were highly involved; they were consulted, cooperated financially and participated in working groups and in the construction and management of heat networks and other renewable energy technologies. Participation is seen as an important factor for success.	Inhabitants were highly involved; they were consulted, cooperated financially and participated in working groups and in the construction and management of heat networks and other renewable energy technologies. Participation is seen as an important factor for success.
Drawbacks reported	The diminished involvement of inhabitants is considered a pity in the light of getting support for future developments.	-	-
B. The renewable energy system			
Energy efficiency	In public buildings, a 40%–50% energy savings was achieved by insulation.	-	In spite of several campaigns and implemented measures, energy consumption in households is still increasing.
Renewable energy sources	Local wood chips, saw dust and waste wood, solar energy	Manure, energy crops, wood chips, solar energy	Wind energy, straw, wood chips, solar energy
Renewable energy technologies	CHP and/or heat plants and/or solar boilers combined with heat networks, PV installations	Biogas installation (CHP) with heat network (2×), heat plant (2×), PV installations	Land-based and offshore wind turbines, heat plants combined with heat networks, heat plant and solar boilers combined with heat network
Drawbacks reported	Transportation still relies on fossil fuels in spite of attempts to provide (local) biofuels.	Transportation still relies on fossil fuels.	Transportation, including the ferry to the mainland, still relies on fossil fuels, in spite of attempts to provide (local) biofuels.
C. Considerations on landscape impact, siting and design of renewable energy technologies			
	Landscape (impact) was not pro-actively considered. Two planning-related issues arose because of noise and dust nuisance: one after implementing a heat plant and the other during the planning of a CHP. The first issue was settled, because the municipality mediated between the heat plant and the school. The second issue was not solved; the CHP has been built at the intended location.	Landscape impact was considered by the formal EIA (environmental impact assessment), for which a landscape maintenance plan was drawn up. This was followed by the detailed allocation and design of buildings and green spaces at the site. To compensate for the impact of the biogas installation on biodiversity and landscape image, an orchard needed to be realized next to the installation.	Landscape impact was pro-actively considered. For the land-based wind turbines, a formal EIA was conducted, prepared by the Samsø Energy Academy, in consultation and cooperation with the inhabitants. Similar to this process, but without formal procedures, the location and the design of the heat plants result from an open, participatory planning process.

Table 4. *Cont.*

Aspect	Güssing (Austria)	Jühnde (Germany)	Samsø (Denmark)
Drawbacks reported	The fact that opposition against the CHP was not solved in concert with the inhabitants of Ludwigshof was judged negatively by one interviewee.	-	-
D. Involvement of landscape architects			
	No landscape architects were involved, except for a planner, who created the eco-tourism cycling route. It was reported that this is in line with the limited planning and design tradition in this part of Austria.	For drawing up the landscape maintenance plan for the formal EIA, a landscape planner was hired by the engineering firm that was responsible for the project management. A local architect was involved in the detailed planning and design of the installation.	Landscape architects at the county were involved in the formal EIA procedure for the land-based wind turbines. A local architect was involved in designing the heat plants and their immediate surroundings.

Güssing, Jühnde and Samsø are commonly regarded as successful examples of energy transition [22–25]. While within (academic) landscape architecture, sustainable development is a major driver to work on energy transition, the cases showed that the economic and social context motivated the transition. The case of Jühnde showed how those different motivations have been combined successfully. Sustainability was a main motivation for the university researchers to initiate the study, and one of the local frontrunners reported that for him “personally, it was one of the main reasons to bring the project forward” (J2); whereas the village community and the mayor emphasized the socio-economic side.

With respect to the processes, the cases demonstrated the main characteristics of transitions. Especially Güssing and Samsø were complex, long-term processes, triggered by multiple problems, containing social and technological components and concerning multiple (scale) levels, phases and stakeholders. In all cases, local frontrunners played a key role in the developments. In Güssing, they conceived and initiated the transition to be further developed by the European Centre for Renewable Energy. In Jühnde, they were important mediators between the university researchers who instigated the transition and the villagers who needed to implement it. On Samsø, Hermansen was a driving force as the project leader and, later, as director of the Samsø Energy Academy. Next to the presence of local frontrunners, a participatory approach appeared essential for the implementation of the renewable energy system in all three cases. Without cooperation among stakeholders, the heat networks of Güssing and Jühnde could not have been realized, because a certain number of connections is needed to make the system work effectively. On Samsø, financial participation by the inhabitants, for example in the form of the shared ownership of the wind turbines, was also crucial, because there was little external funding. The ways in which participation could be organized most effectively in energy transitions and how participation depended on the given planning contexts are beyond the scope of this study, but would be relevant issues for further research.

The renewable energy systems that were realized in these cases, acclaimed for their success, provide valuable insights for both experienced experts and ‘relative newcomers’ interested in energy transition. It appeared that different geographical, socio-economic and planning contexts led to different energy demands and different potentials for renewable energy generation and efficiency. Therefore, the renewable energy systems in these cases were specifically designed to meet the respective energy demand, making use of the available potentials for renewable energy generation and efficiency. As a result, the systems differed with regard to energy sources, technologies and capacities, and the transferability of the cases is limited. While they present inspiring examples, for every new case, the specific, context-dependent potentials for renewable energy generation and efficiency should be identified, as well as the energy demand.

Yet, in these cases, also, two common drawbacks could be identified regarding the energy systems, which offer opportunities to learn and hold the potential to inform and advance future plans for energy transitions. First, this study showed that all cases were not yet able to replace gasoline and diesel adequately. Instead, fossil fuel use is compensated for by a surplus of renewable electricity generation. Next, it appeared that, although Güssing succeeded in reducing energy demand by insulating public buildings, the three cases underused the potential for energy savings. Following the logic of the 'Trias Energetica' by Lysen [36], this means that the amount of energy that is to be provided by renewable sources is higher than necessary. For Güssing, Jühnde and Samsø, this has not been a problem so far, because the population density is relatively low and the limits to renewable energy generation have not yet been reached. Yet, at the global scale and in urban areas with much higher population densities in particular, reducing the energy demand deserves much more attention in the planning and design of energy-conscious environments [3,70].

Landscape impact, siting and the design of renewable energy technologies were considered more extensively in Jühnde and on Samsø than in Güssing. In Jühnde and Samsø, formal environmental impact assessments were required for realizing the biogas installation and land-based wind turbines, respectively. On Samsø, an open and participatory process was the basis for a relatively smooth transition in this respect. Inhabitants were pro-actively involved in discussing the siting and design of land-based turbines, heat plants and their surroundings. In Jühnde, preparing the environmental impact assessment and the siting and design of the biogas installation were conducted by professionals, commissioned by the cooperative partnership, in which villagers participated. The university researchers, the initiators of the project, considered the landscape image while advising farmers on energy crops. In Güssing, no environmental impact assessments were conducted for renewable energy technologies, nor were siting and design of installations considered explicitly in less formal ways. When problems about noise and dust nuisance arose, they were solved in one occasion and remained unsolved in another. How far and in which ways landscape impact and the siting and design of installations were considered seemed to depend on the planning context and the nature of the interventions; for instance, wind turbines have a much higher (visual) impact on the landscape than a heat plant. Yet, the finding that the implementation of renewable energy technologies in Jühnde and on Samsø was not hampered by structural opposition may serve as an indication for the relative importance of the careful siting and design of such technologies as part of a larger, comprehensive transition process.

The actual involvement of landscape architects was limited; only for Samsø was it reported that landscape architects contributed to the environmental impact assessment. In Jühnde other professionals from the spatial domain were involved, such as the landscape planner, who was responsible for the landscape maintenance plan and the preparations for the environmental impact assessment. Next, an architect conducted the site design of the buildings and green spaces at the biogas installation, and an engineering firm was responsible for the project management. In Güssing, where no landscape architect or similar experts contributed, the involvement of landscape architects could have positively contributed, according to one of the interviewees. Thereby, the need to pro-actively consult inhabitants to prevent opposition was stressed, as well as a well-considered location and the physical appearance of interventions. The activities in which landscape architects or similar experts were involved in these cases concern those that were framed as 'operational': they took place on lower spatial scale levels, within limited time frames; they were input in the process toward implementation and aimed for landscape transformation rather than organizing the planning and design process. The emerging approach in landscape architecture that aims to approach energy transition more strategically, and that focuses on optimizing energy efficiency and renewable energy generation by means of reorganizing the spatial arrangement of the larger physical environment, was not a reality in the cases studied. Not denying the considerable achievement of energy transition in all three cases, a theoretical example may illustrate the potential contribution by strategic, energy-conscious landscape architecture. For the three cases, it was reported that fossil fuels for transportation were compensated for by renewable electricity. Admittedly, the development of sustainable transport fuels is well beyond the expertise of landscape architects. On the basis of energy potential mapping, however, the abundance of renewable electricity would have been constituted *a priori*, on the basis of which energy-conscious landscape architects along with other experts could have developed strategies to change the energy sources and technologies, and the means of transportation as well (e.g., by proposing to replace fossil fuel vehicles with electric cars).

For the case of Güssing, one of the interviewees suggested some reasons for why landscape impact, siting and design of renewable energy installations were not considered explicitly, such as a weak institutionalization of planning and design. A reason for the (nearly) absence of landscape architects in the cases of Güssing and Samsø could be that the transitions started there 25 and 15 years ago. Around that time, in many countries, the first wind energy projects were taken up by landscape architects. Back then, it is important to stress that the discipline of landscape architecture was not yet ready to address energy transition in a strategic manner, as was discussed in the literature section of this paper. Yet, if landscape architecture aims to broaden its disciplinary scope and address energy transition in both operational and strategic ways, the question of why landscape architects were not involved in the cases in this study remains valid and needs to be addressed in the future. Moreover, the questions of where and how landscape architects are involved in successful cases of energy transition gain relevance for further inquiry. Some first studies on the contribution of landscape architects in realized transitions, for example in Italy, have recently been conducted, and publications are in review (e.g., [71]).

9. Conclusions

Realizing energy systems that rely entirely on renewable energy sources is a prerequisite for achieving sustainable energy transition, as was demonstrated by the cases discussed in this paper. Although these cases represented inspiring examples, it must be stressed that their renewable energy systems are hardly transferrable to other situations and that for every new case, the specific, context-dependent potentials and possibilities should be identified. Further factors for success seemed to be the presence of (local) frontrunners and a certain degree of citizen participation. Much of the literature on energy transition and landscape architecture focuses on energyefficiency and renewable energy generation, by means of energy-conscious planning and design. In future research on energy transition, the relations and possible synergies between (spatial) expertise and stakeholder participation, within the wider planning context, deserve further attention.

Landscape impact, siting and design of renewable energy installations were in none of the cases the most important aspects for realizing the transitions, yet it appeared important in the sense that resistance to the one or the other proposed intervention can be recognized and mitigated. The case of Güssing showed that (limited) opposition is not decisive for the overall success of the transition. However, Jühnde and Samsø had a relatively smooth process in this respect, demonstrating careful siting and designing, while partly institutionalizing the decision process. How far and in which ways landscape impact, siting and design of installations were considered seemed to depend on the planning context and the nature of the interventions. For some renewable energy technologies, such as wind turbines and biogas installations, environmental impact assessments may be already required. In those instances, landscape architects and similar professionals are among those that can prepare for or conduct environmental impact assessments, as was the case in Jühnde and Samsø.

Based upon the research presented in this paper, it can be concluded that in Güssing, Jühnde and Samsø, landscape architects were not as involved as they, theoretically, could have been. Some of the activities that landscape architects, according to the literature, could have conducted in the transition process were realized by other experts and, in the case of Samsø, also by non-experts. The paper illustrated that the involvement of the spatial domain could have helped to foresee and address some of the drawbacks that surfaced during the transition processes, the realization of the renewable energy system and the mitigation of landscape impacts. Provided that landscape architects continue to broaden their knowledge on the topic of energy transition, more strategic and spatially explicit approaches that have, in the past, contributed to other kinds of transitions could be introduced to energy transition. Hereby, a pro-active attitude on behalf of the discipline is essential, if only to inform the wider public, stakeholders and potential commissioners about the added value of landscape architects to energy transition.

By stating that "The energy landscape is where it happens!" [72], Søren Hermansen supported the emerging paradigm, that landscape is indeed an integrative concept in which the ecological/functional, social and aesthetic aspects of energy-related interventions can be approached together. Because of that, landscape architecture, among other disciplines, can help to integrate the multiple dimensions of energy transition. If we are to strive for long-term, sustainable development, rather than "merely" renewable energy provision, energy transition should be approached pro-actively and strategically, across disciplinary boundaries and spatial scales. The "sustainable energy landscape" concept that was put forward by Stremke and van den Dobbelsteen 10] can inform the energy-landscape discourse, where landscape architects, geographers, engineers and other experts meet to pursue global sustainability goals, while empowering local communities and safeguarding landscape quality.

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Author Contributions

Renée de Waal and Sven Stremke equally contributed to the research in terms of conception, research design, data collection and revising of the paper. Renée de Waal was the main person responsible for data analysis and drafting of the paper.

Conflicts of Interest

The authors declare no conflict of interest.

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