Successfully Navigating the Project Lifecycle for Deployment of Centralized Biogas Projects—The Case of Solrød Biogas

Mark Booker Nielsen *, Rikke Lybæk and Tyge Kjær

Institute of People and Technology, Roskilde University, 4000 Roskilde, Denmark
* Correspondence: mebn@ruc.dk; Tel.: +45-2639-2438

Abstract: The aim of this study is to identify non-technological critical success factors (CSFs) that influence the different phases of the project life cycle for the deployment of centralized biogas projects; as there is a knowledge gap in this area. This was performed by applying a longitudinal process analysis approach and an analytical framework based on findings from previous studies. Data were collected through extensive document collection and analysis, combined with in-depth semi-structured interviews. The study resulted in the identification of a total of 30 non-technological critical success factors in the case of Solrød Biogas. These were subsequently linked to one of the different phases of the project lifecycle (conceptualization phase, planning phase, execution phase) or categorized as general CSFs. We hope that the findings in this study can help ensure better management of biogas projects and enhance the capabilities of governmental bodies in supporting projects in the future, so a higher rate of centralized biogas projects is successfully implemented both in Denmark and other countries

Keywords: biogas technology; bioenergy; critical success factors; longitudinal study; successful deployment of renewable energy

1. Introduction

Facing grand challenges such as climate change, scarcity of resources and land, and ecosystem degradation, we need to find innovative and sustainable solutions for producing and consuming products and services and, after their end-use, reusing and recirculating the resources they are made of, thereby creating a pathway so we can stay within the ecological boundaries of our common planet [1–3].

Biogas produced via industrial-scale anaerobic digestion can be used for the production of renewable energy in the form of electricity, heat, or vehicle fuel [4,5]. Furthermore, biogas production also provides the additional environmental benefits of decreased water, soil, and air pollution via the use of digestate as agricultural fertilizer compared to the traditional use of manure, and thus has been singled out as a potential hub in the circular economy [4–6].

Denmark currently aims to transition to a climate-neutral society by 2050 and, parallel to this, is moving towards a more circular and bio-based economy [7,8]. Since the oil crisis in the early 1970s, there has been a political determination in Denmark to support the deployment of renewable energy, including biogas production [9–11].

In 2020, the production of renewable energy from national biomass amounted to 101.3 PJ in the Danish energy system, and a further 81.7 PJ produced from biomass was imported, primarily in the form of wood pellets. In total, the consumption of renewable energy from biomass was 183 PJ or 27.9% of the total energy consumption of 656.3 PJ [12].

The production of biogas increased rapidly between 2008 and 2020, from 3.9 PJ/year to 21.3 PJ/year. Especially after 2016, the diffusion of biogas technology accelerated rapidly from 6.2 PJ/year [11]. This development was driven mainly by an enhanced feed-in tariff for renewable electricity production using biogas introduced in 2008 and following an
investment grant scheme as part of the Green Growth agreement in 2009. In 2012, the feed-in tariff was further enhanced, and the decision was made to equalize support for direct use, upgrading and transport, and industrial processes, further increasing incentives [11,13,14]. These policy changes resulted in 17 large-scale centralized biogas plants (not including Morsø Bioenergi) and 34 farm-scale biogas plants being implemented between 2008 and 2021 [11,15]. In 2018, a new energy agreement was reached that meant that new biogas plants in operation after 31 December 2019 would not be able to gain support under the current support scheme. In April 2019, the deadline for being in operation was extended to 31 December 2022 for biogas projects already under development [16].

Despite the large role biomass-based resources already play in the Danish energy system, there are still large amounts of unutilized biomass-based agricultural residue, production leftovers, and waste that could be utilized for the production of biogas in Denmark. In a 2018 report from the Danish Energy Agency, the long-term technical biomass potential for production of biogas was estimated to be between 40 and 50 Pj, and if captured CO₂ biogas upgrading is utilized for methanation, the technical potential for green gas is estimated to be as high as 80 Pj [17].

Biogas technology is a versatile technology that is both highly scalable as well as flexible with regard to input and gas product use. For these reasons, biogas is set to play an important role in the transition to a climate-neutral energy system in Denmark in 2050. In four energy scenarios developed by the Danish Energy Agency in 2014, the Danish production of biogas was, in all scenarios, set to increase to 42 Pj in 2050 [11,18]. Moreover, in the sustainable development and STEPS scenarios from the IEA, the global production of biogas must increase from around 1571 Pj in 2018 to 3142 Pj by 2040 if we are to meet the goal of the Paris agreement [4]. With the Russian invasion of Ukraine in February 2022, the need for accelerating the deployment of biogas technology has become more urgent for both Denmark and the rest of the EU [11,19–21].

Deployment of biogas technology is, however, not progressing as quickly as it could, as biogas projects often encounter various challenges that result in either the project lifecycle being prolonged or the project being abandoned completely. The average project lifecycle for deployed centralized biogas plants between 2008 and 2020 in Denmark was around 6–7 years, and a minimum of one-third of all centralized biogas projects initiated after 2008 have been either abandoned or put on standby indefinitely, often after many resources have been invested [11].

In previous studies, some of the different challenges encountered by biogas projects were identified. Lack of local acceptance is probably the most mentioned challenge for the deployment of biogas technology in the research literature. When biogas plants are deployed, there are very often concerns from local communities related to potential odor problems, heavy transport, and a decrease in property values [11,22–25]. It was suggested that local acceptance could be influenced by three factors: (1) perceived benefits, (2) perceived cost, and (3) trust [26]. Local authorities can, on the one hand, play a key role in gaining the trust of local communities, but on the other hand, lack of procedural justice and mistrust in local authorities and project owners may also lead to local opposition [11,27–29].

There are many factors that need to be taken into consideration in site selection for the deployment of a centralized biogas plant. These factors can be grouped into four according to two recent studies from Sweden: (1) supply and demand, (2) synergies and infrastructure, (3) land-use and zoning, and (4) sociopolitical. Only a few optimal sites may thus be available within a region when taking all these factors into consideration—access to road infrastructure, zoning requirements, and proximity to buildings were found to be key constraints [11,24,30,31]. Administrative and regulatory challenges were also found to be restraining factors in the development of biogas projects. A study by Rösch and Kaltschmit (1999) found that there were three main types of administrative challenges linked to the deployment of bioenergy technology: (1) absence of clear regulation, (2) lack of common interpretation of the regulatory framework, (3) regulatory framework that does not fit the technology [32]. Another study found that a lack of institutional trans-
parency and consistency due to inexperience at the municipal level may prolong project development [11,33].

The focus of this study is on identifying non-technological critical success factors (see the review of findings in previous studies in the section below) contributing to the successful deployment of biogas projects. There is still a need for more knowledge on how project owners can successfully navigate the challenges encountered in biogas projects highlighted above. Here, this was performed by identifying the non-technological critical success factors (in the following, referred to as critical success factors) in the different phases of the project lifecycle. This has not been studied before. The lack of attention to the project lifecycle/time perspective limits our understanding of both how biogas projects are successfully managed and the capability of governmental bodies to better support biogas projects and ensure the transition to a climate-neutral energy system and decrease our dependence on imported natural gas.

Research Question

The aim of this study is to investigate the following research question: What non-technological critical success factors can be identified in the different phases of the project lifecycle for the deployment of the centralized biogas plant Solrød Biogas?

2. Materials and Methods

2.1. Review of Non-Technological Critical Success Factors in Deployment of Biogas Plants

The study of critical success factors (CSFs) influencing the successful deployment of projects is well established in the project management literature and has been applied in various fields to identify the factors important for project success (PS) [34,35].

In this section, however, we focused on non-technological critical success factors in the successful implementation of biogas projects, supplemented by similar studies focusing on CSFs in the deployment of bioenergy technology, renewable energy technology, and projects in general.

One critical factor linked to project success (PS) described in the project management literature is the project mission [34]. In the conceptualization phase of the project lifecycle, the goal and general direction of the project should become clear [34,36]. Another CSF is top-management support, ensuring that enough resources and authority are allocated for the project’s success; it is also essential when challenges are encountered [36].

Team factors were also identified as a CSF for the deployment of biogas technology. Linked to this is a long-term perspective by team members identified in a study based on qualitative interviews with stakeholders involved in the deployment of a biogas plant in Sweden [37]. Here, informants declared that they strongly supported environmental sustainability but understood that things took time, and they were all proud to take part in the process of transitioning to renewable energy [37]. In the same study, the entrepreneurial skills and experience of the project team were found to be another CSF. Even though not all actors involved were entrepreneurs, some had entrepreneurial characteristics such as resourcefulness and willingness to take risks, and they also knew how to communicate, gain attention, and negotiate agreements and contracts [37,38]. Furthermore, the Swedish study found that influential enthusiasts/entrepreneurs/change agents were a CSF. Some of these change agents, who had also initiated the project through their drive and enthusiasm, were of key importance in mobilizing other stakeholders, especially in the conceptualization phase. Moreover, some of them had positions where they had access to influential policymakers, investors, and industry stakeholders, and many had transdisciplinary competencies and strong communications skills [37]. These change agents were also persistent in finding solutions/troubleshooting when challenges were encountered [36,37]; linked to this is also the recruitment of the right personnel to be part of the project team [36].

Collaboration is also highlighted in several studies of CSFs for bioenergy production deployment [37,39,40]. In a previous report on lessons learned from establishing Solrød Biogas, the engagement and dedicated partnership between municipal politicians and
administration, industries, agriculture, and knowledge institutions were mentioned as one of the main reasons for the project’s success [41]. Moreover, identifying objectives corresponding to the interests of stakeholders was highlighted as an important part of objective-oriented project planning [41,42]. This is also linked to the project mission previously mentioned. The Swedish study mentioned above also identified well-functioning cooperation between private and public actors as a CSF in the realization of biogas projects. Furthermore, it was found that the project consortium focused on in the Swedish case study had a common understanding that no single actor had the necessary experience and resources to manage the development of the biogas project alone and thus recognized that cooperation was necessary for the project’s success. They also applied an approach where work tasks were circulated between members of the project consortium, ensuring the optimal use of project member competencies and skills [37]. The facilitating and coordinating role of the business development company was stressed as important in ensuring constructive cooperation among stakeholders towards the joint goal that had been established and in providing practical knowledge for preparing funding applications and external communication [37]. In addition, the importance of engaging professional support in the latter phases of project development was pointed out [39]. Adequate communication was identified as a CSF in managing the development of biogas projects and projects in general [36]. In a study of local acceptance of biogas plants in Switzerland, it was found that providing information alleviated the concerns of local communities [19]. In another study in Germany on the implementation of bioenergy projects, it was found that visits to already established biogas plants and personal conversations with local inhabitants living close to these best-practice cases also increased local acceptance [39]. In the same study, the importance of transparency in information and communication processes was also stressed [39,41]. In addition, general advocacy for renewable energy was stressed as important for local acceptance [24]. As already mentioned, 12 important factors for site selection of biogas plants were identified in a recent Swedish study. These 12 factors were categorized into four groups in the study: (1) supply and demand (feedstock supply, biogas demand, digestate demand, CO₂ demand), (2) synergies and infrastructure (available infrastructure, adjacent industries), (3) land use and zoning (nearby housing, zoning, historic preservation sites), and (4) sociopolitical (political strategies and goals, organizational capability, local social acceptance) [30]. Finding the optimal balance between these factors is essential for project success and viability. Municipalities/local authorities also play a variety of important roles in the deployment of biogas projects. It was proposed that municipalities can have the roles of facilitator, regulator, and consumer in the dissemination of biogas technology [16,29]. Another study also pointed their role as educators by providing information to local communities and as a neutral actor in cases with local opposition [28]. Linked to this, trust in local authorities and their fairness, competence, and neutrality were highlighted as important for local acceptance of biogas [24].

2.2. Analytical Framework Applied in This Study

Based on this review of previous studies, we composed the following analytical framework for the identification of CSFs:

- Project management style (A);
- Political and top management support (B);
- Recruitment and project team skills and experience (C);
- The role of change agents/sustainability entrepreneurs (D);
- Collaboration (E);
- Communication (F);
- Gaining the trust of local communities (G);
- Ensuring external funding (H);
- Professional support (I);
- Site selection and viability of business case (J);
• The roles of municipalities (facilitator, regulator, consumer, owner, general advocacy for renewable energy technology, neutral actor, educator) (K).

By combining this analytical framework with the longitudinal process analysis approach presented below, we hope to classify and identify CSFs and gain insight into what is important in the different phases of the project lifecycle for the deployment of centralized biogas plants.

2.3. Longitudinal Process Analysis

In order to identify critical success factors in the three phases of the project lifecycle (conceptualization, planning, execution) or as a general CSF linked to project management, we applied a methodology for longitudinal process analysis purposed by Poole et al. (2000) [11,43–46]. This approach included the chronological listing of events that occurred in the development of the organizational innovation process by registration of the time they occurred (month/year), description of the event, and the data sources in an event database [44]. In this process, an event can be defined as an instance where change can be observed in either the idea, people involved, transactions, relationships, the context, or the outcome [11,44]. The data source of the chronological listing of events in the database was obtained in this study through document collection and semi-structured interviews.

2.4. Case Study

2.4.1. Case Selection

The case of Solrød Biogas was selected for two main reasons [47]: first, because it was possible to gain a comprehensive insight into events during the different phases of the project lifecycle, which is required for a longitudinal study, and secondly, because the project lifecycle for the implementation of Solrød Biogas can, in many aspects, be viewed as a best-practice case. Thus it could provide valuable experiences that could benefit the deployment of other centralized biogas plants. Solrød Biogas is a centralized agro-industrial biogas plant located in Region Zealand in Denmark—one of 17 large-scale centralized biogas plants implemented between 2008 and 2021 in the country. When the biogas plant started operations in 2015, it had the capacity to treat 191,000 tons annually: 44,600 tons of manure, 79,400 tons of pectin residue from the company CP Kelco, 60,000 tons of eluate residues from the company Chr. Hansen, and, finally, 7000 tons of seaweed from the cleaning of local beaches. It was designed to produce 6 million Nm$^3$ biomethane (approximately 0.31 Nm$^3$ per ton biomass), which was sold to the district heating company VEKS for direct use in the production of combined heat and power (CHP) [41,48].

2.4.2. Case Context

Solrød Municipality was the project owner and coordinator during the entire project lifecycle and ended up as the sole owner of Solrød Biogas A/S. Solrød Municipality has, since 1999, been committed to ecologically sustainable development. In 2009, Solrød Municipality presented its first climate mitigation plan, with a goal of achieving a 46% reduction in GHG emissions between 2007 and 2025 [49]. In the climate mitigation plan, deployment of a biogas plant is highlighted as one of 22 climate mitigation actions. In 2011, the climate mitigation plan was also submitted to the Covenant of Mayors. In the following years, two other key actions in the climate mitigation efforts by Solrød Municipality were the extension of district heating areas and conversion to a renewable energy source (Straw) in Gl. Havdrup. At the national level, an enhancement of the feed-in tariff for renewable electricity in 2008 in Denmark re-sparked interest in renewable energy production, including biogas production. In 2009, 240 million DKK was set aside for an investment grant scheme to support the deployment of centralized agricultural biogas plants as part of the Green Growth agreement [13]. In March 2012, the feed-in tariff was further enhanced, and the subsidies for direct use and upgrading were equalized [13]. At the supranational and international level, a key driver for this national development was the EU renewable energy directive adopted in 2008, setting a common target of 20%
renewable energy in EU member states by 2020. Here, Denmark made a commitment to 30% renewable energy in 2020 [50]. Moreover, the COP15 climate summit held in Copenhagen in November 2009 meant that climate mitigation was very high on the political agenda in Denmark, both at the national and local level, at the time Solrød Biogas was initiated [49].

2.5. Document Collection and Analysis

The case study was initiated with an extensive collection of case-relevant documents. These documents were obtained from websites, archives, and informants who took part in the development of the project. In total, 408 documents were obtained, including official planning documents, meeting summaries, project applications, reports, and PowerPoint presentations. Following the collection of the data, documents were analyzed and categorized based on their topics and publication time. Following this categorization, the documents were analyzed again, and events were identified and entered into an event database. Here the time events occurred was registered, together with a short description, a listing of stakeholders taking part, and references [11,43,44]. Based on the event database, a timeline (Table 1) was developed through an iterative process together with an understanding of the project lifecycle [51]. After the event database was complete, a narrative could be constructed and used for the identification of CSFs and categorizing them into the different phases of the project lifecycle or as general CSFs.

Table 1. Identified key events in the project lifecycle of the Solrød Biogas project.

| Event | Month/Year | Event Description |
|-------|------------|-------------------|
| 1.    | July 2008  | Municipal heating plan presented—the idea of a biogas plant was mentioned for the first time. |
| 2.    | July 2008  | The consulting firm NIRAS finds the practice of depositing seaweed on the local beaches by the municipality problematic. A new solution is needed. A private–public beach cleaning partnership was approved by the city council. |
| 3.    | January 2009 | Pre-feasibility study options for implementation of a biogas plant. |
| 4.    | February 2009 | Applications for funding for a feasibility study were submitted to the development and demonstration program EUDP. The application was declined in mid-2009. |
| 5.    | October 2009 | Solrød Municipality presents its first climate mitigation plan. |
| 6.    | December 2009 | Application to a regional development program was submitted and approved. The project outcome will be a feasibility study where alternative locations and the economic viability of a biogas plant in Solrød Municipality are studied. The project period is one year. |
| 7.    | December 2010 | The second application to the regional development program was submitted and quickly approved. This project’s outcome includes obtaining regulatory approvals and elaborating a business case and financing plan. |
| 8.    | December 2010 | “Go ahead” decision to continue the process of implementing a biogas plant by the City Council of Solrød Municipality. |
Table 1. Cont.

| Event | Month/Year | Event Description |
|-------|------------|-------------------|
| 9.    | March 2011 | Efforts to obtain EU funding were initiated. |
| 10.   | October 2011 | The location at Åmarken 6 was selected by the City Council of Solråd Municipality. |
| 11.   | January 2012 | Approval of the amendment to the municipal plan with EIA by the City Council of Solråd Municipality. |
| 12.   | March 2012 | Approval of the Solråd Biogas Plant investment project by the EACI. |
| 13.   | May 2012 | Accountant gave a positive statement about the business and financing plan. |
| 14.   | June 2012 | Contract was signed with EACI. |
| 15.   | June 2012 | Top-management decision to continue with the second part of phase 2. |
| 16.   | August 2012 | Approval of the local plan by the City Council of Solråd Municipality. |
| 17.   | June 2012 | Negotiations with farmers, VEKS, CP Kelco, and Chr. Hansen were initiated. |
| 18.   | December 2012 | Technical advisor was selected. |
| 19.   | January 2013 | Solråd Municipality acquires the land area at Åmarken 6 from the landowner. |
| 20.   | March 2013 | Announcement of a public tender for the turnkey contract for implementing and operating Solråd Biogas. |
| 21.   | March 2014 | Contract was signed with the company Bigadan for the turnkey contract. |
| 22.   | May 2014 | A municipal guaranteed loan for Solråd Biogas was approved by the City Council of Solråd Municipality. |
| 23.   | June 2014 | Contracts were signed with CP Kelco, Chr. Hansen, and VEKS. |
| 24.   | December 2014 | Contract was signed with Bregtentved Gods. |
| 25.   | January 2015 | Construction of Solråd Biogas begins. |
| 26.   | November 2015 | Official opening of Solråd Biogas. |

Phase 3—Execution

25. January 2015 Construction of Solråd Biogas begins.
26. November 2015 Official opening of Solråd Biogas.

Semi-Structured Interviews

Before elaboration of the event database, informants who took part in the project development were contacted, and three in-depth semi-structured interviews, lasting 2–3 h, were conducted [52]. The informants included two project leaders and a project worker from Solråd Municipality. The first part of the semi-structured interviews was focused on events and challenges during the different phases of the project lifecycle and how they were managed. The last part of the interview focused on their perception of critical factors that had influenced the project’s success. The interviews were transcribed, and critical success factors were identified using the NVivo software [47].

3. Results

3.1. Event Timeline: Key Events in the Project Lifecycle of Solråd Biogas

In order to provide an overview, based on the event database, we elaborated a timeline with key events in the project lifecycle for the implementation of Solråd Biogas.
3.2. Project Lifecycle
3.2.1. Phase 1—Conceptualization

The idea for Solrød Biogas first emerged in 2008, driven mainly by two concerns: first, local determination to contribute to both mitigation of climate change and sustainable use of natural resources, and second, the problem of seaweed fouling on local beaches, annoying neighbors and visitors (Events 1, 2).

The idea of a biogas plant was already mentioned in the 2008–2012 municipal heating plan presented in 2008. The plan states that the municipality, together with local stakeholders, is preparing a concept study clarifying the availability of local feedstock for biogas production, including seaweed from local beaches (Event 1).

As part of the implementation of the heating plan, Solrød Municipality decided to initiate a preliminary study of the opportunities for the implementation of a biogas plant for handling seaweed, sludge, pectin residues, and other local feedstocks. Initially, only biomass from within the municipal borders was considered, but this changed with a revision of the heat plan in January 2009 (Event 3). In February 2009, an application was submitted to the Energy Technology Development and Demonstration Program (EUDP) with the aim of preparing a feasibility study. After being evaluated, the application was denied, as there was not enough focus on technology development (Event 4). In the municipal Climate Plan 2010–2025, presented in October 2009, biogas production was mentioned as a key climate action (Event 5).

In the summer of 2009, Solrød Municipality decided to apply to the regional development fund VækstForum Sjælland for support (Event 6). A new application was thus prepared. The project again aimed at elaborating a feasibility study for the deployment of a centralized biogas plant in Solrød Municipality. The project application was quickly approved, and the project started in January 2010, with a project duration of 12 months. Solrød Municipality was the project coordinator, and several universities and knowledge institutions, together with the food manufacturing company CP Kelco, were project partners (Event 5). Among other things, the project included deliverables such as testing the biogas yield in different feedstocks, techno-economic assessments of different business concepts, and the identification of suitable sites where a biogas plant could be implemented (Event 6).

In November 2010, work on the feasibility study was completed with input from project partners. In the final feasibility study report, two sites were identified based on a screening of spatial planning conflicts and transport analysis of feedstock. One was an onsite biogas plant at CP Kelco in Køge Municipality, where the biogas could be utilized for industrial processes, and another site was in Solrød Municipality, where the biogas could be used for CHP production by the district heating company VEKS (Event 6).

Overall, the feasibility study concluded that a biogas plant with feedstock from local manure, pectin residues from CP Kelco, and seaweed from local beaches would have multiple environmental, economic, and socioeconomic benefits. It was therefore recommended by the project team in Solrød Municipality that works on establishing a biogas plant should continue (Event 6, 7). Based on the positive findings from the feasibility study, the City Council in Solrød Municipality decided to continue the project development process in December 2011 (Event 6, 7).

3.2.2. Phase 2—Planning

A second application to the regional development fund VækstForum Sjælland was therefore prepared and submitted in December 2010. The project application was again quickly approved, and the second regional development project started on 1st February 2011. The project duration was 18 months this time, and again Solrød Municipality was the lead partner, but this time only Roskilde University and Grønt Center were included as project partners. The main aim of the new project was the specification of concepts for the biogas plant, a decision on plant location, preparation of data required for obtaining regulatory approvals, and, finally, elaboration of a business case study and financing plan (Event 8).
On 20 June 2011, a public meeting took place as part of the call for ideas and suggestions, a component of the EIA screening process. Over the next six months, the project team worked on the EIA together with the consulting firm PlanEnergi (Event 9).

While these activities were well underway, members of the project team traveled to Brussels in April 2011 for Sustainable Energy Week to obtain more information about the MLEI-PDA funding program. Following this trip, elaboration of an application was quickly initiated by the project team, and in August 2011, after an application was submitted, the project team was invited by the MLEI-PDA to enter negotiations regarding project funding. If the negotiations were successful, the project would receive EU funding for preparing investments in the biogas plant.

In June 2011, work on the amendment to the municipal plan with EIA was initiated. Following the call for ideas and suggestions as part of the EIA screening process, the City Council, in October 2011, approved the site at Åmarken 6 as the location where Solrød Biogas would be implemented. In January 2012, the City Council of Solrød Municipality approved the amendment to the municipal plan with the EIA attached (Event 10, 11), and in August 2012, the new local district plan for the area at Åmarken 6 was also approved (Event 13).

At the same time, in March 2012, negotiations with EACI, the secretariat administrating the MLEI-PDA program, were finalized, and the Solrød investment project was approved. The contract was signed in June 2012, and then the Solrød investment project could be initiated. One of the requirements of the MLEI-PDA program was that a turnkey contract was signed within the following two years, and things thus needed to move forward quickly (Event 11, 12). In mid-2012, negotiations began with farmers, CP Kelco, and Chr. Hansen to supply biomass feedstock and with VEKS for the use of biogas for CHP. These negotiations continued for the next two years (Event 14).

Moreover, at the end of 2012, the company Gascon was selected as a technical advisor after a procurement process. At the start of 2013, Solrød Municipality reached an agreement to buy the land at Åmarken 6 after a long negotiation with the landowner over price (Event 15).

In March 2013, the procurement for a turnkey contract for the implementation and operation of Solrød Biogas was announced (Event 16). Three companies were subsequently selected to enter negotiations.

Negotiations were completed in March 2014, and a turnkey contract was signed with the company Bigadan (Event 17). In May 2014, a municipal loan for financing the project was approved by the City Council, and a month later, in June 2014, contracts were also signed with CP Kelco, Chr. Hansen, and VEKS (Event 18, 19).

However, an agreement about spreading a big share of the digestate was still lacking if the biogas plant was to be realized: because of the large input of agro-industrial feedstock, more farmland and storage capacity was needed than the farmers delivering manure to the biogas plant had at their disposal. Finally, in December, an agreement was reached with the big farming estate Bregentved Gods. The agreement meant that Solrød Biogas would supply Bregentved Gods with 80,000 tons of digestate annually (Event 23).

3.2.3. Phase 3—Execution

In January 2015, construction began of Solrød Biogas, and in November of the same year, the official inauguration took place, with the red ribbon being cut by Solrød Municipality Mayor Niels Hørup together with the then Danish Minister of Energy, Utilities and Climate, Lars Christian Lilleholt, and Vincent Berrutto from the European Commission Directorate General for Energy. At the inauguration, Vincent Berrutto declared that the Solrød Biogas plant was an inspiration for other local communities and an example that others could learn from (Event 24, 25).
3.3. Identifying Critical Success Factors for Deployment of Solrød Biogas

By applying the analytical framework to the collected data, we were able to identify the following critical success factors (CSFs) influencing the successful deployment of Solrød Biogas.

3.3.1. Phase 1—Project Conceptualization
CSF 1: Emergence of the Project Idea (D, C)

The idea of implementing a biogas plant in Solrød Municipality started to emerge during work on the municipal heating plan in 2008 (Event 1). The project initiators working on the plan knew the municipality was interested in finding a new solution for handling seaweed collected from local beaches (Event 2) and were analyzing different options for implementing increased renewable energy production in the municipality to accelerate local climate mitigation. The idea of utilizing the seaweed for biogas production would thus be a win–win solution. Moreover, they knew from work on previous projects, where they had mapped the biomass potential in the Zealand Region, that the company CP Kelco had large amounts of citrus peel residue from their production of pectin that could maybe be used.

CSF 2: Promotion of the Project Idea (C, D, F)

At this very early stage of the project lifecycle, where the project idea had not yet received any support from top management, their promotion of the project idea was critical. The small group of project initiators was enthusiastic about the project idea, and all had long experience with sustainable energy planning and project management in general, which meant they had access to and knew how to approach top management (Event 3).

CSF 3: Support from Top Management (B)

The project was initiated at the right time when climate mitigation was high on the political agenda both locally and nationally (See Section 2.4.2). Solrød Municipality also needed a new solution for handling seaweed collected from local beaches because depositing on the beaches was no longer an option. The multiple benefits that the biogas plant provided meant the project idea came at an opportune moment and quickly gained support from top management in both the administration and the City Council. In early 2009, a “go ahead” to investigate the idea further was thus given. The support from top management meant that more work time could now be used to ensure financial resources for phase 1, so the project idea could move forward. Moreover, the project idea was included as a key action in the climate mitigation plan the municipality had started work on in early 2009 (Event 3, 5).

CSF 4: Building a Collaboration Platform (D, E)

After support was obtained from top management, things slowly started to move forward. The project initiators had a large amount of knowledge about how to obtain funding from different development programs from previous projects and a good network of contacts in regional industries, energy companies, knowledge institutions, and advisory firms. A strong project consortium was built consisting of Solrød Municipality, Roskilde University, Aarhus University, Copenhagen University, CP Kelco, VEKS, and Rambøll, who, together, were able to contribute insight and knowledge about different aspects relating to the implementation of biogas plants. An application was first submitted to EUDP in February 2009 but was denied in mid-2009. The project consortium was, however, not deterred and quickly started to develop a new application to the regional development program—Vækstforum Sjælland (Event 4, 6).

CSF 5: Defining a Project Mission and Creating Common Understanding (A, E)

After the collaboration platform had been established, a shared vision slowly started to emerge between the members of the consortium. It was essential at this point that all
partners, especially VEKS and CP Kelco, could see how the project would benefit their organizations. For VEKS, the biogas plant would provide renewable heating for their district heating network, covering most of greater Copenhagen, and for CP Kelco, the biogas plant would provide an opportunity to recycle citrus residue from their pectin production. Previously, the residue was used for cattle feed, but the number of cattle had been decreasing in Region Zealand for several years, and it was also expensive to transport the residue to other regions in Denmark. The key benefits for Solrød Municipality were, as we already pointed out, reductions in GHG emissions and the handling of seaweed from local beaches (Event 4, 6).

**CSF 6: Ensuring Financing for Phase 1 (A, H)**

After the application to EUDP was declined, the preparation of a new project application to a regional development program was initiated at the end of 2009. The experience and network of the project consortium were essential for coordinating the application process for both the EUDP and the regional development program. The project application also meant that Solrød Municipality would need to make an economic commitment to the project idea by providing 25% of the total project budget through self-financing. The project idea of implementing a biogas plant in Solrød Municipality was now slowly moving forward (Event 6).

**CSF 7: Feasibility Study (J)**

In December 2009, the project application received final approval from the regional development program, and in January 2010, the project was initiated, with a duration of 12 months. The main aim of the first regional development project was to elaborate a feasibility study for the implementation of a biogas plant in Solrød Municipality. The broad knowledge of the project consortium meant that a comprehensive analysis could be conducted. The main deliverables of the project were the mapping of local biomass feedstock and batch testing to determine their biogas yields, assessing different options for collecting and pre-treatment of seaweed, finding suitable sites where the biogas plant could be implemented, and assessing the techno-economic feasibility—including different options for the use of the biogas. Finally, the project would also assess environmental benefits, including a reduction in GHG emissions.

Through the mapping of local biomass feedstock and the testing of their biogas yields as part of the feasibility study, it was estimated that approximately 5.4–6.3 million tons Nm$^3$ of methane could be produced annually from the locally available biomass feedstock, and it became clear that the 77,000 tons of citrus residue from CP Kelco, in particular, would be essential, contributing 75% of the estimated annual methane production. Further, two alternative sites were pinpointed as suitable for implementing a biogas plant: one in Solrød Municipality near the VEKS district heating infrastructure owned by VEKS, where the biogas could be utilized for CHP, and another onsite at CP Kelco, where it could be used for industrial processes. CAPEX and OPEX were also estimated for both options and found to be economically viable. Finally, the feasibility study also concluded that a biogas plant would mean a reduction in GHG of between 35,000 and 40,000 tons annually. Through its collaborative efforts and broad knowledge relating to different aspects of the implementation process for biogas plants and other types of renewable energy technologies, the project consortium was able to uncover the many positive benefits that a biogas plant would provide. Elaboration of a feasibility study was, thus, a distinguishing CSF in receiving the “go ahead” to move to phase 2 and in providing the data for initiating the regulatory approval process (Event 6).

**CSF 8: Communicating Benefits to the Local Community (F)**

In phase 1, the project team was good at communicating the project vision and its multiple benefits to the surrounding community through the local newspaper and newsletters. In particular, the collection of seaweed from local beaches using innovative machines was...
highlighted in many news stories. This helped strengthen support in the local community for the project as seaweed on local beaches was causing odor problems and meant that the beaches were hard to use for bathing and other recreational activities.

CSF 9: Ensuring Financing for the First Part of Phase 2 (H)

During the last part of the feasibility study at the end of 2010, the project team, through their experience from previous projects, knew that it was important to start efforts to ensure financial funding for the first part of phase 2 if the project was to move forward. An application for a follow-up project was therefore elaborated and sent to the regional development program in the last part of phase 1. The project duration of the follow-up project was set for two years, starting on the first of February 2011. It had three work packages. The first was focused on the analysis and determination of issues related to pre-treatment and transportation of biomass to and from the biogas plant, with emphasis on the testing of equipment for seaweed collection and pre-treatment. The second focused on the elaboration of the business and financing plan for the biogas plant, including a detailed activity plan for phase 3 and issuing of the regulatory permissions. Finally, the third focused on activities related to the dissemination of the project’s results. The project application was approved in December 2010 by Vækstforum Sjælland (Event 7).

CSF 10: Receiving the “Go Ahead” to Move to Phase 2 (B)

Due to the feasibility study highlighting the multiple benefits provided by a local biogas plant and because financing for starting phase 2 was already ensured, top management in the administration and political councils gave their full support for the “go ahead” to move to phase 2. The project idea was now moving from just being an idea to becoming a reality (Event 8).

3.3.2. Phase 2—Project Planning

CSF 11: Obtaining the Regulatory Approval “Right” the First Time and without Delays (K, G)

Shortly after the follow-up project was initiated at the start of 2011, it was quickly determined by Solrød Municipality that an EIA (environmental impact assessment) was required for the project. Work on the EIA was thus initiated shortly after, in June 20211, with a call for ideas and suggestions from the public, together with the process for approving an amendment to the municipal plan for the site at Åmarken 6. The amendment to the municipal plan with the EIA attached was approved by the City Council a few months later, in January 2012. The process for approving a new local district plan for the site where the biogas plant was to be implemented was initiated at the start of 2012 and also included a public hearing. The new local district plan was approved in August 2012. Thus, a little over a year after the regulatory approval process had been initiated, all spatial planning permissions had been acquired for the project without any delays. This can also be highlighted as a distinguishing CSF (Event 10, 11, 16).

CSF 12: Communicating Benefits to Local Communities (F)

During the planning phase, communication about the project development continued to be disseminated to the local community. This happened through a homepage that was established in mid-2013 and also allowed visitors to subscribe to a newsletter with information about the project. Several success stories were also published in local and regional media about the project’s achievements and multiple benefits.

CSF 13: Giving “Real Choices” in the Public Hearing Process (G, K)

The regulatory approval process was initiated in June 2011 with a call for ideas and suggestions for the EIA as described above. This call also included a public meeting at the town hall of Solrød Municipality, where the project idea was presented to the local community. The main topic at the meeting was where the biogas plant should be implemented. The local community preferred the location at Åmarken 6, and subsequently,
this site was selected by the City Council in October 2011. Giving the public a “real choice” was emphasized as the most distinguishing CSF by one of the informants and the reason there was almost no NIMBY opposition (Event 10, 11).

CSF 14: Ensuring Financing for the Second Part of Phase 2 (H)

As in phase 1, the project team knew that securing external funding would be valuable for moving the project forward to the second part of phase 2. The EU program “Mobilizing Local Energy Investment (MLEI)” was identified in early 2011 and shortly after an application was submitted in mid-2011. The Solrød Biogas project consortium was then invited to enter negotiations with the EACI administering the MLEI program, and in March 2012, the project was approved. Obtaining the funding from MLEI contributed to framing the biogas project as a local success story and enhanced the support from top management, which could now also use the project as an example of innovative work being carried out in the municipality (Event 9, 12, 14).

CSF 15: Obtaining Accurate Data and Assessing Viability of the Business and Financing Plan (J)

For Solrød Municipality to commit to implementing a biogas plant, it was essential that the project be economically viable. Therefore, extra efforts were spent on mapping the local availability of biomass feedstock and testing the biogas yields from local biomass instead of just using standard values. This was performed to provide as accurate data as possible for the preparation of the business plan for the biogas plant. In order to assess the economic viability of the business plan, Solrød Municipality wanted an accountant with previous knowledge of the economy of biogas plants. One was identified who had handled the bankruptcies of Nysted Biogas and Morsø Bioenergi and thus knew what to be aware of and what could lead to biogas plants not being profitable.

The solid work carried out in both phases 1 and 2 meant that the business plan budget was well prepared. The accountant thus did not find any indicators during his assessment that the budget contained any incorrect assumptions. Obtaining this positive statement from the accountant was a distinguishing CSF in the deployment of the biogas plant (Event 13).

CSF 16: Receiving the “Go Ahead” to Start the Second Part of Phase 2 (B)

The regulatory approval process being well on the way, the lack of NIMBY opposition, the external funding obtained from the MLEI program, and the positive statement from the accountant, together, paved the way for the project to receive the go-ahead to move forward to the second part of phase 2. On 1 June 2012, the Solrød Biogas Plant Investment Project was initiated, and a kick-off conference was held the following day, marking the beginning of phase 3—execution (Event 15).

CSF 17: Ensuring a Good Result from Negotiations (E, I)

Shortly after the initiation of the second part of phase 2, negotiations began with biomass suppliers and energy companies interested in buying the biogas. Negotiations with VEKS and CP Kelco, which both had been a part of the project steering group from phase 1 and clearly knew how the biogas project would benefit their own core businesses, proceeded quite easily. On the other hand, negotiations with Chr. Hansen and local farmers, who had first been approached in the first part of phase 2, were harder. Several informants agreed that it would have been good if the farmers, in particular, had been approached earlier in phase 1 and had been part of the project steering group from the beginning (Event 17).

CSF 18: Making a Deal to Buy the Land Area at the “Right” Time (J)

One of the dilemmas that arose from not settling on one specific site for implementing the Solrød biogas plant but instead giving the public a “real choice”, was that negotiations with the landowner of the final location ended up being quite difficult because the landowner wanted a much higher price for his land than the average price for similar
farming land in the area. Eventually, a deal was made with the help of a legal mediator (Event 19).

CSF 19: Ensuring Project Financing (H, J)

In this phase of the project, it was also essential that a financing solution was found. Solrød Municipality had, at this point, decided to become the sole owner of Solrød Biogas without any co-owners and provide a guarantee for a municipal loan. The municipal loan was provided by the organization KommuneKredit, which offers loans for infrastructure projects in Danish municipalities with an attractive interest rate. Financing was also ensured through the funding from MLEI for preparing the investment in the biogas plant (Event 22).

CSF 20: Agreement on Ownership Structure (E, K)

After exploring different ownership options, the City Council in Solrød Municipality decided that it was willing to take on the role of the sole owner of Solrød Biogas. The gas motor where the biogas would be utilized for the production of CHP would, however, not be owned and operated by the municipality but by the district heating company VEKS. The multiple benefits expected from the project, together with the successful outcome of phases 1 and 2, and the momentum the project had already achieved no doubt paved the way and made it an easy decision for top management in the administration and political councils to back this decision.

CSF 21: Finding Farmland and Storage Capacity for the Digestate (E)

Because Solrød Biogas received most of its biomass feedstock from regional food and ingredients industries—79,400 tons of pectin residue from CP Kelco and 60,000 tons of eluate residue from Chr. Hansen—it was necessary to find farmers who were interested in receiving the digestate and had the storage capacity. Most of the farmers who signed contracts to supply manure were only interested in receiving back the same amount as they supplied. This was a big problem for the project as it was difficult to identify farmers who were interested in receiving large amounts of digestate. If a solution was not found, it would mean that the project would be set on standby or abandoned. At the last minute, in December 2014, a deal was made with the Bregentved Gods to receive 80,000 tons annually of digestate from Solrød Biogas and implement extra storage capacity. The need for implementing or finding extra storage capacity for digestate was underlined by the informants as a CSF that project developers of agro-industrial biogas plants especially should pay attention to (Event 23).

CSF 22: Obtaining a Technical Advisor with In-Depth Knowledge of Implementation of Biogas Plants and Procurement Processes (I)

After the execution phase had been initiated, one of the first steps was to start the procurement of a technical advisor that could assist in the coordination of the procurement process for the turnkey contract and technical issues. Here, it was a priority to select an advisory company with previous in-depth knowledge of the procurement process for the implementation of biogas plants, and in the end, the company Gascon was selected. In October 2013, the procurement process for the turnkey contract for Solrød Biogas was initiated. The public tendering was carried out as a competitive negotiated procedure, where only those companies selected through pre-qualification could submit a tender and enter negotiations. In this process, three companies were selected to enter negotiations, and ultimately the company Bigadan was selected to implement and operate Solrød Biogas for five years. The contract was signed in March 2014 (Event 18).

CSF 23: Receiving the Go-Ahead to Start Construction (B)

Top management was, at this point, very supportive and invested in seeing the project succeed and did not back out even as negotiations with Bregentved Gods became more difficult, and it became necessary to provide an additional municipal loan for the
implementation of storage capacity for the digestate. This was probably because they had been engaged from the beginning and shared the project vision, and had insight into the multiple benefits that it would provide (Event 20, 21, 22, 23, 24).

3.3.3. Phase 3—Project Execution
CSF 24: Supervising the Quality of the Construction Work (I)

The construction of Solrød Biogas proceeded without any major problems or delays, and operations could therefore start in August 2015. Bigadan’s many years of experience with implementing biogas plants in Denmark were essential to this, underlining the importance of selecting a technical advisor with in-depth knowledge of the biogas sector for coordination of the procurement process, taking part in negotiations, and ensuring the quality of the construction work (Event 25, 26).

3.3.4. General CSFs
CSF 25: Open and Collaborative Project Organizational Structure (A, C, E)

The project’s organizational structure was essential to the project’s success (PS). In phase 1 in 2009, a project steering group was assembled with top management representatives from the stakeholders VEKS and CP Kelco and top management from Solrød Municipality, together with the project manager of the project team in the Solrød Municipality administration. The role of the project steering group was to monitor the progress of the project and to give their support when central decisions were needed during the project lifecycle, especially at the key decision points in CSF 8 and CSF 15 about proceeding with the project (See Figure 1). Moreover, a project management committee was assembled, which was responsible for the daily coordination of the project at Solrød Municipality, along with an interdisciplinary committee consisting of the technical advisor and Roskilde University that could provide input to the project management committee on complex issues during phase 2. Finally, the project organizational structure consisted of five working groups that were formed to handle different aspects of the project development: (1) Regulatory Approvals Group, (2) Procurement Group, (3) Seaweed Group, (4) Agricultural Group, and (5) Economy and Company Group [41,53].

| Phase 1 | Phase 2 | Phase 3 |
|---------|---------|---------|
|          |          |         |

![Figure 1](image-url). Linkages between identified events in the Solrød Biogas project. See description of events 1–26 in Table 1.

CSF 26: Objective-Oriented Project Planning (A, C, D)

The project initiators chose to apply an objective-oriented project planning approach (OOPP) and also had a solution-oriented mindset. This meant that when problems were
encountered during project development, the focus was on how these problems could be solved or turned into opportunities that could benefit stakeholders. One of the ways this was accomplished was by inviting people with special knowledge about the problem to meet or join the interdisciplinary committee for a short duration until a solution was found. The initiators were always trying to find solutions and looking for ways forward [41].

**CSF 27: A Shared Vision (A, D)**

The project initiators successfully created a strong vision and shared it with both top management and stakeholders from other organizations. The multiple benefits that were identified through the feasibility study and the use of the OOPP approach meant that all stakeholders were able to see themselves in the project vision. For the project team in Solrød Municipality, the many environmental benefits seem to have been the strongest motivation in their work to try to implement the biogas plant. The shared vision created a clear direction and purpose and meant that the project team was persistent when challenges were encountered and were active in obtaining new knowledge needed for upcoming work tasks.

**CSF 28: Use of a Project Document—The Biogas Planning Tool (F)**

In order to ensure that all stakeholders and members of the project consortium agreed on the central data assumptions and plans for establishing the biogas plant, a project document (Excel sheet) was used. The project document showed the expected biogas production based on the planned biomass input and biogas yields and expected CAPEX and OPEX costs, together with the expected annual revenue. The project document could quickly show how changes in the planned biomass input or assumptions about the biogas yields would influence the annual revenues. The project document thus ensured that everybody agreed on the central data assumptions and was on the same page. Moreover, it provided the data for the business and financing plan (CSF 15). The project document was later developed into a biogas planning tool for project owners [41,53].

**CSF 29: Transparent Project Communication (F)**

Transparent communication was essential to the project development. Thus, all permanent members of the interdisciplinary committee were included in all email correspondence important for the development of the project. This meant that the interdisciplinary committee had full insight and could always provide support when it was needed [41].

**CSF 30: Competencies and Experience of the Project Team (C)**

The project team was comprised of employees with many years of experience in and skills linked to planning renewable energy plants and regulatory approval processes in municipalities. They also had solution-oriented problem-solving mindsets, which meant they were not deterred when challenges were met and kept believing in the project vision. This also meant that they, ad hoc, were able to obtain new knowledge when it was needed and had the communication and leadership skills to inspire stakeholders. Through their many years of experience, they also had large networks, which meant they knew how to find the answers to complex technical or legal issues and had both access to and knew how to communicate their project ideas to top management.

4. Discussion

As discussed at the start of this article, many biogas projects are abandoned during the project lifecycle, often after many resources and much time has been invested. With the need to accelerate biogas production, both in Denmark and the rest of the EU, there is a need to better understand how this can be avoided. In this article, an in-depth case study of the best-practice case Solrød Biogas was conducted with the aim of identifying CSFs in the different phases of the project lifecycle, hereby hopefully proving insights that can help
project managers ensure that more biogas projects are successfully implemented without project prolongations in both Denmark and elsewhere in the future.

In the Solrød Biogas case, the local and regional context of general advocacy for local climate action provided the background for the attempt to deploy the biogas plant. Moreover, the national context of the framework condition for deploying direct use of biogas was improved with the enhanced feed-in tariff as part of the new energy act in 2008 and an investment grant scheme established as part of the Green Growth agreement in 2009. This context created the environment from which the project idea emerged and was, of course, essential. Even though the context provided a good opportunity, it took the visionary thinking and belief in the project idea by the project initiators for the project to emerge and gain momentum in phase 1—conceptualization. The first step was gaining support from top management/the City Council for preparing an application to the innovation program EUDP. One of the keys to the support from top management was that the project, besides reducing local GHG emissions, also provided an innovative solution for handling local seaweed. The first application to EUDP was, however, denied as the project idea was not found to provide enough technological innovation—the main aim of the EUDP program. The next application to the regional development program Vækstforum Sjælland, submitted shortly hereafter, was, however, approved, and a one-year project aimed at preparing a feasibility study of the opportunities for deploying a biogas plant in Solrød Municipality was initiated. This feasibility study, which was prepared by the partners in the project, was a distinguishing CSF as it provided the data needed by top management to decide whether they should give the go-ahead for moving the project forward to phase 2. The momentum for overcoming this decision point (CSF 10) in the project lifecycle was, of course, also influenced by other CSFs identified in phase 1; here, defining the project mission and building a collaboration platform can also be highlighted. The feasibility study provided mapping of local and regional biomass feedstock, identified suitable sites for the deployment of a biogas plant in Solrød Municipality, together with options for the use of the biogas (direct use for CHP, upgrading, use in industrial process, and transport) and techno-economical assessments of different business concepts. These are also some of the components that distinguish biogas projects from many other types of projects. Unlike, for example, fossil energy projects where coal or oil is typically imported, biogas projects rely primarily on local biomass feedstock (waste, leftovers, and side streams) found within 20–30 km of the selected site and on farmland for the spreading of the digestate. Furthermore, the options for the use of biogas also depend on the local and regional energy infrastructure. This means that stakeholders involved in biogas projects are typically locally or regionally based. In the past 10 years, however, national energy companies such as E.ON and NGF Nature Energy have also been engaging in the biogas projects in Denmark but are still in close collaboration with local stakeholders. The Solrød Biogas case also draws attention to the importance of funding programs aimed at preparing investment in renewable energy projects (e.g., by providing funding for conducting feasibility studies). The complexity of biogas projects requires collaboration between many different stakeholders and clarification of many specific issues; here, the feasibility study is invaluable in ensuring that non-viable biogas projects are not moved forward to phase 2 and in clarifying the many uncertainties that are especially found in the conceptualization phase. After the decision to move the Solrød Biogas project forward to phase 2 was made, the feasibility study in the Solrød case also provided the data needed for initiating the regulatory approval process. The first step in this regulatory approval process was the call for ideas and suggestions as part of the EIA process. As part of this process, a public meeting was held in the town hall. Here, the project idea was presented, and the different suitable sites that had been identified were discussed with members of the local community. Based on the ideas and suggestions from the public during the hearing, the City Council decided on the site where the biogas plant has since been constructed. Giving the public a “real choice” and the opportunity to influence the site selection during the pre-hearing process was stressed as the most distinguishing CSF by one of the informants. One reason for
this is that it may have created a feeling of procedural justice and helped gain the trust of the local community. Public funding programs also played a key role in moving the project forward in phase 2. In the first part of phase 2, it was funded through the regional development program Vækstforum Sjælland, and in the second part, it was the EU MLEI (Mobilizing Local Energy Investments) program. This shows the importance of these kinds of funding programs, not only aimed at technological innovation but also at supporting the development of specific local renewable energy projects. The positive statement from the accountant was also a distinguishing CSF as it paved the way for the City Council to approve a municipally guaranteed loan. Finally, in the last part of phase 2, the selection of a technical advisor with in-depth knowledge of the biogas sector that could support Solrød Municipality during the procurement process was essential. The selection of a technical advisor to support the negotiations with local farmers regarding the delivery of feedstock and supply of digestate was also important for the project’s success (PS). The general CSFs provide insight into the project management approach of the project team in the Solrød Biogas case. The project vision here can be a highlight as a distinguishing CSF, providing the motivation to keep going when challenges were encountered. Moreover, the use of the project document—the biogas tool was a distinguishing CSF that can be recommended to other projects, as it ensured that all members of the project consortium could see the data sources used for assessing the economic viability of the project and quickly see how changes, e.g., in the feedstock mix, would affect biogas production.

The development of a biogas project is a very complex process and often also very time-consuming; in the Solrød Biogas case, it took around 6–7 years. After the accelerated deployment of biogas production in Denmark between 2008 and 2020, the biogas sector is now quite well established; it has, however, taken a very long time to progress to this point. If biogas production in the EU is to be quickly accelerated in the same way in the coming years, it is important that a larger proportion of projects are successfully completed. The CSFs identified in the Solrød Biogas case provide insight into some of the potential CSFs that project managers should pay attention to in the different phases of the project lifecycle of the deployment of centralized biogas projects and general CSFs in the project management.

5. Conclusions

The aim of this study was to investigate what non-technological critical success factors influence the different phases of the project lifecycle for the successful deployment of centralized biogas plants. In total, we were able to identify 30 critical success factors that have either been linked to different phases of the project lifecycle or categorized as general CSFs in the case of Solrød Biogas (See Figure 2).

In phase 1, the feasibility study (CSF 9) can be considered a distinguishing CSF, which allowed for identifying suitable sites, mapping potential biomass feedstock, and making techno-economical assessments of different business concepts. This study provided the data needed for deciding if the project should move forward to phase 2.

In phase 2, giving the local community an opportunity to voice their opinion about different potential sites was also a distinguishing CSF (CSF 13). Other distinguishing CSFs in phase 2 that should be paid special attention to were the quick regulatory approval process (CSF 11), the positive financial statement from an accountant with insight into the economy of biogas plants (CSF 15), and the selection of technical advisors with in-depth knowledge of the biogas sector (CSF 22).

The literature review showed that there is a need for a better understanding of the CSFs linked to different phases of the project lifecycle for the deployment of biogas technology, but also for bioenergy technology and renewable energy technology in general. This study attempted to fill out a little of this knowledge gap, but there is still a need for more research within this area, especially into CSFs, to gain the trust and support of local communities.

We hope that the CSFs identified in this study can support future project managers and contribute to theorizing linked to successful management of the development of biogas projects and renewable energy projects in general. Moreover, we hope that the insights
from this study will enable governments to better support biogas projects, especially during phase 1 and the beginning of phase 2, where there are most project uncertainties, and thereby contribute to higher rates of projects being successful and accelerating the deployment of biogas technology and the transition to climate-neutral energy systems.

Figure 2. CSF categorized into the different phase of the project lifecycle or as general.

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