DOCTORAL THESIS

Co-Designing Energy Transition in Cultural Heritage Districts

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Architecture

LULEÅ UNIVERSITY OF TECHNOLOGY

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Abstract

The accelerating transition towards renewable energy presents an opportunity to create sustainable urban environments. Growing concerns about energy security and resilience are driving a move towards decentralised, small-scale electricity generation that is closer to end users, particularly in urban areas. These end users can act as *prosumers*, a term that combines producers and consumers of renewable energy. In this context, advancements in photovoltaic systems, along with increasing electricity demand, underscore the potential of renewable energy to transform urban spaces sustainably.

In this thesis, it is investigated how small-scale photovoltaic systems can be sensitively and effectively integrated into *cultural heritage districts*. These environments face the dual challenge of meeting sustainability goals while safeguarding material and intangible heritage values. The study addresses two key research questions: (1) How can *participatory design* methods be created to address barriers and facilitators when prosumers, as key stakeholders, are included in the processes for urban energy transition within cultural heritage districts? And (2) what are the barriers and facilitators of urban energy transition in such contexts?

The integrated framework conceptualises heritage districts as complex socio-technical systems in which diverse stakeholder values, institutional frameworks, and material constraints interact. The research explores how participatory processes can mediate between competing objectives, technological innovation, aesthetic coherence, and cultural continuity, while enabling equitable decision-making and contextually adapted design outcomes.

Methodologically, the study employs a qualitative abductive analysis research project centred on three case studies in Sweden: Porsön in Luleå, Öjeby Church Town in Piteå (both in Norrbotten), and Södertorg (the South City Square) in Visby, Gotland. These sites were selected for their solar potential, heritage contexts, and varying conditions. Across these cases, a series of participatory design workshops were conducted to engage potential prosumers, local authorities, heritage professionals, and energy experts in co-designing *photovoltaic* interventions. Through dialogue and design experimentation, the research tested and refined participatory methods for heritage contexts.

The results reveal that involving residents and local actors early in the design process enhances better social acceptance and contextual

appropriateness. At the same time, expert input remains essential to ensure technical feasibility and aesthetic quality. Furthermore, energy transition can act as a catalyst for urban renewal, strengthening the attractiveness, accessibility, and sustainability.

The research contributes, both theoretically and practically, to the fields of sustainable urbanism, heritage conservation, and participatory design research. It establishes that a normative, value-driven participatory design approach, situated within a communicative and complex systemic perspective, can bridge the gap between conservation and innovation.

The study shows that advanced participatory design in *urban living labs* facilitates the design processes. Future efforts could include qualitative assessments and quantitative analyses of energy performance to develop a guideline manual for decision-makers and planners. Finally, the thesis calls for revising existing policies, regulations, and heritage management instruments to support context-sensitive renewable energy integration.

Sammanfattning på Svenska

Omställningen till förnybar energi kan ge möjligheter att forma framtida hållbara städer. Ökade krav på energisäkerhet och resiliens driver en utveckling mot en decentraliserad och småskalig elproduktion närmare slutanvändare, särskilt i stadsmiljöer. Dessa slutanvändare kan agera som *prosumenter*, ett begrepp som kombinerar producenter och konsumenter av förnybar energi. I detta sammanhang utgör en ökad elanvändning samt den tekniska utvecklingen inom solcellssystem en betydande potential.

Denna avhandling utforskar hur deltagande design kan stödja aktörer i att gemensamt genomföra en varsam och ändamålsenlig integration av *solcellssystem* i *kulturmiljöområden*. Dessa miljöer står inför en dubbel utmaning: att uppfylla samtida krav på hållbarhet och livskvalitet samtidigt som materiella och immateriella kulturvärden bevaras. Forskningsproblemet behandlar hur energiomställningen kan förenas med en varsam och kontextuellt anpassad integrering av solceller i byggda miljöer, genom deltagande designprocesser som beaktar lokala värden, kulturhistoriska kvaliteter och intressenters perspektiv.

I studien utvecklas ett integrerat ramverk där kulturarvsdistrikt förstås som komplexa sociotekniska system, inom vilka olika aktörers värderingar, institutionella ramar och materiella förutsättningar samverkar dynamiskt. Mot denna bakgrund analyseras hur deltagande och kommunikativa processer kan mediera mellan delvis motstridiga mål såsom teknisk innovation, estetisk utformning och kulturell kontinuitet, samtidigt som demokratiska beslutsprocesser och kontextanpassade gestaltningslösningar möjliggörs.

Metodologiskt bygger studien på en abduktiv, kvalitativ forskningsansats med tre fallstudier: Porsön i Luleå, Öjebyns kyrkstad i Piteå (Norrbotten) samt Södertorg i Visby (Gotland). Dessa platser har valts utifrån deras höga solenergipotential, skilda kulturhistoriska sammanhang samt varierande sociala och institutionella förutsättningar. Inom ramen för respektive fall genomfördes en serie workshops i *deltagande design* där boende gemensamt utvecklade och prövade möjliga solcellsintegrationer. Separata workshops med kommunala företrädare, kulturmiljöexperter och energispecialister genomfördes också.

Resultaten visar att tidig involvering av framtida prosumenter och lokala aktörer i en samskapande process stärker den sociala acceptansen och bidrar till mer kontextuellt förankrade lösningar. Samtidigt framträder betydelsen av

expertkunskap för att säkerställa teknisk genomförbarhet och arkitektonisk kvalitet. Fallstudierna visar vidare att energiomställningsinitiativ kan fungera som katalysatorer för bredare stadsförnyelseprocesser genom att öka attraktionskraften, tillgängligheten och den långsiktiga hållbarheten i kulturarvdistrikt.

Avhandlingen bidrar såväl teoretiskt som praktiskt till forskningsfältet kulturarvsstudier. Den visar att en normativt grundad värdeorienterad deltagande- och samskapandeansats, förankrad i ett kommunikativt och komplexitetsteoretiskt perspektiv, kan överbrygga motsättningen mellan bevarande och innovation.

Baserat på studien rekommenderas en fortsatt utveckling av deltagande design inom ramen för *urbana testbäddar*. Ett förslag är att etablera en virtuell testbädd där olika scenarier för solcellsintegration kan simuleras, utvärderas och förfinas i samverkan med olika aktörsgrupper. Framtida forskning bör kombinera olika kvalitativa metoder för att studera gestaltningsmässiga och sociala effekter tillsammans med kvantitativa analyser av energiprestanda, med målet att utveckla en handbok med riktlinjer för beslutsfattare, planerare och prosumenter.

Avslutningsvis argumenterar avhandlingen för behovet av att vidareutveckla befintliga policyer, regelverk och kulturmiljöbevarande för att möjliggöra en kontextkänslig integrering av förnybar energi. Att skapa en sådan samordning mellan energiomställning och kulturmiljövård utgör inte enbart en teknisk utmaning, utan även ett normativt och etiskt åtagande för hållbara urbana framtider.

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"Power corresponds to the human ability not just to act but to act in concert."
Hannah Arendt – The Human Condition

1
Introduction

Background

The convergence of environmental objectives, advancements in renewable energy technologies, and evolving electricity demands presents a significant opportunity to enhance local electricity generation in urban contexts (European Environment Agency, 2023; International Renewable Energy Agency, 2020; Bertilsson et al., 2024; International Energy Agency [IEA], 2023a).

In the context of rapid urbanisation and growing awareness of cultural identity, participatory approaches may be increasingly relevant for fostering social sustainability and equitable development, as they enable the inclusion of diverse perspectives, support power redistribution, and strengthen community engagement in urban decision-making (Gonçalves et al., 2025; Arnstein, 2019/1969).

In this thesis, an investigation is presented on *participatory design* as a method for addressing the intersections of sustainable urban development, photovoltaic integration, and cultural heritage. The aim is to contribute to a deeper understanding of how inclusive and democratic practices can support resilient, sustainable, and culturally rich urban environments. Consequently, this research will examine how participatory processes can be effectively organised and designed to harness local knowledge in support of sustainable urban planning and energy transitions.

Small-scale *photovoltaic systems* are especially well-suited for decentralised installations near the point of consumption, and their deployment may contribute to the development of a more sustainable and resilient energy infrastructure (Sandwell et al., 2025; IEA, 2019; IEA, 2023b).

Photovoltaics refers to the direct conversion of sunlight into electricity using semiconductor materials, most commonly silicon. When photons of light strike the material, they excite electrons, generating an electric current via the photovoltaic effect (Nelson, 2003). A photovoltaic system is a complete setup that uses this principle to produce usable electricity. It typically consists of solar

panels that capture sunlight, inverters that convert direct current into alternating current, and supporting components such as wiring, mounting structures, and sometimes batteries for storage. These systems can operate either connected to the electrical grid or independently as standalone systems (IEA, 2022).

Sweden's electricity system originated as a decentralised network of small-scale hydropower plants serving local demand (International Atomic Energy Agency, 2010; Perers et al., 2007) but was progressively centralised through state-led investments in a national grid and large-scale generation from the mid-twentieth century (Vattenfall, n.d.; Swedish Energy Agency, 2025a). This centralised model has underpinned a highly reliable and low-carbon energy system, supported by hydropower and nuclear energy. In recent years, however, policy frameworks at both national and European levels have increasingly promoted decentralised and flexible energy systems, including distributed renewable generation, energy communities, and urban energy integration (European Commission, 2020; IEA, 2019, 2023a; Swedish Energy Agency, 2025b).

In the context of urban energy systems, *prosumers* are individuals or households who both consume and generate electricity, often through rooftop photovoltaic systems or small-scale renewable technologies. Beyond mere consumption, prosumers actively participate in energy networks by storing, sharing, or selling surplus electricity, contributing to grid flexibility, resilience, and local energy autonomy (Parag & Sovacool, 2016). From a participatory perspective, prosumerism represents a form of energy citizenship, where residents are not passive users but engaged actors in the planning, governance, and operation of energy systems (Campos et al., 2020; European Environment Agency, 2022).

Integrating prosumers into local energy communities aligns with broader sustainability and social equity goals, enabling the co-creation of energy solutions, local decision-making, and community empowerment. Policy frameworks such as the EU Clean Energy Package explicitly encourage prosumer participation as a strategy for decentralised, low-carbon, and socially inclusive urban energy transitions (European Commission, 2019; Directive (EU) 2018/2001).

In urban planning and heritage research, *cultural heritage districts* are important tools for preserving local identity and historical continuity while supporting sustainable development. They can also contribute to cultural tourism,

strengthen local economies, and encourage community participation in heritage stewardship (Bandarin & van Oers, 2012; Smith, 2006).

Cultural heritage districts are geographically defined areas in which a concentration of historic resources collectively represents significant cultural, architectural, or historical value. These districts typically have clearly defined boundaries, such as a neighbourhood, historic village centre, or cultural landscape, within which heritage elements together form a coherent historical environment (Ashworth & Tunbridge, 2000). These districts are characterised by the concentration of historic buildings, streetscapes, and public spaces that reflect the area's historical development (Bandarin & van Oers, 2012). Their significance lies not in individual monuments, but in the relationships between structures and their surroundings. While individual buildings may not be remarkable, together they embody important historical periods, cultural traditions, or architectural styles, thereby emphasising the cultural meaning of entire environments rather than isolated sites (Pendlebury, 2009).

Cultural heritage districts often possess distinct architectural and artistic value, presenting both challenges and opportunities for integrating renewable energy technologies, such as photovoltaics. These areas require thoughtful restoration, upgrades, and adaptations to meet contemporary living standards and sustainability goals. To investigate the conditions under which small-scale photovoltaic systems can be introduced into such environments, this study aims to identify the underlying factors that enable or constrain initiatives by potential prosumers and other local actors.

Project Studies

The empirical foundation of this study is based on two preceding research projects with three case studies in Sweden. The first project, titled Solar Cities, was a pilot study conducted in Porsön, a suburban district located in Luleå, Norrbotten. The other project, Prosumers' Perspectives in Cultural Heritage Districts, expanded this investigation to heritage contexts, specifically focusing on Öjeby Church Town in Piteå, also located in Norrbotten, and Södertorg in Visby, Gotland (Figure 1). All three case studies are heritage in various forms; consequently, this research falls within the field of heritage studies.

The Porsön case study is an initial testbed for participatory design methods and tries to identify factors influencing residents' engagement and acceptance of prospective PV integration. The two following ones (Öjebyn and Visby) are

selected for their unique and multifaceted challenges. Architecturally, they comprise historically significant buildings and environments.

Socio-institutionally, the cases include distinct governance and planning issues (see detailed case descriptions in the case study chapter). Climatologically, both Piteå, Luleå and Visby offer favourable conditions for solar energy production, with high solar radiation and extended daylight hours throughout the year. However, Luleå and Piteå's harsh winter conditions, characterised by snow, cold temperatures, and prolonged darkness, introduce additional difficulties.

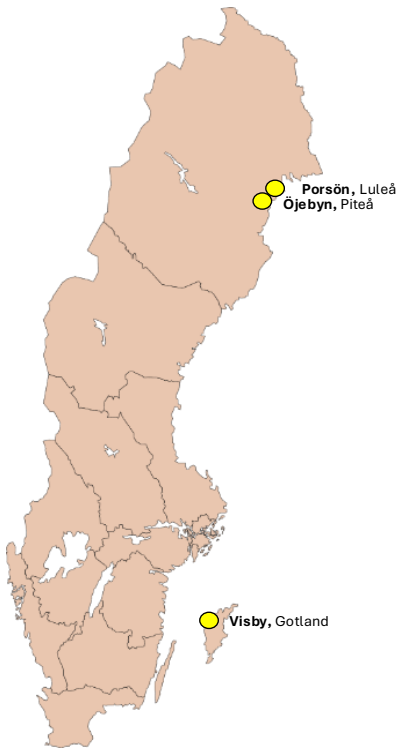

Figure 1. *Case study locations in Sweden (Porsön–Luleå, Öjebyn–Piteå, and Visby–Gotland). Map refined by the author based on an open-source Sweden base map (Wikimedia Commons).*

Across the three case studies, Porsön (Luleå), Öjebyn (Piteå), and Visby (Gotland), participatory design methods are employed to engage potential prosumers as well as institutional stakeholders, such as local authorities, including city planners, heritage conservation experts, and energy specialists. These actors contribute their local and context-specific knowledge to the planning and implementation of renewable energy solutions, such as photovoltaic technologies.

The participatory design processes aim to facilitate the exploration of energy transition possibilities from the perspective of future prosumers, fostering positive synergies among aesthetic, social, and technical considerations, as participatory approaches enable collaborative knowledge production and context-sensitive urban energy solutions (Bouw et al., 2023; McConnell et al., 2025). Such synergies are essential, as energy transitions increasingly extend beyond technical systems to shape everyday urban experiences and aesthetics (Törnroth et al., 2022). In this way, this research is situated at the intersection of architectural aesthetics, social factors, and technological advancements. (Figure 2).

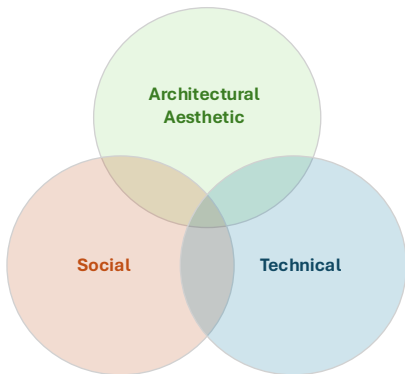

Figure 2. *A framework to visualise the study's position at the intersection of architectural aesthetics, social, and technical fields. When all three dimensions align, the energy transition may have the best conditions to succeed in urban and heritage contexts.*

The architectural–aesthetic dimension is grounded in a contemporary, value-based conservation approach that prioritises the preservation of cultural and

historical significance while enabling the careful integration of photovoltaic technologies. This perspective recognises heritage as a socially constructed and value-laden practice, shaped through negotiation and participation (Muñoz Viñas, 2005; Avrami et al., 2000; Smith, 2006). This aligns with classical preservation principles such as reversibility, minimal intervention, and visual compatibility, ensuring that renewable energy systems do not compromise the integrity of heritage buildings (International Council on Monuments and Sites [ICOMOS], 2011). In this context, photovoltaics is not treated merely as a technical addition but as a design element that requires sensitivity to form, materiality, and visual impact.

The social dimension encompasses socio-cultural, socio-economic, and socio-technical factors, reflecting how communities perceive and engage with photovoltaic integration in heritage environments. Public acceptance is influenced by place attachment, cultural identity, and perceived visual impacts, as well as issues of cost and accessibility (Gonçalves et al., 2025; Campos et al., 2020a). Furthermore, the emergence of prosumers highlights changing roles in energy systems, reinforcing the importance of participatory approaches that incorporate local knowledge and values into decision-making (Parag & Sovacool, 2016).

The socio-political factor plays a critical role in shaping the feasibility and direction. Regulatory frameworks, planning policies, and heritage protection laws often mediate the balance between conservation and innovation, influencing what forms of intervention are permitted (Boverket, 2023). In addition, governance structures, incentive schemes, and energy policies, such as those promoting renewable energy adoption and prosumer participation, can either enable or constrain local implementation. The integration, therefore, requires navigating multi-level governance systems in which local planning authorities, national regulations, and EU directives intersect, often necessitating negotiation among stakeholders with differing priorities.

The technical dimension involves the ongoing development of photovoltaic technologies and their compatibility with existing building materials and structures. Innovations such as building-integrated photovoltaics (BIPV) and flexible modules enable more adaptable and less visually intrusive applications (IEA, 2020). Taken together, these dimensions demonstrate that integrating small-scale photovoltaics into heritage contexts is a multidimensional challenge, requiring the alignment of aesthetic sensitivity, social acceptance, and technological feasibility.

Research Gaps

The integration of photovoltaic technologies into cultural heritage districts presents a multifaceted challenge. Unlike conventional urban planning contexts, there is no objective or quantitative framework to guide such integration. Aesthetic and cultural values are socially constructed and deeply embedded in local traditions and identities (Hubbard, 1996). These values resist standardisation and require context-sensitive approaches that acknowledge the lived experiences and cultural significance of place.

To address this complexity, the present study is informed by participatory design, drawing inspiration from the classic Scandinavian model originally developed for workplace environments. This approach emphasises democratic engagement, enabling individuals to articulate their needs and evaluate potential solutions collaboratively (Spinuzzi, 2005). Participatory design offers a methodological framework that is particularly well-suited to engaging diverse stakeholders in the planning of renewable energy projects. Through tools such as mock-ups, games, temporary interventions, and informal idea-sharing strategies, Participatory Design facilitates inclusive participation regardless of technical expertise or language proficiency (Tejedor et al., 2018).

The literature review indicates that previous research has not comprehensively examined a participatory design approach that involves residents and stakeholders in integrating new renewable energy techniques, such as photovoltaic systems, into cultural heritage districts. Participatory Design emphasises inclusion, collaboration, empowerment, iteration, and contextual understanding to create products and services that better meet users' needs and expectations by leveraging their knowledge and experiences. This can be essential as it is argued that established technological regimes dictate what is planned and built (Geels, 2002; Smith, 2003).

A participatory process challenges this paradigm and establishes technological norms, fostering innovation and advocating solutions that better meet specific cultural and environmental needs. Furthermore, the local community should engage in design workshops because environmental preferences are shaped by individual experiences and social contexts. Also, dominant architectural styles do not significantly influence these preferences, contrary to the beliefs of some professionals in the field (Hubbard, 1996).

One methodological approach to uncover these factors involves convening potential prosumers, local stakeholders, practitioners, and authorities in collaborative settings where they can discuss, design, and plan for the integration

of photovoltaic technologies within their communities. Accordingly, this research adopts a participatory framework, aiming to bring together diverse actors engaged in the urban energy transition.

In Sweden, researchers have explored the balance between preserving historic environments and integrating solar energy technology (Legnér & Femenias, 2022). The study's objectives were to understand how conservation policies impact the installation of photovoltaic panels on one- or two-family houses in Stockholm's residential areas. Installing photovoltaics in historic areas can affect socio-cultural values, making it challenging to implement renewable energy solutions without altering the historic character. The study concludes that well-defined routines and guidelines can help reconcile the use of solar energy with the conservation of historic environments, and that the existing policies in cultural heritage areas do not respond to the community's needs.

Existing building legislation and related policy instruments, such as energy taxation and subsidies, are primarily designed and implemented at the individual level rather than at the district or neighbourhood scale (Boverket, 2025). This misalignment is problematic, as residents in urban environments are widely recognised as the most knowledgeable actors regarding the specific needs, practices, and potentials of their own neighbourhoods (Arnstein, 2019/1969). Addressing this gap is therefore essential, since future urban energy transitions require context-sensitive planning and innovative solutions that can be effectively developed through the meaningful inclusion of residents and local communities.

Visual impact of photovoltaic systems, particularly in relation to architectural aesthetics and heritage values, remains a subject of ongoing debate (Lingfors et al., 2019; Polo López et al., 2020). This issue becomes especially complex when considering the integration of photovoltaic technologies into cultural heritage districts. Visibility and historical assessments are standard procedures, and the introduction of contemporary technologies must be carefully negotiated. However, the conventional appearance of photovoltaic modules often clashes with the traditional architectural character of heritage sites. Building-Adapted Photovoltaics (BAPV), typically characterised by static and rectangular designs, pose aesthetic challenges when integrated into existing structures. Nevertheless, the continued development of Building-Integrated Photovoltaics (BIPV) offers promising alternatives that may better align with the visual and architectural integrity of heritage environments.

Research Significance

This research responds to participatory design theory by emphasising the importance of democratic engagement and the redistribution of decision-making power in cultural heritage energy transitions. The proposed participatory design process seeks to empower potential prosumers by recognising them as active contributors rather than passive recipients of energy system transformations. From a participatory design perspective, effective and just energy transitions require the early and continuous involvement of stakeholders at the neighbourhood or district level, as inclusive participation enhances the legitimacy and quality of decision-making processes (Glucker et al., 2013).

Becoming a prosumer is a personal choice and depends on property ownership (European Parliament, 2016; Molavi & Bydén, 2018). However, it is important to consider affordability and ownership, as not everyone interested in becoming a prosumer may have the financial means to invest in renewable technologies like photovoltaic systems. This raises broader questions about accessibility and potential disparities in the benefits of renewable energy initiatives. Therefore, prosumers should be acknowledged as key stakeholders; however, citizens without property ownership must also be included as legitimate participants, as equitable energy transitions depend on recognising diverse social groups and ensuring meaningful involvement of all affected communities in decision-making (Jenkins et al., 2016; Campos et al., 2020a, 2020b).

Achieving public acceptance is another critical component of urban energy transitions and is closely linked to trust, transparency, and meaningful participation. From a participatory design perspective, residents must be actively involved in the design and decision-making processes to understand the benefits of energy technologies. Furthermore, this study aims to contribute to the development of knowledge and competencies for integrating small-scale, decentralised renewable energy technologies, such as photovoltaic systems, by generating empirically grounded recommendations for participatory design processes. By foregrounding co-creation and stakeholder engagement, the research supports the development of energy solutions that are not only technically viable but also socially accepted and contextually appropriate at the neighbourhood and district levels. Conversely, navigating the regulatory landscape and achieving political consensus can be a challenging task. Thus, securing the necessary funding for *smart city* projects can be difficult. These projects often require substantial initial investments, and the return on investment may not be immediately apparent.

Research aim, objectives, and questions

This study is situated within the field of heritage studies and explores how participatory design can be leveraged to reconcile modern technological innovation with traditional architectural aesthetics. In doing so, it aims to support forms of urban renewal that are not only sustainable but also visually coherent and socially inclusive. Specifically, the research seeks to develop and apply participatory design methods that actively involve prosumers in urban energy transition planning at the district scale, with particular attention to the sensitivities and constraints of cultural heritage environments (Figure 3).

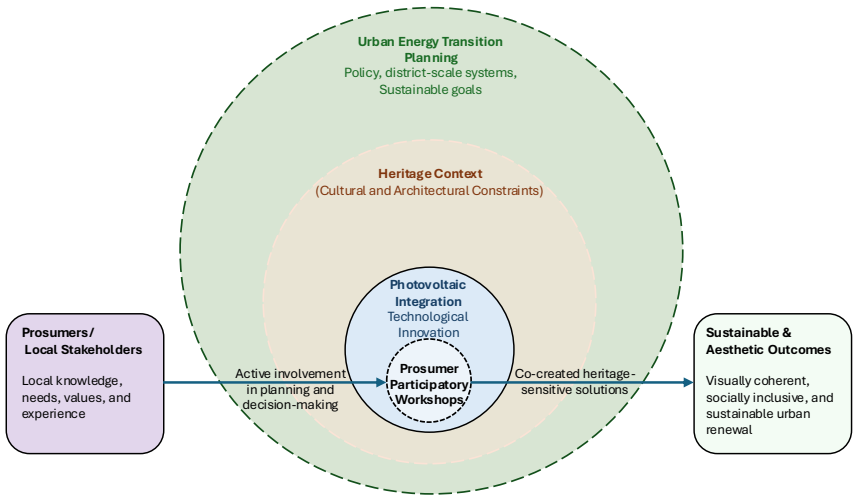

Figure 3. *The diagram illustrates how photovoltaic integration is situated within heritage-sensitive urban planning, with participatory design acting as the central mechanism that connects prosumers to sustainable and aesthetically coherent outcomes.*

Drawing on empirical data and existing literature, this research project is grounded in the assumption that urban energy transitions, when guided by participatory and context-sensitive design processes, can act as catalysts for sustainable, aesthetically coherent, and socially accessible urban renewal in historically rich districts.

Based on this, the research questions are:

1. **How can participatory design methods be created to address barriers and facilitators when prosumers, as key stakeholders, are included in the processes for urban energy transition within cultural heritage districts?**
2. **What are the barriers and facilitators of urban energy transition in cultural heritage districts?**

Research Design

The study explores the cultural and social context of heritage districts and the integration of photovoltaic technologies within them. It emphasises the perspectives of prosumers, institutional stakeholders, and additional actors, such as local organisations and community associations of the local community, focusing on their experiences and the meanings they ascribe to cultural heritage. Consequently, the study adopts the *ontological* position that social entities are constructed by social actors (Honderich, 2005). Grounded in empirical observation, the study collects context-sensitive data to understand how these participants perceive and respond to photovoltaic technology in these sensitive environments.

Furthermore, this study employs a *qualitative research design* (Creswell, 2018). Qualitative research seeks to explore people's beliefs, experiences, and behaviours through non-numerical data to understand the "why" and "how" of a phenomenon. This orientation is iterative and contextually situated, providing rich and detailed insights into complex human experiences. Its advantages lie in its flexibility and capacity to capture contextual depth; however, challenges include the potential for researcher bias and the limited generalizability of the findings (Bhandari, 2020; Hassan, 2024).

The research philosophy guiding this study is *interpretivism* (Denzin & Lincoln, 2017), a *hermeneutic* view that emphasises interpretation in the construction of knowledge (Zimmermann, 2015). Hermeneutic perspectives hold that only through interpretation can the knowable be accessed. Thus, the paradigm assumes that observers subjectively construct reality and that phenomena are nuanced, context-specific, and less amenable to direct measurement. Interpretivism emphasises understanding perceptions and experiences, privileging qualitative methods such as interviews and focus groups.

Beyond mere description, the research systematically analyses this empirical data to identify patterns and insights that lead to a deeper conceptual understanding. Therefore, *abduction* (Dubois & Gadde, 2002; Timmermans &

Tavory, 2012), a form of inferential reasoning, is crucial in the research process, allowing the researcher to formulate theories that explain the observed phenomena. This approach connects the subjective experiences in heritage districts with broader, rational insights into how photovoltaic integration interacts with cultural and regulatory contexts, using empirical findings as a foundation for theoretical exploration.

Finally, it operates within a *transformative worldview,* highlighting its ability to inspire positive change (Creswell, 2018). The transformative paradigm prioritises the perspectives of marginalised individuals and groups, in this case, the prosumers' voices, in the integration of renewable energy initiatives and urban renewal. It advocates for an action-oriented agenda, extending beyond a *constructivist* stance, to support equity and social justice. This worldview underpins the project's aspiration to contribute to meaningful societal transformation.

Thesis Outline

Chapter 1 began with background information and an exploration of the research problem. followed by an overview. and rationale for the research. The significance and justification of the study were then discussed. After this, an outline of the research aims, objectives, and questions was provided. Finally, the research design was outlined.

Chapter 2 reviews the state of the art in the literature and provides examples related to the topic, focusing on the integration of photovoltaic technology in cultural heritage districts. It starts with an overview of existing and ongoing photovoltaic technologies, emphasising research conducted in Southern and Central European countries, where most research has been conducted. Following this, the chapter provides an overview of Swedish building legislation, cultural heritage policies, energy taxation and subsidies, energy communities, and economic associations in Sweden. Consequently, there is a need for a socio-institutional examination of existing preservationist viewpoints, as well as an analysis of the legislation, regulations, and policies that impact heritage areas in Sweden.

Chapter 3 explores the Conceptual Framework essential for understanding the relationship between participatory design processes and the energy transition in cultural heritage districts. As the research field is within heritage studies, the *Contemporary Conservation Theory* is used to highlight the importance of understanding diverse stakeholder values and beliefs in conservation efforts, treating heritage as a cultural narrative shaped by experience. The *Communicative Action and Planning* Framework is used as the theoretical lens which addresses

power imbalances in community engagement by promoting open dialogue and equitable decision-making, ensuring marginalised voices are heard. Participatory Design is the method used in the studies. It emphasises stakeholder involvement, which enriches development and fosters ownership, particularly valuable in cultural heritage areas where local knowledge informs sustainable practices, like integrating photovoltaic systems. Together, these concepts form a comprehensive framework for navigating the complexities of urban planning while honouring both heritage and innovation. To strengthen the theoretical foundation, the inclusion of *Complexity Theory* and *Value-Sensitive Design* highlights why iteration and co-implementation are not just useful but necessary in this context. Together, these theories reinforce that planning in this domain cannot be static or top-down. Instead, it requires continuous iteration and collaborative implementation, where learning, adaptation, and negotiation are embedded throughout the process. This approach ensures that both the complexity of the system and the diversity of stakeholder values are meaningfully addressed over time.

Chapter 4 outlines the methodological framework of the thesis, detailing the research design and methodological choices that underpin the study. This chapter explains the overall research strategy and clarifies the distinction between methodology and methods. It describes the data collection procedures, sampling strategies, and analytical approaches employed, as well as the rationale for their selection. Additionally, it reflects on the researcher's role, positionality, and professional background, acknowledging how these factors may have influenced both the research process and the interpretation of the findings.

Chapter 5 presents the empirical case studies that form the core of the research. This chapter introduces the selected study areas and contextualises them in terms of their cultural, historical, spatial, and regulatory characteristics. The case studies serve as the empirical foundation for examining photovoltaic integration within culturally sensitive environments and for exploring stakeholder perspectives and governance conditions.

Chapter 6 offers a systematic analysis of the empirical material derived from the case studies. Drawing on data collected through workshops, focus groups, and other qualitative methods, this chapter identifies key themes, patterns, and relationships pertinent to the research questions. The analysis integrates findings across cases to highlight both commonalities and context-specific dynamics.

Chapter 7 presents a discussion of the results, situating the empirical findings within the broader scholarly literature and policy context. This chapter critically reflects on the implications of the results for theories of sustainable heritage preservation, energy transition governance, and participatory planning. It also

addresses methodological limitations and reflects on the study's contribution to existing research.

Chapter 8 concludes the thesis by synthesising the main findings and articulating the research's overall contributions. This chapter revisits the research questions and demonstrates how they have been addressed through the analysis of the case studies and the included papers. It concludes by outlining key implications for policy, planning practice, and future research related to photovoltaic integration in cultural heritage contexts.

Chapter 9 outlines the future research. Pathways to effective participatory practice in cultural heritage contexts. Complexity Theory recognises the interconnectedness of urban environments, advocating for adaptive responses to change and fostering resilience in cultural heritage districts. Value Sensitive Design prioritises ethical values and social implications, encouraging designers to reflect on the impacts of their decisions on stakeholders and the environment.

The last Chapter provides a structured summary of the papers included in the thesis. Each paper is presented in relation to its research objectives, theoretical framework, methods, and main findings, situating the individual contributions within the overarching aims of the thesis.

The research papers are included in the appendices. Paper 1, the systematic review, and Papers 2 and 3 are the case studies.

2
State of the Art

Research on Photovoltaic Integration in Cultural Heritage Districts

While preserving the integrity of cultural heritage districts is crucial, completely exempting them from contributing to societal energy demands or from adapting to broader technological and environmental developments may be unrealistic. Nevertheless, the following preservation-oriented approaches described in this section may be contradictory, as they can significantly reduce the available area for active photovoltaic integration on building envelopes. To address this limitation and minimise direct impacts on historic buildings, some studies propose locating solar panels on adjacent contemporary structures rather than on heritage fabric itself (Hubinský et al., 2020). This approach may simplify the integration and enable energy generation while maintaining the historical character of the surrounding environment. However, as this study examines the integration of photovoltaic systems within cultural heritage districts, direct integration strategies on historic buildings must also be considered.

Given that a large proportion of historic buildings are in central and southern European countries, much of the existing research has focused on these regions. Previous studies indicate that assessments of photovoltaic integration in heritage contexts are typically multi-stage and comprehensive. Methodological contributions (Polo López & Frontini 2014; Polo López et al. 2021; Peluchetti et al. 2021; Marchwiński & Lucchi 2024; Pelle et al. 2020; Di Rocco et al. 2024) are increasingly shifting from conceptual models to operational frameworks that combine building typology assessments, multi-criteria evaluation, and aesthetic–technical design guidelines. Across studies, successful integration is linked to *visual compatibility, reversibility, and material coherence;* however, many frameworks remain insufficiently validated and context-specific, thereby limiting their wider applicability.

Some of these assessments first identify constraints and restrictions by reviewing existing criteria for the acceptable use of photovoltaics, including relevant legislation, regulations, and prohibitions issued by public authorities.

They then examine the perspectives of architectural restorers and conservation professionals through the analysis of conservation documents, detailed development plans, and interviews. Finally, architectural, historical, and aesthetic values are evaluated through fieldwork and systematic documentation. This structured approach ensures that the multiple dimensions of historic building preservation are considered (Polo Lopez et al., 2020).

A *visual assessment* is considered necessary because the integration of photovoltaic systems is problematic primarily due to their visual impact. Such an assessment can be conducted by identifying architectural and scenic evaluation criteria that address multiple aesthetic factors (Lucchi et al., 2014). These criteria include maintaining planarity and respecting existing architectural lines, as well as the orientation and slope of the roof; ensuring that photovoltaic panels are arranged in a uniform configuration; installing panels in compact groupings by minimizing the spacing between individual modules; and avoiding the placement of solar panels beyond roof edges or in highly visible areas, while integrating the modules in a manner that enhances the building's overall original appearance. Lucchi et al. (2014) continue to emphasise the importance of preserving the original form and value of historic buildings, as well as adhering to local regulations and policies. Buildings are classified based on their heritage constraints to determine suitable retrofit interventions. The research uses historical analysis, visual tests, and *Geographic Information System (GIS)* data to identify roof surfaces suitable for installation without compromising the historic aesthetics. The paper reviews various European and international projects aimed at developing guidelines for integrating photovoltaic systems into historic buildings, ensuring compatibility with physical, mechanical, and aesthetic aspects. The study concludes that while traditional systems have limited applicability, innovative integration methods can significantly enhance energy efficiency without altering the historic character of buildings.

In Sweden, Lingfors et al. (2019) explore a method for assessing the visibility of building envelopes, particularly in integrating photovoltaics in the historic district of Visby in Gotland. This method is unique because it evaluates visibility from the perspective of the building envelope itself rather than from *ground vantage points*. The technique assesses visibility based on the building's envelope, accounting for factors such as solar irradiation and cultural heritage values. This approach aims to balance the benefits of solar energy with the preservation of cultural heritage, ensuring that modern technology does not compromise historical aesthetics. Integrating photovoltaics should not compromise the aesthetic or historical value of buildings, especially in culturally significant areas.

Polo Lopez et al. (2020) explore the integration of *building-integrated photovoltaics (BIPV)* systems in heritage areas. They highlight the potential

benefits, such as reduced energy bills, enhanced comfort, and improved environmental sustainability, while preserving the historical, material, and aesthetic values of these structures. They assert that BIPV systems could be customised to resemble traditional building materials, making them suitable for heritage contexts. Thus, barriers and challenges exist, including regulatory constraints, the need to preserve architectural heritage, and the technical challenges of integrating modern technology into historic buildings. The study proposes criteria for the compatible use of BIPV and calls for evaluating them through architectural preservation, legislative frameworks, and case studies. Their research emphasises the importance of striking a balance between energy efficiency and the conservation of cultural heritage.

Building on recent research, particularly the framework proposed by Lucchi (2022), a structured approach for integrating solar energy systems into heritage contexts is outlined. This begins with evaluating the historical and cultural significance of the site and assessing the heritage value of the buildings. It emphasises the preservation of key architectural features to maintain the site's authenticity. The framework highlights the use of building-integrated photovoltaics (BIPV) and *building-integrated solar thermal (BIST)* systems, designed to be aesthetically compatible with traditional materials. BIST systems may enhance the building envelope while offering added benefits like improved thermal insulation. Customisation, including low-reflectance glazing and innovative coatings, further addresses visual integration. Furthermore, regulatory compliance is crucial, ensuring interventions respect conservation guidelines while minimising irreversible changes. Strategies advocate incremental implementation through pilot projects, enabling testing and refinement, with continuous monitoring of both technical and heritage impacts. Stakeholder engagement is vital, promoting collaboration among conservators, energy specialists, policymakers, and local communities. Educational initiatives are essential for understanding the benefits and limitations of renewable energy systems in heritage settings. While the framework emphasises reversibility, visual compatibility, and participation, reliance on advanced materials may raise costs and complexity, impacting scalability. Long-term evidence on material ageing and visual impacts remains limited, suggesting the framework is an adaptive approach that requires ongoing assessment, providing a foundation for reconciling energy transition and heritage conservation goals.

Historical and visibility assessments are comprehensive processes that involve several steps. First, constraints and restrictions are identified by examining existing criteria for the acceptable use of Photovoltaics, i.e., legislation, regulations, and prohibitions issued by authorities. Second, the perspectives of architectural restorers and conservators are examined through conservation

documents, detailed development plans, and interviews. Finally, architectural, historical, and aesthetic values are assessed through fieldwork and documentation. This thorough process ensures that all aspects of historic building preservation are considered (Polo Lopez et al., 2020).

Stefania De Medici (2021) provides evaluation criteria for introducing small-scale photovoltaic systems that maintain the integrity of historic structures. The paper highlights the challenge of integrating innovative photovoltaic systems, such as *solar flags* and *solar-driven announcement boards*, into historical buildings without compromising their architectural and cultural value. It proposes specific criteria for evaluating the suitability of photovoltaic installations on heritage buildings. These criteria include visual impact, reversibility, and the potential for energy production. The article presents several case studies of photovoltaic systems successfully integrated into historical buildings, demonstrating that a balance between sustainability and preservation is possible. The study provides guidelines for architects and planners on how to integrate photovoltaic systems in a manner that respects the buildings' historical and aesthetic significance. It suggests policy measures to support the adoption of photovoltaic systems in heritage buildings, including financial incentives and regulatory frameworks that encourage sustainable practices while protecting cultural heritage.

Governance and municipal practice emerge as the strongest determinants of feasibility (Lucchi 2022; Bianco, Cascetta, & Nardini 2021; Lucchi et al. 2020; Lucchi et al. 2022; Rosa 2020; Formolli et al. 2021; Legnér & Fermenías 2022). Comparative analyses show that clear authorisation procedures, coherent regulatory frameworks, and explicit evaluation criteria are crucial for implementation, whereas fragmented regulations create uncertainty and inconsistent decision-making. Municipalities play a central mediating role: where planning tools, early design guidance, and transparent communication are embedded in local routines, photovoltaic adoption is smoother, and conflicts with conservation objectives are reduced.

Barrier-focused studies (Akbarinejad et al. 2023; Akbarinejad et al. 2024; Tsoumanis et al. 2021) consistently identify institutional and economic challenges, regulatory ambiguity, uneven responsibilities, and limited or misaligned financial incentives as more significant than technical constraints. Multi-criteria decision-making frameworks help structure trade-offs among visual impact, feasibility, and stakeholder acceptance; however, local governance conditions often limit their transferability.

Research on social acceptance (Schaffer and Brun 2015; Bottino-Leone et al. 2024; Lucchi, Adami, & Stawinoga 2023; Polo López & Frontini 2014; Haukkala 2015; Karjalainen & Ahvenniemi 2019) reveals that cultural and aesthetic concerns significantly influence public perceptions in heritage contexts.

Acceptance increases when photovoltaic systems are discreetly integrated and accompanied by transparent communication. However, social acceptance should be seen not as a static goal but as a fluid and developing state, influenced by continuous interactions among stakeholders, knowledge systems, and governance frameworks. (Wolsink, 2007; Devine-Wright, 2011).

Awareness of photovoltaic recycling and circularity remains low, underscoring the need for enhanced information strategies. Although stakeholder engagement and co-design are recommended, empirical evidence on their practical implementation is limited, and broader socio-technical analyses show how existing power structures and socio-economic inequalities shape adoption patterns. Overall, the reviewed literature shows an evolution toward more structured and interdisciplinary approaches to integrating photovoltaic systems in heritage settings. The literature indicates that heritage-compatible photovoltaic integration is primarily a socio-institutional challenge rather than a technical one. Clear governance, design quality, and meaningful stakeholder engagement remain the key conditions for effective and culturally sensitive energy transitions in heritage districts.

Ongoing Photovoltaic Technology Development

Recent research in photovoltaic technology highlights challenges associated with integrating *building-applied photovoltaics (BAPV)* into historic buildings (Rosa, 2020; Basher et al., 2023). Although more visually sensitive solutions are expected to emerge as photovoltaic technologies continue to develop, BAPV systems remain the most widely applied approach in heritage contexts, largely due to their technical feasibility and reversibility, which aligns with established conservation principles (Fouseki & Cassar, 2014).

However, as BAPV installations are frequently perceived as add-on elements rather than integral architectural components, they often disrupt the visual coherence of façades and roofscapes and conflict with the aesthetic and cultural values of heritage sites (Marchwiński, 2023). Moreover, the limited range of standard photovoltaic panel colours and textures typically fails to harmonise with traditional construction materials, resulting in pronounced visual contrast (Rosa, 2020). To address these challenges, manufacturers are increasingly creating more visually appealing Building-Applied Photovoltaic (BAPV) solutions. This includes modules with black back sheets, frameless designs, and surface treatments that minimise visual contrast. Additionally, advanced photovoltaic technologies are being introduced to hide visible components like busbars and cell interconnections. This enhances visual consistency and reduces

the perceived technological intrusion on historic building aesthetics (Basher et al., 2023; Munari Probst & Roecker, 2017). To achieve a more harmonious integration of BAPV within heritage contexts, the literature emphasises the importance of design strategies that minimise visual impact, including the use of surface treatments, anti-reflection coatings, and careful matching of colours and textures to the existing building fabric (Munari Probst et al., 2021).

In parallel, Building-Integrated Photovoltaics (BIPV) are technologies that incorporate photovoltaic materials into building elements like roofs, facades, and glazing systems, replacing traditional materials while generating electricity. In historic contexts, the use of BIPV must adhere to conservation principles outlined by the International Council on Monuments and Sites (ICOMOS), such as minimal intervention, reversibility, and respect for cultural significance (ICOMOS, 2011; ICOMOS, 2019). BIPV offers enhanced visual integration compared to conventional systems since energy-generating components can align with the building's architectural style. *Semi-transparent and transparent BIPV systems*, particularly those used in windows and skylights, are valuable in heritage settings as they allow for renewable energy generation without sacrificing daylight or visual integrity (Zhao et al., 2023).

Emerging thin-film photovoltaic technologies, including *organic photovoltaic (OPV) systems*, expand design possibilities for heritage integration due to their lightweight and flexible nature. These technologies can be discreetly installed while maintaining compatibility with historic materials (ICOMOS, 2019). Current research aims to improve the efficiency and optical properties of these films to balance energy performance with transparency (Liu et al., 2023). When thoughtfully designed, thin-film photovoltaic systems can enable energy generation in historic buildings while preserving their authenticity and cultural significance, aligning with ICOMOS recommendations for sustainable development in heritage contexts (ICOMOS, 2011; Zhao et al., 2023).

Regulatory, Heritage and Renewable Energy Frameworks for the Built Environment in Sweden

As this study examines case studies in Sweden, understanding Sweden's building legislation and cultural heritage policies is vital, as they mediate the balance between heritage conservation and energy transition goals. Therefore, this section aims to identify how the regulatory framework influences the integration of photovoltaic systems into culturally significant settings.

The Historic Environment Act (Kulturmiljölagen, SFS 1988:950) provides a strong legal foundation for protecting cultural and historical values, mandating

that changes respect these features. The Planning and Building Act (PBA) (Plan- och bygglagen, SFS 2010:900) further ensures that alterations in valued areas require permits and may be restricted in protected zones.

Sweden's heritage governance is characterised by a higher degree of municipal responsibility and discretion, compared to other European and Nordic countries, particularly through the Planning and Building Act and the comprehensive planning system (översiktsplan), which embeds cultural heritage considerations within broader local development strategies (Riksantikvarieämbetet, 2026). This decentralised approach enables heritage values to be assessed in relation to local priorities, including renewable energy deployment, but also leads to variation in how interventions such as photovoltaic installations are evaluated across municipalities.

The Planning and Building Act

Sweden's primary legislation governing construction and planning is the Swedish Planning and Building Act (PBA) (SFS 2010:900). The Act specifies which types of construction require permits and outlines the legal obligations for obtaining them. It also outlines the legal obligations of local municipalities when issuing building permits, the types of constructions that require a permit and those that do not, binding definitions of key concepts, citations for illegal construction activity, and how the interests of citizens should be protected.

Local authorities are responsible for issuing building permits and ensuring compliance with regulations during construction. The Act includes provisions to protect the public's interests, including environmental considerations and the management of public spaces. Furthermore, it mandates public involvement in the planning process. This ensures that residents' voices are heard, fostering community engagement and support for urban development projects. Municipalities must develop comprehensive plans that outline long-term visions for urban growth. These plans coordinate various aspects of urban development, such as housing, infrastructure, and public services, to create cohesive and well-functioning urban areas. The PBA covers comprehensive municipal plans, detailed development plans, and area regulations. It provides guidelines on supervision, access, intervention, and sanctions for construction activities.

Consequently, the Act has a significant influence on urban development in several ways and allows municipalities to plan and regulate land use, ensuring that urban development aligns with local needs and priorities. This helps maintain high standards in building safety, design, and functionality, contributing to the overall quality of urban environments. It emphasises sustainable urban development, requiring municipalities to integrate

environmental considerations into their planning processes. Its decentralised approach allows for tailored urban planning considering specific community requirements (Swedish Government, 2021). Moreover, it includes promoting energy-efficient buildings, sustainable transport systems, and green spaces (Government Offices of Sweden, 2014).

The Comprehensive Plan (Översiktsplanen) is a key tool in municipal spatial planning, guiding long-term development and management of land and water. Each municipality is tasked with creating a comprehensive plan that outlines land use, built environment development, and protection areas of cultural, historical, or environmental significance (Boverket, 2023). Though not legally binding, these plans help mediate conflicts between public and private interests, balancing objectives like heritage preservation and renewable energy deployment (Boverket, 2017).

Under the PBA (SFS 2010:900), municipalities must update these plans each term to stay responsive to societal and technological changes, including sustainable energy solutions. Collaborative efforts across municipalities can also address regional planning challenges, such as heritage management and renewable energy (Boverket, 2023).

In cultural heritage districts, comprehensive plans are essential for integrating photovoltaic systems while preserving aesthetic and historical values. They are vital for aligning climate action with heritage conservation at municipal and regional levels as they specify locations, designs, and materials, e.g., photovoltaic installations, supporting sustainable energy transitions without compromising protected sites (Boverket, 2025).

The Cultural and Environmental Act and Heritage Protection

The Cultural Environment Act SFS 1988:950 (Riksantikvarieämbetet, 2019) constitutes a cornerstone of Sweden's legislative framework for the protection and management of cultural heritage. This Act establishes that the preservation and stewardship of the cultural environment is a national responsibility, shared collectively by public authorities, institutions, and individual property owners. Its overarching objective is to ensure that cultural heritage resources are safeguarded, managed, and transmitted to present and future generations as part of a living and evolving environment. Furthermore, the Act provides formal protection for cultural heritage assets that fulfil certain criteria related to their historical and cultural significance. Decisions regarding the designation of *listed buildings* (known as byggnadsminnen) are primarily made by the County Administrative Boards (Länsstyrelsen), while the national government is responsible for designating state-owned listed buildings. The Act also offers

specific protection for church buildings, church sites, ecclesiastical furnishings, and cemeteries, acknowledging their unique historical, architectural, and social importance within the Swedish cultural landscape. Through these provisions, the legislation aims to preserve a variety of cultural environments and ensure public access to them over time.

Designated cultural heritage refers to buildings, sites, landscapes, or artefacts recognised for their cultural-historical value and legally protected through formal regulatory frameworks. Such designation imposes restrictions on alteration, demolition, and use to safeguard historical, aesthetic, social, or scientific significance (UNESCO, 1972; Riksantikvarieämbetet, 2019). Heritage authorities enforce these protections to ensure the long-term conservation of important cultural assets. Notable examples include the Hanseatic Town of Visby, inscribed on the World Heritage List for its well-preserved medieval urban fabric (UNESCO, 1972), and Öjeby Church, which is protected under Sweden's Historic Environment Act as part of the national ecclesiastical heritage framework (Riksantikvarieämbetet, 2019).

Non-designated heritage assets are buildings, monuments, sites, or landscapes with cultural, historical, architectural, or social significance that lack formal recognition. They may not meet strict criteria for official listing or have not yet been evaluated. Despite this, they contribute to local identity and character, making them important in planning and development. Consequently, non-designated heritage is often more vulnerable to alteration, neglect, or loss. This distinction between designated and non-designated heritage is particularly relevant in planning and development processes, where levels of legal protection directly influence permissible change. In Sweden, heritage assets not formally protected under the Historic Environment Act (1988:950) may still have local or regional cultural value (Riksantikvarieämbetet, 2019). However, the Swedish National Board of Housing, Building and Planning states that municipalities must identify cultural values in their planning processes, especially in comprehensive and detailed development plans (Boverket, 2017). Furthermore, the Swedish Planning and Building Act (2010:900) mandates that cultural and historical values in the built environment be considered in land use and development decisions. Additionally, surveys or heritage inventories are crucial for understanding and protecting valuable assets. They document and evaluate buildings and environments based on their historical, architectural, and social significance (Riksantikvarieämbetet, 2019). In Sweden, municipalities and county boards conduct these inventories to inform planning decisions and identify structures worthy of protection.

Museums play a complementary and essential role in the preservation and management of Sweden's cultural environment. Their responsibilities extend

beyond the care of collections to include the conservation of culturally and historically significant objects, buildings, and environments, encompassing both tangible and intangible heritage. Through exhibitions, public programmes, and educational initiatives, museums contribute to raising awareness of cultural heritage values and promoting societal engagement in heritage preservation. In addition, museums undertake research and documentation activities that ensure knowledge about cultural environments is systematically recorded and made accessible for future generations. Collaboration with governmental bodies, local communities, and international organisations further strengthens their role in safeguarding and promoting cultural heritage within broader societal and policy frameworks (Museilag (2017:563), 2017).

Sweden's approach to cultural heritage protection significantly differs from other European countries, particularly through its emphasis on shared responsibility and integration into spatial planning. Unlike centralised systems like Germany's *Denkmalschutz* or France's *Monuments historiques,* Sweden's decentralised model empowers municipalities to incorporate cultural values into everyday planning. This flexibility can lead to variations in how heritage values are interpreted and protected locally, influencing decisions on interventions such as photovoltaic installations in historic areas. Consequently, Sweden serves as a relevant case for examining how heritage frameworks can be adapted to align with energy transition objectives while upholding international conservation principles endorsed by ICOMOS.

Energy Policies Supporting Decentralised Small-Scale Photovoltaic Systems

Studying energy policies alongside building and cultural heritage regulations is essential for understanding how the energy transition can be realised in historic contexts without undermining conservation objectives. Energy policy plays a crucial role in the deployment of photovoltaic systems in Sweden, alongside legislative and planning frameworks for the built environment and cultural heritage. While these frameworks dictate where and how photovoltaic installations can occur, energy policies establish the economic and regulatory conditions that impact their viability. For studies on integrating photovoltaics in sensitive or historic areas, it's vital to consider national energy policies in conjunction with planning and heritage governance. Any shift towards decentralised renewable energy must align with and adapt existing policies on energy production, distribution, and taxation.

Over recent decades, the Swedish government and regulatory authorities have increasingly recognised the role of decentralised and small-scale energy systems in achieving national climate and energy objectives. Consequently, a range of policy instruments has been implemented to support distributed renewable energy generation, including financial incentives, market-based mechanisms, and regulatory measures designed to facilitate grid connection and electricity trading. The effectiveness of these policies is reflected in the rapid growth of photovoltaic installations across the country, particularly within the residential and public building sectors (Swedish Energy Agency, 2024). Furthermore, guidance on the practical implementation of photovoltaic systems is provided through sector-specific reports, such as those published by Public Property Sweden (Offentliga Fastigheter) (Sveriges kommuner och regioner, 2021), which present examples of photovoltaic installations in public buildings and outline relevant legislative and regulatory conditions. Such grey literature plays an important role in translating national energy policy into operational knowledge for municipalities, property owners, and public actors engaged in energy retrofitting projects.

From an economic perspective, Sweden offers several incentive schemes for small-scale renewable electricity producers regulated under the Swedish Income Tax Act and administered by the Swedish Tax Agency (Skatteverket). Private individuals, legal entities, and Swedish trading companies are eligible for a tax reduction of 0.60 SEK per kilowatt-hour for surplus renewable electricity fed into the grid, up to a maximum of 30,000 kWh per year. This incentive is regulated through the income tax system and requires that the network concessionaire be notified of electricity production and grid feed-in (Income Tax Act [1999:1229]; Skatteverket, 2024). In addition, the *electricity certificate system* (elcertifikatsystemet) functions as a market-based support mechanism aimed at increasing the share of renewable electricity generation. Renewable electricity producers are eligible to receive electricity certificates and guarantees of origin for a period of up to 15 years, if production is measured by an approved meter and reported to the Swedish Energy Agency via an authorised reporting service. The market value of electricity certificates fluctuates over time, introducing an element of economic uncertainty for producers (Swedish Energy Agency, 2025b).

Regulatory obligations also apply depending on the scale of production and consumption. If a solar power installation produces more than 60,000 kWh annually and the electricity is consumed within the property, the facility becomes subject to *quota obligations* (kvotplikt) and must be reported to the Swedish Energy Agency (Sveriges Kommuner och Regioner, 2021). The definition of small-scale energy facilities further varies across regulatory domains, including

energy taxation, grid access, and production licensing. Under the Swedish Energy Act (Energilagen, SFS 1994:1775), producers supplying electricity to a concession-obligated grid are generally subject to energy taxation. However, micro-producers are exempt from grid fees for electricity fed into the grid and are entitled to tax reductions administered by the Swedish Tax Agency, reinforcing incentives for decentralised production. Additionally, several business models are available to prosumers, within the Swedish energy system. Research indicates that *Power Purchase Agreements (PPAs),* in which electricity is sold under contract to an external buyer, often represent the most economically advantageous model. Direct ownership of photovoltaic systems can also be financially viable, while leasing arrangements or coupling photovoltaic installations with *Battery Energy Storage Systems (BESS)* tend to offer lower economic returns under current market conditions. The financial performance of these models is commonly assessed using *Net Present Value (NPV)* and Payback Period calculations, which provide standardised metrics for evaluating investment feasibility (Molavi & Bydén, 2018).

Sweden's rapid growth in photovoltaic energy is evident, with over 92,000 grid-connected installations and a total capacity of around 1,593 MW by early 2022, contributing about four percent of household electricity consumption (Swedish Energy Agency, 2024). Recent regulatory reforms from the Energy Markets Inspectorate aim to boost consumer empowerment by promoting electricity sharing through the public concession grid, helping to mitigate exposure to fluctuating prices (Energimarknadsinspektionen, 2025). Technological developments, particularly in metering infrastructure, also support the integration of decentralised photovoltaic systems. *Smart meters*, capable of monitoring, recording, and communicating electricity generation and consumption in real time, have undergone significant regulatory and technical improvements in Sweden over the past two decades. These systems are especially beneficial for prosumers, enabling more precise energy management, grid interaction, and participation in emerging energy markets (Rajaguru, Johansson, & Granath, 2023).

Taken together, Sweden's energy policy framework provides strong economic and regulatory incentives for the expansion of decentralised photovoltaic systems. However, when photovoltaic installations are proposed within culturally or historically sensitive environments, these energy policy drivers must be reconciled with the constraints imposed by planning and heritage legislation.

Energy Communities in the Context of the Energy Transition and Cultural Heritage

Energy communities exemplify the intersection of energy policy, local governance, and societal engagement. When integrated into heritage-sensitive planning, they offer a promising pathway to deploy photovoltaic systems in historic and culturally significant contexts, balancing climate action with the preservation of architectural and cultural values.

Energy communities have emerged as an increasingly important component of contemporary energy policy and governance, particularly in the transition towards decentralised and renewable energy systems. They consist of individuals, households, businesses, and organisations that collectively generate, share, and manage energy resources, often to promote sustainability, local self-sufficiency, and social cooperation while reducing dependence on fossil fuels and centralised energy systems. Members of energy communities typically produce energy from renewable sources, such as photovoltaic systems or wind power, and consume it locally. This localised production and consumption can reduce transmission losses, enhance energy efficiency, and contribute to grid stability. Energy communities are characterised by collective decision-making and shared management structures, enabling members to participate actively in decisions concerning energy production, distribution, and consumption (European Commission, 2022). At the European level, energy communities are formally recognised within the *Clean Energy for All Europeans* package, which provides a legal framework for *Citizen Energy Communities (CECs)* and Renewable *Energy Communities (RECs*). These entities can take various legal forms, including cooperatives, non-profit organisations, and limited liability companies, depending on national implementation (European Commission, 2024).

Energy communities offer environmental, economic, and social benefits. Environmentally, they support renewable energy generation and greenhouse gas reduction. Economically, members may benefit from lower energy costs, collective purchasing, and local retention of energy expenditures, while socially, energy communities strengthen cohesion and collective responsibility for sustainability. In Sweden, regulatory frameworks already accommodate energy communities, and proposed reforms by the Energy Markets Inspectorate aim to simplify their establishment and operation further, allowing broad participation in CECs and RECs (Palm & Boije af Gennäs, 2022; Palm, 2021).

Complementing regulatory and organisational developments, national research initiatives such as the *E2B2* programme provide tools and knowledge to optimise energy use in buildings while considering human behaviour, building typologies, and lifecycle impacts (Energy, Buildings and Built Environment

Research Programme [E2B2], n.d..). For prosumers within energy communities, business models such as *Power Purchase Agreements (PPAs)* or direct ownership of photovoltaic systems remain financially viable, while collective investment structures facilitated by economic associations (ekonomiska föreningar) enable shared risk, pooled resources, and coordinated deployment (Molavi & Bydén, 2018; Bolagsverket, 2024). By combining the economic, technical, and organisational capacities of energy communities with context-sensitive planning and heritage management, it becomes possible to implement decentralised photovoltaic generation in ways that respect cultural landscapes and support Sweden's climate and energy goals.

3
Conceptual Framework

This chapter develops a conceptual framework that synthesises concepts from multiple theoretical domains to address the complex challenges of integrating renewable energy technologies within culturally significant urban environments (Figure 4). This integration provides a foundation for examining how participatory, communicative, and value-driven processes can facilitate sustainable energy transitions in heritage contexts.

The selected theories reflect a deliberate effort to bridge the disciplinary boundaries between participatory design, urban planning, and preservation. Together, they provide an integrative lens for understanding the interdependencies among social, cultural, and technological systems that shape urban transformation. The framework thus transcends conventional disciplinary silos by combining the normative orientation of communicative planning, the reflective and experiential dimensions of participatory design, and the value-based tenets of contemporary conservation theory. Ultimately, this integrated framework bridges theory and practice by also aligning theories on complexity and value-sensitive design, enabling more democratic, context-sensitive, and sustainable urban energy transitions

Within this framework, Heritage Studies provides the contextual grounding by emphasising the cultural, historical, and spatial values embedded in the built environment. It frames heritage not as static, but as a dynamic and socially constructed process, shaped by contemporary needs, identities, and future aspirations. Contemporary Conservation Theory contributes a critical dimension to the framework by expanding traditional notions of heritage beyond material preservation to include intangible, social, and experiential values (Smith, 2006; Muñoz Viñas, 2005). This perspective acknowledges that conservation decisions are inherently subjective and culturally contingent. In the context of integrating photovoltaic technologies into heritage districts, this recognition is crucial for balancing the imperatives of sustainability and cultural continuity (Avrami, 2016).

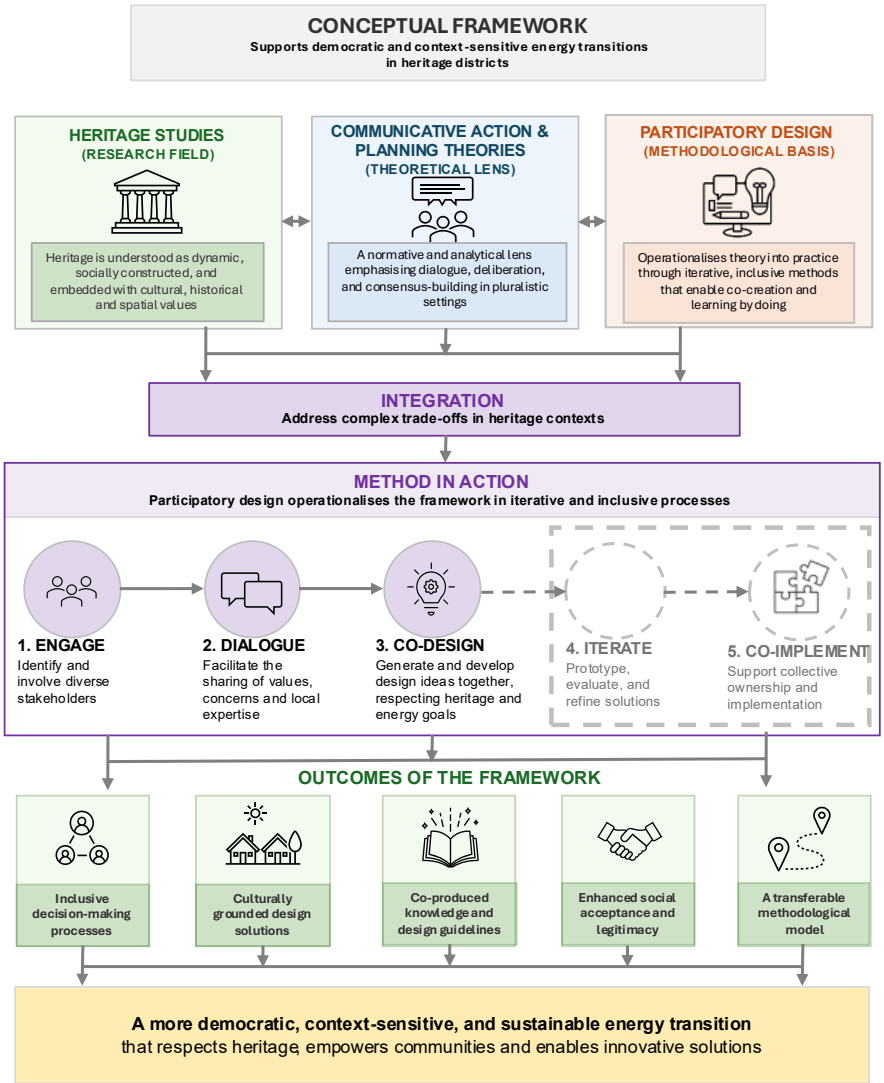

Figure 4. *The framework integrates Heritage Studies as the research field, Communicative Action and Planning Theories as the theoretical lens, and Participatory Design as the methodological foundation. To strengthen the theoretical framework, integrating complexity theory and value-sensitive design (VSD) highlights that iteration and co-implementation (steps 4 and 5 in the figure – method in action) are essential in this context.*

Communicative Action and Planning Theories (Habermas, 1991; Healey, 1997) offer a normative and analytical lens for understanding how decisions are made in pluralistic societies. They emphasise dialogue, deliberation, and consensus-building among diverse stakeholders, highlighting the importance of transparency, inclusivity, and power relations in planning processes. In the context of energy transitions, these theories help conceptualise how different actors, prosumers, planners, policymakers, and experts can engage in meaningful negotiation over competing values such as conservation, sustainability, and technological innovation.

Participatory Design functions not merely as a guiding principle but as a central research methodology, operationalised through empirical design and data collection processes. Its iterative and inclusive nature enables the articulation and integration of local knowledge, cultural identity, and community values into design development, as stakeholders are actively involved throughout multiple stages of the process (Wacnik et al., 2024; Björgvinsson et al., 2012). As a complementary theoretical foundation, Participatory Design frames participation as both a method of engagement and a process of inquiry, emphasising collaboration, mutual learning, and the co-production of knowledge between researchers, practitioners, and communities (Robertson & Simonsen, 2012). This perspective aligns with broader epistemological traditions of participatory and communicative research, where knowledge is understood as relational, situated, and collectively constructed through iterative and reflexive processes (Kemmis et al., 2015).

Complexity theory views heritage and energy transition planning as a dynamic system with interconnected actors and uncertainties. Outcomes in such systems are often unpredictable, and small changes can have significant, non-linear effects (Byrne, 2003). Therefore, a one-time planning effort is inadequate. Iterative processes enable stakeholders to continuously test, reflect, and adapt interventions as new insights arise, helping them navigate uncertainty and respond to changing conditions.

Value-sensitive design integrates human values into the design process through a structured methodology for identifying and incorporating ethical considerations such as fairness and human well-being (Friedman, 1996). However, values can be plural, contested, and context-dependent, with different stakeholders prioritising them differently. Co-implementation is therefore essential, as it allows stakeholders to actively engage not only in defining but also in translating these values into practice. Ongoing collaboration helps negotiate conflicts and iteratively refine solutions to better reflect shared or balanced values (Friedman et al., 2013; Ehn, 1993).

Contemporary Conservation Theory, Sustainable Preservation, Heritage and Environmental Futures

Early modern preservation theory is grounded in the principle that cultural heritage should be preserved in a manner that remains true to its original history, materials, and function. This perspective emphasises the importance of authenticity, material integrity, and respect for the passage of time, advocating minimal intervention to avoid falsifying historical evidence (Ruskin, 1849; Riegl, 1903/1982; Brandi, 1963/2005). According to Jokilehto (2018), this traditional approach views authenticity as an objective attribute of a building's physical fabric, an intrinsic quality rooted in its materiality and historical continuity. Within this paradigm, the conservation object itself was privileged over the subjective interpretations or social meanings attached to it (Bedoire, 2017). Consequently, the task of conservation was primarily technical, oriented toward material preservation and historical fidelity.

Contemporary conservation theory has evolved as a critical and reflexive field that challenges the assumptions underlying early modern preservation thoughts. In recent decades, scholars have questioned the notion of conservation as a neutral, scientific process, emphasising its social, political, and cultural dimensions. A central debate within this shift concerns whether conservation should be understood as an act of preservation, maintaining the object's "truth" as an unchanging historical record, or as a transformative process that enables heritage to adapt to contemporary contexts and needs. Muñoz Viñas (2005) argues that conservation is not merely a technical endeavour but also an interpretative and creative act shaped by human values and intersubjective negotiation. From this perspective, authenticity is not a fixed quality residing in the material substance of a heritage object but a socially constructed attribute that emerges through dialogue among stakeholders. His concept of *intersubjectivism* positions conservation within a communicative framework: an artefact or building attains the status of a conservation object only when its social, cultural, or scientific significance is recognised within a broader societal context. When these shared meanings dissipate, the object risks losing its heritage value altogether.

This intersubjective understanding aligns closely with Habermas's theory of communicative action, in which rational consensus is achieved through inclusive dialogue rather than through technocratic authority. Yet, as Muñoz Viñas cautions, conservation practice has often been characterised by restricted arguability, the tendency to limit participation to experts and institutional actors

while excluding citizens, local communities, and other affected groups. This exclusionary dynamic mirrors what Laurajane Smith (2006) identifies as the *Authorised Heritage Discourse (AHD)*: a dominant narrative that privileges expert knowledge and institutional authority while marginalising alternative or community-based understandings of heritage. Smith argues that heritage is not a static inheritance but a cultural process or performance in which meanings are continuously negotiated and contested among diverse actors.

Reframing conservation through the lenses of participatory design, complexity theory, and value-sensitive design provides a more inclusive and dynamic framework for addressing these tensions. Participatory design, rooted in democratic ideals of co-creation, emphasises that those affected by design and planning decisions should have an active role in shaping them. Applied to heritage conservation, this approach challenges ownership-based definitions of stakeholder legitimacy, acknowledging that citizens, whether residents, visitors, or members of a broader cultural community, possess valid perspectives that contribute to the evolving meaning and value of heritage.

Building on the theoretical evolution from early modern preservation to contemporary conservation, *sustainable preservation* represents an emergent paradigm that repositions heritage practice within the broader framework of environmental, economic, and social sustainability. Contemporary conservation foregrounds intersubjective value and adaptive reuse; sustainable preservation extends this discourse toward long-term ecological and social resilience. It reflects a systems-based understanding of heritage, one that recognises the complex interdependencies between built environments, communities, and the planet's ecological systems. Peter Calthorpe (2011) situates sustainable urbanism as a foundational response to the climate crisis, advocating for an integrated approach to urban design that combines renewable energy systems, conservation techniques, and green technologies. His work emphasises that sustainability is not only a technological pursuit but also a design ethos, one that requires urban form, mobility systems, and energy infrastructure to operate as interrelated components within a larger socio-ecological whole. The integration of "smart" grids, climate-responsive architecture, and next-generation transit networks reflects a shift from isolated interventions toward adaptive, self-regulating systems. This systems perspective is equally relevant to the field of heritage conservation, where interventions must balance the stability of cultural values with the dynamic requirements of environmental adaptation.

Erica Avrami (2016) further develops this conceptual bridge by exploring the intersection of historic preservation and sustainability. She highlights both the synergies and tensions between preservation practices and sustainability objectives, arguing that while preservation can advance environmental goals by

reducing resource consumption, promoting urban densification, and supporting social cohesion, it can also conflict with sustainability imperatives when rigid preservation policies hinder adaptive interventions or renewable energy integration. Avrami's critique underscores the need for heritage policy to evolve beyond static regulatory frameworks toward more reflexive and adaptive systems capable of responding to changing environmental, economic, and societal conditions. This can lead to more inclusive and equitable solutions that respect historic and environmental values. Operationalising sustainable preservation requires multidimensional strategies that link theory with practice. *Adaptive reuse* is a key instrument, allowing historic buildings to serve contemporary needs while preserving their cultural significance. This strategy minimises the environmental footprint of new construction and maintains the material and symbolic continuity of place. Minimally invasive technologies, such as interior storm windows or reversible insulation systems, enhance energy efficiency without compromising architectural authenticity. Similarly, updating preservation guidelines to accommodate climate-adaptive modifications, such as solar panels or green roofs, reflects a pragmatic balance between historic integrity and ecological performance. Central to these strategies is stakeholder engagement. Involving local communities in planning processes ensures that diverse perspectives and lived experiences shape the outcome, aligning with the participatory and communicative frameworks that underpin contemporary conservation theory. Such engagement promotes inclusivity, equity, and cultural relevance, transforming preservation from an expert-driven practice into a collaborative societal endeavour.

To foster sustainable preservation, Avrami (2016) advocates for a research-based approach that incorporates feedback loops and continuous learning, highlighting the complexity of policy development. Central to this strategy is systematic research that assesses the long-term impacts of preservation and sustainability, allowing for informed decision-making. Empirical data on energy performance, economic outcomes, and social effects are essential for aligning preservation practices with sustainability goals. The author further emphasises the need for policy frameworks that link preservation and sustainability, thereby reducing fragmentation across sectors. This integration requires collaboration among heritage professionals, urban planners, environmental specialists, and policymakers. Moreover, education and training through workshops and certification programs are vital for embedding sustainable practices in the field, fostering a shared understanding of how to pursue cultural heritage conservation alongside sustainability objectives. These approaches reinforce that heritage conservation is not a static act of preservation but an ongoing process of negotiation and adaptation within a complex socio-ecological system.

Sustainable preservation thus extends contemporary conservation theory by embedding it within the paradigms of resilience, circular economy, and participatory governance. It transforms conservation into a forward-looking practice, one that safeguards cultural identity while enabling sustainable futures.

Communicative Action and Planning Theories

This section discusses communicative action and planning theories, including some criticisms of these ideas and their justification for this study.

German philosopher and sociologist Jürgen Habermas developed the theory of communicative action. Habermas's framework emphasises the role of communication in social interactions. The theory also addresses power imbalances by stressing the importance of dialogue and mutual understanding in social interactions (Habermas, 1991). Hanna Arendt, preceding, explored the concept of *vita activa* (active life) and its three fundamental activities: labour, work, and action. Related to Habermas' theory is the notion of action: In Arendt's view, action is the most significant activity, as it involves interaction and communication between individuals in the public sphere. Action is tied to freedom and plurality, allowing humans to initiate new events and influence the course of history (Arendt, 2018/1958). Max Weber's influence on communicative action is significant through his ideas of rationalisation and social action. His concept of rationalisation, involving the increasing dominance of reason and logic in social life, influenced Habermas's distinction between communicative and strategic action. Communicative action aims at mutual understanding and consensus, while strategic action is oriented toward success and manipulation (Sharlamanov, 2024).

Habermas' writings contain some cornerstones, which are discussed here. He begins to suggest that rationality in communication extends beyond instrumental reasoning. It includes communicative action as a fundamental part of human rationality. This means pursuing goals (*strategic rationality*), participating in meaningful communication, and achieving mutual understanding (*communicative rationality*). In an ideal conversation, everyone communicates openly and sincerely, aiming for a *rational consensus* without influence or pressure. This sets a standard for fair communication and helps to identify and minimise power imbalances (Habermas, 1991).

Thus, the widely impactful theory of communicative action has encountered some criticisms. These critiques shed light on the intricate and multifaceted nature of communicative action theory, implying that while it offers valuable

insights, it may only partially encompass the complexities of human communication and social interaction.

Critics argue that Habermas's emphasis on rational communication is overly idealistic. Power dynamics and social inequalities often distort communication, making it challenging to engage in true rational discourse. (Kompridis, 2006) Some see the focus on achieving consensus through dialogue as unrealistic. In many cases, conflicts and disagreements are inevitable and cannot always be resolved through rational discourse (Baxter, 2006). Applying the theory to real-world situations can be challenging. Critics argue that the abstract nature of communicative action makes it challenging to implement in practical contexts, such as politics or organisational management (Haferkamp, 1985).

Also, Hillier (2003) challenges Habermas' notion of rational consensus formation, arguing that achieving consensus is unrealistic due to conflict, non-reciprocity, and power dynamics in decision-making processes. She introduces the idea of agonism, which recognises the permanence of conflict and the role of power struggles in planning and political discourse. Hillier suggests that incorporating insights from Jacques Lacan alongside Habermas' theories rooted in psychoanalytical traditions could offer a more nuanced understanding of the complexities in planning practices (Hillier, 2003).

Chantal Mouffe (2005) explores the complex and contradictory elements of contemporary liberal democracy. She argues that democracy is characterised by a tension between two essential principles: liberalism, which places a strong emphasis on individual rights and the rule of law, and democracy, which focuses on equality and popular sovereignty. Mouffe critically analyses the views of thinkers like John Rawls and Jürgen Habermas, who prioritise the pursuit of consensus and rational deliberation in democratic politics. Instead, she advocates for *agonistic pluralism*, which proposes that democratic politics should be a space for legitimate conflict and dissent. This approach emphasises the value of adversaries rather than enemies, aiming to cultivate a dynamic and vibrant democratic process characterised by lively debate and the recognition of diverse viewpoints. The work articulates that conflicts are an inherent part of political life and are likely to be temporary. Instead, she emphasises the importance of ongoing debate and contestation to sustain a balance between liberal and democratic values. According to Mouffe, this continual engagement is crucial for the functioning of a healthy and vibrant political system.

Some propose a new framework for planning to address this kind of discussion, emphasising the importance of understanding institutional contexts and advocating for communicative action. This approach involves engaging various stakeholders in dialogue to shape urban spaces, aiming to create more sustainable and equitable environments. It also calls for planners to adopt more

inclusive, communicative, and collaborative approaches to address the contemporary challenges of urban development (Healey, 1997).

This approach is particularly feasible in Sweden. Throughout history, the people of Sweden have traditionally relied on discussions and dialogue to reach decisions rather than resorting to formal voting processes. As a result, Sweden has cultivated a rich tradition of employing communicative practices as the cornerstone of its decision-making processes. This tradition presents ample opportunities for continued refinement and development in the future (Wänström, 2013).

Davidoff argued in the 1960s for a more inclusive and democratic approach to city planning. He emphasises the need for planners to advocate for various interest groups within society, especially marginalised communities. Planners should not be neutral technicians but advocates who represent the interests of different groups, much like lawyers represent their clients. Recognising that various groups have different needs, Davidoff proposed that multiple plans should be developed to reflect these diverse interests. This approach contrasts with the traditional unitary plan that often serves the interests of the more powerful. (Davidoff, 1965).

Urban planning ensures efficient and equitable land use globally while protecting natural, built, and historic resources (Couch, 2016). Urban planning theory includes two main categories: (a) theories of planning and (b) theories in planning. *Theories of planning* focus on the procedural aspects, while *theories in planning* address the content and goals of plans (Faludi, 1973). The landscape of planning theory has evolved significantly. The initial transformation involves reconceptualising planning as a holistic process that engages the entirety of society, transitioning from a narrow technical focus to a broad societal scope. The subsequent shift has elevated planning to an art form deeply intertwined with politics. The framework of planning theory encompasses three critical tasks: the development of a philosophy centred on human welfare, the ability to accommodate the complexities, scales, and time pressures of the real world, and the assimilation of insights and knowledge derived from diverse disciplines into the practice of planning (Friedmann, 2020). This argumentation is relevant to examining contextual differentiation: how participatory design methods can adapt to diverse contextual factors, including geographical, social, and environmental variations, and investigating the impact of contextual nuances on integrating photovoltaic systems within built environments.

In Sweden, two key principles guide the approach to sustainable urban development, which aligns with the focus of this study. First, social inclusion ensures that urban development benefits all segments of society and promotes equality and accessibility. Second, public participation involves the community

in the planning process to ensure that development meets the needs and desires of residents (Government Offices of Sweden, 2018).

Although it is crucial to include citizens in planning (Forester, 1999). It is also essential that a design process involves experts. The art of knowing and doing extends *subsidiary awareness* to a point beyond ourselves; for example, the object is what is essential. This reduces the experts' subjectivity (Polanyi, 2015). Planning should reflect normative values rather than just process and technical matters. It is not a value-free activity but a political action in which planners must make *normative* judgments. (Friedmann, 2020) Participation, deliberative democracy, and collaborative planning are essential for achieving humanistic goals, but they must be developed and implemented.

John Forester (2009) continues to explore how effective deliberative practices can enhance participatory planning. He draws on real-world accounts from urban and rural settings to demonstrate how these practices facilitate practical and timely decision-making processes. The book integrates insights from political science, law, philosophy, literature, and planning to address the challenges and possibilities of deliberative practice. He emphasises the importance of political vision and pragmatic skills in managing complex issues, such as environmental quality, urban design, and economic development. He highlights how skilful deliberation can navigate the suspicion, anger, and power dynamics often present in participatory planning (Forester, 1999). He continues to address power imbalances in participatory planning by emphasising planners' role as facilitators of deliberative democracy. He suggests that planners engage in the politics of meaning, which involves listening, learning, and shaping attention within the participatory process. He problematizes the notion of the *public* as inherently contentious and filled with power dynamics. He argues that planners can help mitigate these imbalances by fostering inclusive dialogues and ensuring that all voices, especially those of marginalised groups, are heard and considered. This approach aims to create a more democratic and just planning process by enhancing the quality and quantity of communication among all stakeholders. Forester believes planners can navigate and address the power imbalances that often hinder effective participatory planning by focusing on these micro-planning practices.

Additionally, Forester discusses the *politics of meaning* in participatory planning, which revolves around how planners can shape and influence the understanding and significance of issues within the planning process. This concept emphasises the role of planners in facilitating meaningful dialogue and ensuring that diverse perspectives are acknowledged and integrated into decision-making. He argues that planners should act as mediators, helping stakeholders articulate their concerns and aspirations. Doing so can create a shared understanding of the

issues, which is crucial for effective and inclusive planning. This involves listening actively, planners must listen to all stakeholders, especially marginalised groups, to understand their perspectives and needs. Planners can help frame issues in ways that resonate with different stakeholders, making the planning process more inclusive and democratic. By encouraging open and respectful dialogue, planners can help stakeholders find common ground and work towards mutually beneficial solutions. This approach addresses power imbalances by ensuring that all voices are heard and that the planning process is transparent and participatory.

Participatory Design, Cultural Heritage and Photovoltaic Technologies

Participatory design has increasingly been recognised as a means of empowering communities through processes of shared creativity and collective innovation (de la Peña et al., 2017; Rosetti, 2022). Rather than viewing citizens as passive recipients of expert decisions, this approach situates them as active co-creators of the environments in which they live. It emphasises the value of local knowledge, cultural context, and lived experience as essential forms of expertise that inform and enrich the design process. In acknowledging the plurality of stakeholder values and perspectives, participatory design fosters more inclusive modes of knowledge production, enhancing both the social legitimacy and contextual sensitivity of architectural and technological outcomes (Luck, 2018).

Arnstein's seminal contribution to participatory theory underscores the ethical and epistemic rationale for involving residents directly in shaping their surroundings, asserting that those who live within a neighbourhood possess a unique, situated understanding of its dynamics and potential (Arnstein, 2019/1969). In the context of cultural heritage, this recognition is particularly critical: the involvement of local actors enables the co-creation of solutions that balance the protection of historical and aesthetic values with the integration of emerging technologies such as photovoltaic systems.

Within this framework, participatory design can be viewed as a practical extension of design research, an evolving field that examines how people engage with and influence design processes. Design research offers both methodological tools and theoretical foundations for participatory engagement, combining empirical inquiry with creative exploration to bridge the social, cultural, and technical dimensions of design practice. Techniques such as mock-ups, co-design workshops, and temporary interventions are commonly used within participatory design but are also a fundamental part of design research,

as they generate both design outcomes and research insights through iterative, collaborative experimentation (Gugerell & Zuidema, 2017; McGookin et al., 2021).

Participatory design research further expands this perspective, serving as a methodological nexus that integrates qualitative and quantitative insights to illuminate how people interact with technologies, environments, and systems. As Cross (1982) argues, design research foregrounds user needs, motivations, and behaviours, ensuring that design outcomes are not only technically efficient but also culturally resonant and socially legitimate. When applied to heritage contexts, design research may facilitate participatory processes that are both research-driven and inclusive, producing solutions that are sustainable, situated, and adaptive to local socio-cultural ecologies. The challenge of integrating photovoltaic technologies within heritage districts exemplifies the necessity of such an approach. While photovoltaic systems may be essential for mitigating climate change, their visual and material characteristics often conflict with the aesthetic, cultural, and regulatory frameworks governing heritage conservation. In this context, participatory design becomes more than a methodological choice; it carries normative significance. By engaging diverse stakeholders in co-creation, participatory design cultivates communicative spaces where technological innovation and cultural preservation are negotiated rather than opposed.

Stegall (2006) reminds us that sustainability transcends the production of "green" artefacts; it must instead be understood as a holistic integration of ecological principles into the fabric of everyday life. Sustainability, therefore, encompasses material performance, social practice, and cultural meaning. In heritage districts, photovoltaic integration cannot be reduced to a technical retrofit but must instead involve fostering sustainable lifestyles and behaviours that resonate with local traditions and collective values. Participatory design may provide the necessary framework for aligning sustainability objectives with the lived realities of heritage communities. Holm et al. (2010) situate design as a pivotal mechanism for addressing sustainability through interdisciplinary collaboration. Sustainable design, they argue, requires systemic transformation, rethinking how societies inhabit, produce, and interact with their environments. This systemic perspective is particularly pertinent within heritage contexts, where the intersection of conservation and energy transition demands a re-evaluation of entrenched paradigms in urban planning, technology, and policy. Participatory design supports such systemic rethinking by mobilising diverse actors to negotiate values, articulate priorities, and collectively envision transformative futures. In the same vein Samson (2010) critiques the rationalist and materialist underpinnings of conventional urban planning, which often

prioritise economic efficiency over cultural expression and creativity. Drawing on Deleuzian thought, she proposes a process-oriented, dynamic conception of urbanism, one that embraces uncertainty, multiplicity, and emergence. This aligns closely with complexity theory, which views heritage environments as adaptive systems where cultural, material, and technological elements co-evolve. Participatory design resonates with this orientation by fostering adaptive processes that remain responsive to changing socio-technical and ecological conditions. In heritage districts negotiating the dual imperatives of preservation and decarbonisation, such dynamic and *cross-disciplinary* modes of engagement are needed.

The dynamics of technological change further underscore the importance of participatory and communicative approaches. Rip and Kemp (1998) conceptualise technological evolution within sociotechnical regimes, stabilised networks of practices, norms, and institutions that structure innovation. While these regimes sustain continuity, they also resist disruption, constraining the integration of renewable technologies in historically conserved settings. Overcoming such inertia requires cultivating niches, protected spaces where experimental innovations can evolve. Smith's (2003) framework of *Strategic Niche Management (SNM)* underscores the importance of collaborative governance and local experimentation in nurturing these niches. Participatory design aligns closely with this logic, creating localised arenas where new socio-technical practices, such as contextually sensitive photovoltaic applications, can be co-developed with residents, designers, and regulators. Geels' (2002) *multi-level perspective (MLP)* further elaborates this dynamic, framing transitions as the interaction of niches, regimes, and broader socio-technical landscapes. Heritage districts embody the complexity of these interactions: they are anchored in entrenched conservation regimes yet increasingly shaped by social pressures, such as climate policy and energy security. Within this complex system, participatory design functions as a mediating mechanism that links niche experimentation (e.g., pilot photovoltaic projects) with institutional regimes and broader landscape transformations, facilitating adaptive transitions that may be both culturally legitimate and technologically progressive.

Von Hippel's (2005) concept of user-centred innovation reinforces the epistemic value of local participation. By treating users as co-creators rather than passive recipients of technology, this approach foregrounds the role of situated knowledge in driving innovation. In heritage contexts, prosumers and local actors may hold significant

insights into building traditions, social practices, and aesthetic norms that expert-driven or technocratic planning processes cannot substitute.

Integrating Complexity Theory into Planning, Conservation, and Participatory Design

To understand and guide contemporary social and urban change, it is valuable to draw on complexity theories. Contemporary urban systems are dynamic, interdependent, and adaptive, rendering traditional linear and rational planning models insufficient. As Byrne (2003) argues, planning must move beyond control-oriented paradigms to embrace uncertainty, diversity, and emergence. This shift reframes planning as a communicative and reflexive practice centred on learning, negotiation, and adaptation rather than prediction and control.

Complexity theory highlights that urban and social systems are characterised by non-linearity, emergence, path dependence, and sensitivity to initial conditions. Small interventions can have disproportionate and unpredictable effects, while patterns and forms emerge from interactions among multiple actors rather than from top-down design. The historical trajectories of cities constrain future possibilities, and outcomes vary significantly depending on timing and context. Such insights challenge the rationalist planning tradition and align more closely with communicative approaches that emphasise dialogue, participation, and collective sense-making. From this perspective, planning and participatory design become processes of co-evolution within *complex adaptive systems (CAS),* where continuous feedback and adaptation are central. Habermas' theory of communicative action provides an important foundation for this orientation, framing planning as a process of mutual understanding and deliberation among diverse actors. Additionally, it is important to align with institutional processes that can help implement outcomes. When these conditions are lacking, or only partially fulfilled, participatory design often remains in an exploratory phase, yielding insights that have little to no impact (Sanders & Stappers, 2008; Ehn, 2008). Within complex systems, communicative action supports adaptive governance by enabling collective reflection and coordinated action in the face of uncertainty.

In the context of conservation and the urban energy transition, complexity theory offers a productive framework for understanding socio-technical change as emergent and relational. Energy transitions unfold through networks of human and non-human actors, institutional structures, material infrastructures, and cultural practices. Their trajectories are contingent and path-dependent, shaped by historical energy systems, spatial configurations, and local values. Heritage settings exemplify this complexity: they embed layered histories, contested meanings, and diverse stakeholder interests, making linear planning or technological substitution insufficient. A complexity-informed approach positions participatory design as a mode of experimental governance within

energy transitions, an iterative process through which actors co-create knowledge, explore alternatives, and negotiate change. It emphasises the capacity of communities to adapt, learn, and transform within existing constraints. Adapting Byrne's (2003) complexity framework in this way situates planning, conservation, and participatory design as communicative and adaptive practices capable of responding to the contingent, emergent, and interdependent realities of contemporary urban energy transitions.

The case studies provide a situated context in which to explore these theoretical propositions. As a historical settlement undergoing an energy transition, it embodies the interplay between material infrastructures, cultural heritage, and social negotiation that complexity theory helps to illuminate. The process of transitioning toward sustainable energy futures within a heritage environment reveals how technical, social, and symbolic systems are deeply intertwined and mutually adaptive. Following Byrne's (2003) argument and extending it through Healey's (2007) relational understanding of planning and Hillier's (2010) conceptualisation of cities as complex, self-organising assemblages, the cases illustrate how planning operates within open, contingent, and emergent systems. This perspective aligns closely with Innes and Booher's (2010) notion of collaborative rationality, which frames planning as an adaptive process emerging from interaction, learning, and negotiation among interdependent actors. Participatory design in this context becomes a means of navigating complexity through inclusive, communicative practices that foreground local knowledge, values, and identities. Rather than treating heritage as a constraint on innovation, case studies can serve as a generative resource for imagining and co-producing resilient, place-based transitions.

Through iterative dialogue and experimentation, stakeholders collectively learn to balance continuity and change, aligning the preservation of cultural meaning with the pursuit of environmental transformation. This situated analysis thus operationalises Byrne's (2003) complexity framework, enriched by Healey's (1997), Hillier's (2010), and Innes and Booher's (2010) relational and collaborative perspectives, to show how adaptive, communicative planning practices can support just and context-sensitive energy transitions in historic urban settings. In this sense, conservation is not solely about safeguarding the past but about facilitating an ongoing dialogue between past, present, and future. Adaptive design practices that repurpose historic buildings for contemporary use exemplify this synthesis: they maintain continuity with heritage while accommodating new functions and meanings relevant to modern life (Muñoz Viñas, 2005). Through participatory engagement and value-sensitive reflection, conservation can become a communicative and transformative practice, one that

acknowledges heritage as a living system co-constructed by its stakeholders rather than as a static artefact preserved by experts.

Value Sensitive Design

An existing methodological framework that provides a systematic and principled means to integrate human values into technological and spatial design processes is the value-sensitive design framework. Developed by Batya Friedman and Peter Kahn at the University of Washington (Friedman et al., 2013), the framework offers a structured approach for embedding ethical and social considerations into design practice. It operates on the premise that technologies, and by extension, design interventions, should promote values such as privacy, autonomy, justice, environmental responsibility, and fairness. It supports and extends participatory design methodologies, offering a conceptual and procedural foundation for inclusive and ethically attuned design and planning in complex socio-technical systems.

Value-sensitive design encompasses three interrelated and iterative modes of investigation (Figure 3): (1) Conceptual Investigations, which identify and clarify stakeholders and the values at play within a particular design context. (2) Empirical Investigations, which gather and interpret data on how individuals and communities interact with technologies and articulate their value priorities; and (3) Technical Investigations, which explore and evaluate how specific design choices embody, support, or potentially undermine those values. The iterative nature ensures that design processes remain adaptive, reflexive, and responsive to emerging insights and changing circumstances, an approach particularly aligned with complexity theory and the recognition that cultural and technological systems are non-linear, dynamic, and interdependent. In this respect, it serves as a mediating framework that accommodates uncertainty and diversity in stakeholder perspectives, enabling the negotiation of value conflicts and the co-production of shared meaning over time.

Within the context of cultural heritage districts, the approach offers a valuable methodology for navigating the tension between technological innovation, such as integrating renewable energy systems, and the conservation of historical and aesthetic values. As demonstrated in the application of value-sensitive design to the renovation of Dipoli by Luisa Mok and Sampsa Hyysalo (2018), the framework provides a means to operationalise ethical reflection in design decisions, ensuring that technological transitions are embedded within the social and cultural fabric of place. In heritage settings, this might include, for example, the careful siting of solar panels or energy-efficient retrofitting

strategies that respect architectural integrity and community identity while supporting environmental sustainability (Figure 4).

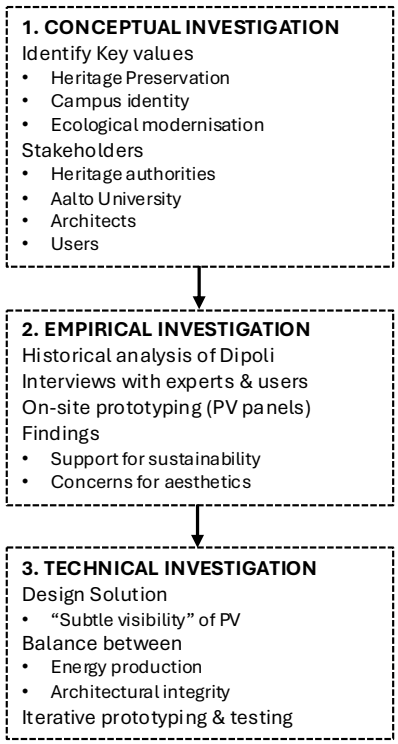

Figure 4 *Application of Value Sensitive Design in the Dipoli renovation project (adapted from Mok & Hyysalo, 2018).*

Furthermore, value-sensitive design aligns closely with communicative planning theory (Healey, 1997; Forester, 1999), which foregrounds dialogue, inclusivity, and mutual understanding among diverse actors. Both frameworks emphasise the importance of stakeholder engagement and deliberative processes to surface underlying values, address power asymmetries, and negotiate equitable outcomes. From a Habermasian perspective, the process can be viewed as a manifestation of communicative rationality within design practice, where argumentation, justification, and consensus-building inform decision-making in ethically complex contexts.

The practical implementation of value-sensitive design in heritage-related energy transitions involves several structured stages. These include identifying direct and indirect stakeholders, clarifying relevant values (e.g., authenticity, sustainability, accessibility), and articulating value scenarios that explore how design choices affect those values in practice. Subsequent stages involve empirical inquiries, through interviews, workshops, and participatory observation, to understand stakeholder perspectives, followed by technical investigations to explore how design alternatives might embody or reconcile conflicting values. The process culminates in the iterative development, testing, and refinement of prototypes or design proposals, guided by continuous stakeholder feedback and reflective evaluation against the identified values. However, operationalising it in practice presents several challenges (Friedman, 2021). Power asymmetries among stakeholders can result in specific values being privileged over others, particularly in contexts where institutional, professional, or economic interests dominate. These factors highlight a fundamental discrepancy between the desire for participation and the actual governance structures in place. Although participatory design is typically aimed at making planning more democratic, its effectiveness largely depends on how open and flexible institutions are, as indicated by research on empowered participatory governance. (Fung & Wright, 2003).

Moreover, assessing whether a design genuinely embodies the intended values is a methodologically complex process, requiring both qualitative and quantitative evaluation tools. The identification and prioritisation of values can also be contentious, especially when conflicts arise between preservation and innovation, or between privacy, efficiency, and transparency. Finally, embedding value-sensitive design principles in professional and industrial practice necessitates cultural and organisational shifts, as well as alignment with regulatory and policy frameworks that may not yet fully accommodate value-oriented methodologies. These challenges underscore the necessity of a reflective, iterative, and communicative approach to the framework, one that can engage with complexity, embrace pluralism, and adapt to evolving stakeholder constellations. Within participatory design traditions, value-sensitive design may contribute a robust ethical and methodological layer, enabling stakeholders to articulate and negotiate values explicitly rather than implicitly. By doing so, it strengthens the democratic and dialogical dimensions of design processes within heritage and sustainability transitions.

Ultimately, applying value-sensitive design within cultural heritage districts ensures that technological interventions, such as energy retrofits, innovative heritage systems, or adaptive reuse strategies, are not merely technically and functionally viable, but also ethically defensible, culturally resonant, and socially

sustainable. This alignment of communicative action, participatory design, and complexity-informed thinking situates it as a critical framework for mediating the relationship between technological change and the enduring values of place in the context of the energy transition. Taken together, communicative planning theory, participatory design, complexity theory, and value-sensitive design provide a comprehensive understanding of planning and design in heritage contexts undergoing energy transition. This integrated perspective conceptualises planning as a negotiated and communicative process, design as a participatory and knowledge-generating practice, and heritage transformation as a dynamic and value-laden process within complex systems.

4
Methodology

This chapter outlines the methodology and methods employed in this study. Methodology denotes the overarching research strategy and philosophical framework that guides the study, including assumptions about knowledge production and scientific inquiry (Åsberg, 2000). It provides the rationale for selecting methods and explains how these are combined into a coherent research design. Accordingly, this chapter outlines the study's methodological orientation, research design, and analytical framework, clarifying how the researcher's theoretical commitments inform decisions regarding case selection, data generation, and analytical approach, and how these methodological choices are integrated to address the research questions.

Abductive and Normative Inquiry

This research is guided by an abductive logic combined with a normative research orientation. Together, these approaches support an inquiry into participatory design practices situated at the intersection of cultural heritage and energy transition planning, a field characterised by uncertainty, competing values, and ongoing negotiation.

The study adopts an *abductive research logic*, which differs from deductive and inductive approaches by emphasising an iterative movement between empirical material and theory. Rather than testing predefined hypotheses or deriving theory solely from data, abductive reasoning allows theoretical concepts to be continuously refined in response to empirical observations. Abduction is particularly appropriate in contexts where existing theoretical frameworks only partially explain emerging empirical realities, and where the interplay between local knowledge, institutional structures, and socio-technical practices produces outcomes that are not entirely predictable (Dubois & Gadde, 2002; Timmermans & Tavory, 2012).

Stakeholders in this study, including municipal planners, residents, heritage experts, and energy consultants, bring diverse knowledge, perspectives, values, and priorities to the process. These dynamics may often generate unexpected or

contradictory outcomes. In the cases of Porsön, Öjebyn, and Visby, the concurrent negotiation of cultural heritage preservation and energy transition creates complex decision-making environments as energy transition strategies are usually assumed to conflict with heritage preservation. Observations from the case study's participatory workshops, interviews, and design interventions inform the refinement of theoretical categories. At the same time, insights from participatory design, contemporary conservation theory, communicative action, planning, and value-sensitive design provide conceptual tools for interpreting local practices. This cyclical process between theory and practice facilitated the generation of provisional explanations that were repeatedly tested and adjusted as additional material was analysed. Consequently, the study develops interpretations rooted in the specific context under examination. In addition to its abductive logic, the study is grounded in a normative research orientation. Normative research refers to a form of inquiry concerned with the establishment, evaluation, and prescription of values, standards, or principles that guide human action (Sayer, 2011). Unlike empirical research, which seeks to describe, explain, or predict phenomena through systematic observation and analysis, normative research addresses questions of how things ought to be (Friedman, 1996). It therefore moves beyond the identification of existing conditions to engage with the formulation of ideals or visions that inform decision-making, policy, and design.

Normative research operates at the intersection of theoretical reasoning and empirical investigation. Theories provide the conceptual scaffolding, the normative ideals and evaluative criteria, while empirical work grounds these ideals in the realities of practice (Sayer, 2011; Flyvbjerg, 2004). Within the fields of planning, design, and heritage studies, normative research plays a critical role in articulating the ethical, cultural, and social dimensions that underpin practice (Flyvbjerg, 2001; Mason, 2008). It does not aim solely to observe or measure behaviour but to interpret and evaluate it, considering broader societal goals and moral frameworks. For instance, within communicative planning theory, normative inquiry manifests in the pursuit of deliberative democracy, inclusivity, and mutual understanding as guiding principles for planning processes (Habermas, 1991; Healey, 1997). Similarly, in contemporary conservation theory, normative research is concerned with defining what should be preserved, why it holds value, and how change can occur without eroding cultural integrity (Avrami, Mason, & de la Torre, 2000; Pendlebury, 2009). In this interaction, empirical investigations serve to test, refine, and contextualise normative propositions, revealing how values are interpreted, negotiated, and enacted in specific settings. For example, participatory design processes can be examined empirically to assess how principles of inclusivity and co-creation, normative

ideals, are realised or constrained in practice (Björgvinsson et al., 2012; Luck, 2018). Normative research is employed to bridge theory and practice in developing a methodological framework for sustainable energy transition within heritage districts. The normative dimension is expressed through the adoption of communicative action, which prescribes ethical orientations for participatory engagement and technological integration (Habermas, 1991).

These theoretical commitments are complemented by empirical case studies that examine how such principles are applied in real-world design and planning contexts. Through this dialogue between normative theory and empirical evidence, the research aims to generate actionable knowledge that is both contextually grounded and value-driven. Thus, normative research within this framework not only describes existing heritage and energy practices but also critically evaluates them against theoretical ideals of inclusivity, sustainability, and cultural continuity (Healey, 1997; Mason, 2008). It offers a reflective stance that situates design and planning as inherently moral and political activities, ones that involve not only technical decisions but also judgments about what constitutes a just and sustainable future (Flyvbjerg, 2001; Sayer, 2011).

Case Study Method and Implementation

The case study method is the primary strategy for this study. A case study is an empirical inquiry that investigates a contemporary phenomenon in its real-life context, particularly when the boundaries between the phenomenon and its context are not clearly defined (Yin, 2009). The integration of energy transition measures within culturally and historically sensitive environments constitutes such a context, as technical, social, regulatory, and cultural dimensions are deeply intertwined and cannot be meaningfully separated. To ensure this, a structured research design that involves defining the case, formulating research questions, and employing theoretical concepts to guide the study is required.

The case study method enables an examination of complex social processes and supports the exploration of how stakeholders interpret, negotiate, and enact change in situ. Rather than isolating variables, case studies allow for the investigation of relationships, meanings, and practices as they unfold within specific settings. This makes the approach appropriate for research concerned with participatory design, where knowledge is produced through interaction and situated experience. The entire research study utilises multiple sources of evidence, such as participatory design workshops, stakeholder interviews, participant observation, design artefacts, and documentation (field notes, audio recordings, photographs), to ensure analytical triangulation and sensitivity to

contextual specifics. The research employs a *multiple-case study design* to examine participatory design processes across contrasting heritage contexts. Multiple-case designs are particularly appropriate when research seeks to explore variation, identify patterns, and assess the robustness of analytical insights across different settings (Yin, 2009). By including more than one case, the study can investigate how contextual conditions shape the negotiation of heritage values and energy transition measures.

Data collection follows a *cross-sectional logic*. Data are collected from different stakeholder groups within each case, including residents, urban planners, heritage professionals, and energy experts. This combination enables the analysis of both temporal dynamics and the interplay of diverse perspectives within each case. In these case studies, the cases are selected to enable both similarity and contrast, supporting a logic of analytical replication. The cases differ in terms of heritage designation, scale, institutional governance, and spatial characteristics, while addressing a shared challenge of integrating photovoltaic systems within heritage-sensitive environments. This contrastive logic allows the entire study to explore how participatory processes and design outcomes are shaped by differing contextual conditions, without treating cases as representative samples. This design strengthens the analytical contribution of the study by situating findings within a structured comparative framework rather than deriving conclusions from a single empirical setting.

The study is guided by an *idiographic research approach,* focusing on the uniqueness of individual cases (Windelband, 1998). Idiographic research seeks to understand phenomena in their specific context, generating case-specific insights rather than broad generalisations typical of nomothetic research. An idiographic stance is central to examining participatory design and energy transition planning in heritage environments, where values, practices, and regulatory frameworks are locally embedded and historically contingent. The approach enables close attention to how stakeholders interpret, negotiate, and enact change within specific contexts, and how meanings emerge through situated interaction. As such, the idiographic orientation aligns with the interpretive and abductive research logic underpinning the study. The idiographic approach allows for analytical generalisation, where insights from detailed case analysis enhance theoretical understanding of participatory design, heritage governance, and energy transition planning (Yin, 2009). By systematically comparing cases, the study reveals relevant patterns and tensions while maintaining focus on contextual specificity.

Case Selection and Overview

This entire study examines three empirical cases, Porsön (Luleå), Öjebyn (Piteå), and Visby (Gotland), selected to represent contrasting configurations of cultural heritage and energy transition contexts in Sweden (Table 1). Together, the three cases provide a broad, analytically coherent empirical foundation for examining how participatory design processes mediate the integration of small-scale photovoltaic systems within culturally sensitive environments. Limitations related to feasibility and project boundaries influenced the case study selection. Nonetheless, the cases were selected in alignment with the research questions and methodological goals of the overall study.

Each case constitutes a bounded spatial and institutional context in which heritage values, regulatory frameworks, and energy transition ambitions intersect, yet they differ significantly in heritage designation, governance structures, and everyday practices. This contrast enables analytical comparison across cases while remaining consistent with the study's idiographic approach. Rather than seeking representativeness, the selection supports analytical generalisation by illuminating how differing heritage values, regulatory conditions, and stakeholder constellations shape participatory design processes and energy transition outcomes in context-specific ways.

Case Study	***Type of Heritage***	***Key Characteristics***	***Energy Transition Challenges***
Porsön (Luleå)	Modern heritage (post-war functionalism)	District centre from the 1970's post-war expansion, functionalist planning, mass housing, and university-oriented infrastructure	Ageing housing stock; adapting collective infrastructures; legitimising modern heritage while addressing renewable energy integration
Öjeby Church Town (Piteå)	Rural heritage	Small-scale church historic district; vernacular wooden architecture; local building traditions; strong community identity	Balancing everyday practices with sustainable energy solutions; integrating PV while respecting traditional materials and forms
Södertorg, Visby (Gotland)	Global World Heritage	UNESCO World Heritage city; medieval masonry and timber architecture; extensive international regulations	Negotiating heritage protection under UNESCO guidelines; regulatory constraints on local innovation; balancing global preservation rules with local energy needs

Table 1 *presents a comparative overview of the three case studies, outlining their heritage type, defining characteristics, and key challenges related to photovoltaic integration.*

Participatory Design as Research Practice

This research is situated within a participatory design framework, in which knowledge is generated through interaction, dialogue, and shared reflection among diverse stakeholders. Within such a framework, the researcher is not a neutral observer positioned outside the research process, but an active participant whose role influences both the generation and interpretation of empirical material. The section clarifies the researcher's positioning within the participatory design processes, detailing the roles adopted, the roles deliberately not assumed, and the implications of these choices for knowledge production (Bødker, 1996; Ehn, 1993; Schön, 1983).

Participatory design is employed in this study not only as a set of methods for stakeholder engagement, but as an epistemological approach to knowledge production. It is grounded in the assumption that situated, experiential, and tacit forms of knowledge are essential for understanding how energy transition measures are perceived, negotiated, and enacted within culturally sensitive heritage environments. Involving stakeholders, including prosumers, urban planners, and heritage experts, in participatory activities enables access to various forms of knowledge that are difficult to capture through interviews or document analysis alone. These processes support the emergence of shared understandings while also revealing tensions, disagreements, and asymmetries among stakeholders. In this sense, participatory design functions both as a means of data generation and as an analytical lens that makes socio-technical and institutional dynamics visible.

Researchers Role and Participatory Positioning

My background is in Architecture, with several years of professional experience primarily in housing design. I have worked both independently and within architectural firms, contributing to design development, project coordination, and mentorship. These experiences have underscored the value of engaging residents and other stakeholders in design and decision-making processes, shaping my approach to facilitating participatory design workshops. In these settings, I draw on my professional experience to support structured yet flexible workshop environments, where diverse forms of knowledge can be articulated and negotiated. My familiarity with design processes enables me to translate between technical, spatial, and experiential perspectives, fostering dialogue among participants with different backgrounds. Alongside my doctoral research, I have gained teaching experience at the university level. This pedagogical experience informs my role in workshops, particularly in guiding collaborative

learning processes, framing discussions, and supporting reflective practices. Together, these professional, academic, and pedagogical experiences shape my engagement with participatory design as a framework for integrating cultural heritage into contemporary urban transformation.

Within the participatory design workshops, several roles were enacted to support the process. While other researchers also contributed as initiators, facilitators, observers, and evaluators, my involvement was characterised by overall responsibility for the design, implementation, and reflexive assessment of the participatory process. I held a leading position in shaping and coordinating these roles throughout the research. In the role of *initiator*, I took primary responsibility for framing the research focus and designing the participatory process. This included defining the scope of the workshops, formulating guiding questions, and selecting context-appropriate methods. Although these tasks were, at times, developed in collaboration with other researchers, I led the alignment of participatory activities with the research objectives while remaining responsive to stakeholder concerns. As a *facilitator*, I guided the workshops and structured discussions, while other researchers supported facilitation when needed. My role involved creating conditions for inclusive participation, encouraging dialogue, and ensuring that diverse perspectives were acknowledged. I also contributed to shaping the atmosphere of the workshops, recognising the importance of informal interactions, such as coffee breaks and social conversations, as spaces where meaningful exchanges and tacit knowledge can emerge in participatory design settings (Ehn, 1993). In the role of *observer*, I was primarily responsible for systematically documenting the workshops, supported by contributions from other researchers. Field notes, audio recordings, photographs, and reflective accounts were used to capture both verbal and non-verbal dimensions of participation. This role enabled a degree of analytical distance and supported subsequent reflection on how knowledge was produced, negotiated, and prioritised within the participatory setting (Bødker, 1996).

Finally, I assumed a leading role in evaluation, gathering and analysing feedback on both the design outcomes and the participatory process. Other researchers contributed to this evaluative work; however, I coordinated reflections on whether the proposed design ideas addressed participants' needs and values and assessed the effectiveness of the participatory format in enabling meaningful engagement. This role supported ongoing methodological reflexivity and informed adjustments to subsequent workshops and analytical strategies (Schön, 1983).

Facilitation of Tacit Knowledge and Reflexive Practice

A central objective of the case studies' participatory process was the facilitation of tacit knowledge exchange. Drawing on Collins's (2010) distinction between explicit and relational tacit knowledge, the study recognises that much stakeholder knowledge is embedded in practice, experience, and social interaction. While some of this knowledge can be articulated through discussion and documentation, other aspects remain implicit or are constrained by social dynamics and communication norms. Facilitation practices were therefore oriented toward creating safe and trusting environments in which participants felt encouraged to share experiential insights (Bødker, 1996; Ehn, 1993; Schön, 1983). Storytelling, reflective dialogue, and iterative feedback were used to support the articulation of knowledge that might otherwise remain unexpressed. In line with Klein's (1998) emphasis on naturalistic decision-making, experiential judgment, and intuition, these practices acknowledged participants as competent actors navigating complex and uncertain situations.

I also engaged in reflexive practice by recognising how my own background, expertise, and behaviour influenced the participatory setting. Leading by example, through openness, attentiveness, and a willingness to share uncertainty, was understood as a means of encouraging similar practices among participants (Schön, 1983). Reflexivity was thus embedded not only in *post hoc* analysis, but in the ongoing conduct of the participatory process.

Deliberately Non-Adopted Researcher Roles

In the workshops, several participatory roles were adopted; however, the roles of co-designer and advocate were intentionally excluded. Although these roles are commonly used in participatory design practice, omitting them was a deliberate methodological choice aimed at maintaining clarity in the facilitation process and avoiding undue influence over participant-led design development.

This decision is also supported by Udoewa (2022), who argues that when participatory design is not grounded in genuine community leadership, it risks reinforcing or amplifying existing power asymmetries. In such cases, participation can become structurally constrained, limiting authentic community agency while consolidating control over decision-making and design direction within the role of the facilitator or designer.

The role of co-designer, in which the researcher collaborates directly with participants to generate design solutions, was intentionally avoided. Given the researcher's professional background as an architect, assuming a co-designer role carried a significant risk of shaping outcomes through professional authority

or technical expertise. To ensure that participants retained ownership over design ideas and that their perspectives remained central, the researcher refrained from contributing design proposals or solutions. Similarly, the role of advocate was not assumed. Acting as an advocate would have involved representing participants' interests within formal decision-making or institutional processes. However, the study was not embedded within a real-world implementation project, nor did it engage directly with formal planning or regulatory bodies in a decision-making capacity. As such, advocacy was neither methodologically appropriate nor empirically meaningful within the scope of this research.

A Transdisciplinary Participatory Orientation

This study adopts an *Urban Living Lab (ULL)* approach, understood as a form of situated urban experimentation where multiple stakeholders collaboratively engage in the co-creation of solutions in real-world contexts (Evans et al., 2016). ULLs are part of a broader shift toward experimental modes of urban governance, particularly in response to sustainability and climate challenges (Bulkeley & Castán Broto, 2013). Central to this approach are processes of co-creation, iterative learning, and the integration of diverse knowledge forms, including experiential, technical, and institutional perspectives (Voytenko et al., 2016). In this project, stakeholder engagement was structured through parallel workshops with potential prosumers and institutional actors, enabling the elicitation of complementary knowledge while accounting for power asymmetries. The workshop structure combines (1) prosumer-focused design workshops with (2) institutionally oriented workshops involving planners, building conservation experts, and energy specialists, thereby integrating perspectives from participatory design, urban planning, heritage conservation, and energy transition studies.

The study adopts a *transdisciplinary* orientation, engaging multiple domains of knowledge, but operationalises this through a parallel workshop design. The workshop was structured in two parts, which were conducted separately without iterative interaction between participant groups. The integration of perspectives was therefore achieved at the level of analysis, where insights from the different workshops were brought into dialogue by the researcher. The designation transdisciplinary is particularly relevant in this context, as the research not only draws on multiple academic domains but also actively integrates non-academic, such as residents and professionals, forms of knowledge into the design and inquiry processes (Nicolescu, 2002). Through this integration, the workshops

facilitate collaborative knowledge production that responds to complex, real-world challenges at the intersection of cultural heritage and energy transition. Transdisciplinary research involves integrating multiple disciplines (Lang et al., 2012). At its core, the approach is grounded in participatory design, while simultaneously addressing spatial planning concerns, heritage values, and sustainability objectives. The involvement of both professional stakeholders and prosumers extends the process beyond the boundaries of any one discipline, bringing together technical expertise and situated, experiential knowledge (Table 2).

Discipline	***Who is involved***	***Integration level***	***Includes public?***	***Goal***
Multi-disciplinary	Multiple Disciplines	Low	No	Parallel input
Inter-disciplinary	Multiple Disciplines	Medium–High	No	Integrated knowledge
Cross-disciplinary	One discipline using another discipline	Low	No	Perspective shift
Trans-disciplinary	Disciplines + society (prosumers)	Very High	Yes	Real-world solutions

Table 2. *Overview of disciplinary approaches, multidisciplinary, interdisciplinary, cross-disciplinary, and transdisciplinary, highlighting their defining characteristics, modes of knowledge integration, and the nature of collaboration across disciplinary and non-academic domains.*

Sampling of Participants

This research uses a purposive and exploratory sampling strategy aligned with its interpretive and case study focus. The approach focuses on participants with relevant knowledge or interest in integrating photovoltaic systems within cultural heritage districts, highlighting cases and stakeholders who can offer valuable insights for the research questions. Initial workshops also included experts and local authorities to establish a contextual understanding of regulatory, technical, and planning conditions. Subsequent design workshops on

focus groups prioritised residents and stakeholders to foreground everyday experiences, practices, and perceptions related to photovoltaic integration.

Participants were primarily recruited through convenience sampling, drawing on existing local networks, public invitations, and collaborations with municipal and community actors. This approach was complemented by snowball sampling, whereby participants invited acquaintances or colleagues with relevant experience or interest to join the workshops. Snowball sampling proved particularly valuable for broadening the stakeholder base and for accessing locally embedded knowledge. The research's exploratory nature influenced the selection of participant groups and the sequencing of data collection. Instead of defining fixed categories beforehand, the study evolved iteratively with stakeholder input, using early workshop insights to identify additional actors and perspectives for later research stages. This adaptive sampling supported abductive logic by letting empirical findings guide further data generation.

Across the three case studies, participant groups varied in size, composition, and engagement, highlighting differences in local context and governance. These variations were seen as analytically significant, illustrating how participatory local and heritage conditions influence processes and energy transition discussions.

Data Collection Methods

Data collection was designed to generate contextualised empirical material, aligning with the interpretive and participatory methodological approach. Multiple qualitative methods were used to assess both articulated and tacit forms of knowledge. The tacit knowledge was evaluated through the design artefacts. Employing several data collection techniques also enabled triangulation across sources and facilitated the movement between empirical observations and theoretical interpretation.

Data were collected across the three case studies, using a combination of participatory design workshops, additional individual stakeholder meetings, participant observation, artefact collection, and documentation. Collection occurred both longitudinally, across multiple points in time, and cross-sectionally within each case, allowing examination of evolving perspectives and contextual variation across sites.

Participatory Design Workshops

Participatory design workshops constituted the primary data collection method. The workshops were structured as collaborative and exploratory settings in which stakeholders jointly examined opportunities and constraints related to

photovoltaic integration in their local heritage context. Workshop activities included group discussions, collaborative mapping, sketching, scenario development, and the annotation of photographs and plans.

These co-creative workshops served multiple purposes. First, they functioned as arenas for eliciting participants' experiences, concerns, and aspirations regarding energy transition and heritage preservation. Second, they enabled participants to materially and spatially explore design possibilities, thereby externalising forms of reasoning that are not always accessible through verbal methods alone. Third, the workshops facilitated interaction among stakeholders with diverse expertise, making visible the negotiations and tensions inherent in participatory planning processes.

The first phase of the design workshops focuses on engagement and observation, involving participatory design with potential prosumers and initial project meetings with institutional stakeholders. Through these activities, this research project seeks to inform participants about urban energy transition initiatives while systematically observing interactions and responses to generate qualitative insights into stakeholder engagement. The second phase centres on perception assessment and examines how prosumers and institutional stakeholders respectively perceive urban energy transitions within cultural heritage districts. This phase aims to capture similarities and differences in understanding, expectations, and concerns across stakeholder groups. The third phase focuses on analysing barriers and facilitators, aiming to identify key obstacles to implementing energy transitions in cultural heritage contexts, as well as the enabling factors that support successful and contextually appropriate transitions in these areas.

Workshops were adapted to local conditions in each case study, with variations in group size, duration, and activity format. This flexibility was intentional, allowing the participatory process to remain responsive to local institutional arrangements, community dynamics, and participant availability. Material artefacts produced during the participatory design workshops constituted an important source of empirical material. These artefacts included maps, sketches, annotated photographs, diagrams, and scenario models generated by participants as they explored photovoltaic integration within the heritage environment. The artefacts were treated not merely as illustrations of verbal discussions, but as expressions of embodied, spatial, and relational reasoning. All artefacts were systematically collected, digitised, and documented. Photographs and scans were accompanied by contextual notes indicating the workshop setting, the activity during which the artefact was produced, and relevant participant interactions. This documentation enabled artefacts to be

analysed alongside interview transcripts and field notes, supporting an integrated analytical approach.

Additional documentation was collected to support contextual understanding and analytical depth. This included field notes, audio recordings, photographs, and relevant planning or heritage documents encountered during the research process. Site visits to each case study area were conducted to familiarise the researcher with the physical, architectural, and spatial characteristics of the heritage environments under study.

Site visits also informed the interpretation of workshop discussions and design artefacts by grounding them in the material realities of place. Observations from site visits were recorded through photographs and written reflections and were treated as complementary empirical material rather than as standalone data sources.

Additional Institutional Stakeholder meetings

To complement the collective co-creative workshop setting, stakeholder meetings were conducted with selected residents and professional participants, including municipal planners and heritage professionals. The interviews provided opportunities for more in-depth reflection on issues that were difficult to address in group settings, such as institutional constraints, professional responsibilities, and past experiences with energy or heritage projects.

Data Collection Timeline and Scope

Data collection unfolded iteratively over time, with insights from early workshops and interviews informing the design of subsequent data collection activities. This *longitudinal approach* supported the abductive research logic by allowing emerging interpretations to shape ongoing empirical engagement. At the same time, data collection within each case study captured cross-sectional variation among stakeholder groups, enabling comparison within and across cases. Together, these data collection methods generated a multifaceted empirical dataset that captures the complexity of participatory design processes at the intersection of heritage and energy transition planning. The combination of verbal, observational, and material data provided a foundation for the subsequent analytical strategy outlined in the following section.

Analytical Approach to the workshop's data

The analysis of the empirical material from the participatory design workshops utilised a qualitative, interpretive strategy that aimed to capture the complexity

of the data. The analytical process was iterative, involving continuous movement between empirical material, emerging analytical categories, and relevant theoretical concepts. This back-and-forth process reflects the study's interpretive and abductive research orientation. For this reason, the analysis strategy section is presented before the analytical framework section, which is presented later. Doing so clarifies the procedural logic and sequencing of the analysis, how interpretations were developed in practice, before introducing the conceptual lenses that later guided analytical focus and interpretation.

Hybrid Qualitative Analysis Approach

Rather than relying on a single analytical technique, a hybrid analytical strategy was adopted, integrating thematic, narrative, and artefact-based analyses in line with methodological triangulation in qualitative research (Denzin, 1978). This approach integrates thematic, narrative, and artefact-based analyses. This combination enabled the examination of what stakeholders articulated verbally, how they constructed meaning through stories and positioning, and how they explored possibilities materially and spatially through design artefacts.

A reflexive thematic analysis (Braun & Clarke, 2006) served as the primary analytical method. All transcripts and fieldnotes were openly coded to capture expressions related to knowledge needs, planning constraints, spatial preferences, heritage sensitivities, and collaborative practices. Codes were iteratively clustered into broader thematic categories, allowing patterns across stakeholder groups to emerge. The coding process was iterative and reflexive rather than linear. Initial codes were generated inductively from the empirical material and were subsequently refined, merged, or reconfigured as analysis progressed. Through repeated engagement with the data, codes were clustered into broader thematic categories that captured patterns across stakeholder groups and case studies. Analytical memos were used throughout this process to document emerging interpretations, theoretical connections, and reflexive considerations.

To complement thematic analysis, a narrative analytical lens was applied, drawing on Labov and Waletzky's (1997) structural model of narrative. This approach enabled examination of how participants framed their experiences through storytelling, particularly how regulatory constraints, expert guidance, and participatory encounters were organised as narrative problems, tensions, and resolutions. Analysis of stakeholders' narrative is a systematic process for identifying all actors who hold an interest in, influence over, or are affected by a given project, policy, or decision, and for assessing their perspectives, relationships, and relative power. By focusing on narrative evaluation, it was possible to analyse how claims to expertise and authority were legitimised or

contested, and how participants positioned themselves in relation to decision-making power within the participatory process.

In parallel, a material analysis was conducted on the artefacts produced during workshops. Maps, sketches, annotated photographs, and scenario models were digitised and examined for patterns in participants' proposed photovoltaic placements, expressed constraints, and value markers. The artefacts were treated as design probes that revealed embodied and spatial reasoning, not always articulated verbally. The three analytical strategies were synthesised through interpretive triangulation. Convergences across thematic codes, narrative structures, and material artefacts were used to refine and validate the final analytical insights. Divergences and similarities were examined to understand tensions between stakeholder perspectives and to ensure the interpretations remained grounded in the empirical material.

Analytical Framework

Building on theoretical foundations in Chapter 3, an analytical framework is developed to guide the empirical investigations. The analytical framework operationalises Complexity Theory and value-sensitive design as guiding perspectives for analysing participatory design processes in heritage contexts undergoing energy transition. While these theories are introduced in the theoretical chapter, they are applied here as analytical tools. Complexity theory informs the understanding of planning contexts as dynamic, adaptive systems, while value-sensitive design provides a lens for examining how values are articulated, negotiated, and embedded in design processes.

The framework adopts an interpretive research approach, viewing planning processes, heritage values, and technological interventions as socially constructed through interactions among stakeholders. It is designed to ensure alignment between research questions, empirical material, and analytical procedures, while also enabling systematic comparison across case studies. To translate the theoretical perspectives into empirical analysis, the framework is structured around four interrelated analytical dimensions. These dimensions were developed abductively through iterative engagement with the empirical material and were applied across all case studies (Table 3).

Analytical Dimensions	Modes of Inquiry
1. Participatory Design as a Dynamic Method in Complex Systems.	This dimension examines participatory design in complex adaptive systems, focusing on stakeholder composition, facilitation methods, roles, and power dynamics. Interactions are influenced by the underlying dynamics rather than being strictly planned.
2. Value Articulation and Knowledge Negotiation.	This dimension explores the expression and contestation of different knowledge forms and values, such as experiential, tacit, and institutional types. It examines how values are articulated, expertise is negotiated, and conflicts between knowledge systems are resolved.
3. Heritage Values within Socio-Technical Systems	This dimension examines the interplay between heritage values, regulations, and energy transition goals, focusing on authenticity, continuity, and change in the integration of photovoltaic technologies.
4. Design Outcomes and Spatial Imaginaries	This dimension explores how future possibilities are envisioned through participatory design, focusing on spatial strategies, photovoltaic placements, and design artefacts. Outcomes are context-dependent and shaped by values, knowledge, and system conditions.

Table 3. *The table outlines the four analytical dimensions used for the inquiries. It structures the examination of empirical material by focusing on specific aspects of a phenomenon, thereby enabling systematic interpretation and comparison.*

5
Case Studies

This chapter presents the three case studies from the research project. The cases Porsön and Öjebyn are presented in published articles. The case study conducted in Visby, Gotland, is not published as a standalone journal article. However, the Visby case serves as a complementary empirical episode that broadens the scope of the thesis beyond just the published articles. This is the reason why it is presented in this covering essay. The purpose of this entire research project is twofold. First, it aims to demonstrate the methodological evolution of the participatory design approach employed throughout the research. Second, it seeks to provide empirical support for the cross-case synthesis presented in Chapter 7, the results chapter.

Overall, the cases aim to explore how participatory design methods can support dialogue about heritage values and energy transition scenarios in heritage districts. The case studies aim to answer the sub-question: How can design tools and tangible artefacts support dialogue around energy transition scenarios in heritage districts?

Porsö District in Luleå

The Porsö case study investigates the use of participatory design, focusing specifically on the integration of small-scale photovoltaic systems in a post-war district of Luleå, Northernmost Sweden. It serves as a pilot study aimed at developing a PD approach for incorporating small-scale photovoltaic systems in a non-designated post-war heritage context, with an emphasis on a district-scale perspective. Postwar heritage refers to the cultural legacy from the period after World War II, roughly from 1945 to the early 1970s. It includes both material and immaterial aspects of reconstruction, modernisation, and social transformation that occurred during this time (DOCOMOMO International, 2004).

The Porsö district (Figure 5) features a variety of building typologies that can be organised into five main areas for this study. The core areas include the university campus, which forms its own enclave, institutional buildings characterised by a post-modern, expressive industrial style. Additionally, there is the District Centre, which is like many other "ABC (Arbete, Bostad, Centrum

or grannskapsenhet)" cities, work, residential, and central urban areas, developed during Sweden's "miljonprogram" (million program) from 1965 to 1975. Both environments are characterised by their large-scale design.

Figure 5 *Satellite map of the case study area of Porsön. Source: Google Earth.*

The residential areas within the district are divided into several sub-areas, featuring a mix of high-rise student housing, low-rise apartment blocks, and single-family homes. The area is surrounded by extensive green infrastructure, primarily consisting of a large recreational park in the south, which includes open fields, groves of trees, a gazebo, and a small bay of the sea. Additionally, there is grey infrastructure such as parking lots, small squares, roads for vehicles, and dedicated bicycle and walking paths adjacent to various facilities.

The case study utilised empirical data collected from (1) a co-creative workshop held with residents in Porsön and (2) an additional workshop with institutional stakeholders. These workshops were the primary method of data collection, designed to promote dialogue, encourage collective reflection, and create design proposals for the local integration of PV systems. For the first creative workshop, participants were recruited from a survey conducted about resident acceptance of solar power in Porsön. Initially, 35 individuals were contacted from the list generated in this pre-study, and ultimately, 5 participants attended the workshop. After recruiting participants, an agenda for the workshop was sent out to inform attendees about the activities. A flyer was

also created to market the event and attract more participants, including residents, university employees, and students in the area.

The workshops consisted of two preceding sessions (WS1 – the workshop with the residents, and WS2 – the workshop with the institutional stakeholders). WS1 was a face-to-face co-creative workshop conducted with one group of five participants. In this workshop, a variety of participatory techniques, including group discussions and collaborative design exercises, were used to gather participants' experiences, preferences, and concerns. The participants worked with 2D collages (Figure 6), spatial mapping, and 3D modelling (Figure 7) to express values, spatial preferences, and ideas for integrating small-scale photovoltaics into specific district sites. The framework developed by Sanders, Brandt, and Binder (2010) focuses on engaging non-designers in participatory design activities across three dimensions: form, purpose, and context. *Form* refers to activities such as making, storytelling, or role-playing. *Purpose* highlights the reasons for using specific tools and techniques, which include probing participants for insights, preparing them for the topic of interest, understanding their experiences, and generating concepts for future designs.

Figure 6. *The participants discussed potential locations for small-scale photovoltaic systems in the Porsö District. (Photo: Author).*

Figure 7. *Participants are working with hands-on model-making activities. (Photo: Author).*

The following workshop (WS2) with stakeholders, a representative from the planning department at Luleå municipality, and a representative from the local energy company, was informed about the outcome of the resident workshop and discussed the following questions: *"1. Are there future collaborations on solar energy?" "2. What are the technical limitations?" "3. What is possible to do and what are the obstacles?"* The approach involved a deliberate discussion where participants engaged in dialogue, asking and answering questions. Mural boards displayed each question, and participants wrote their responses on post-it notes, which were organised by the three main questions. The workshop fostered open discussion with additional related questions posed. By including representatives from the municipal planning bodies and energy organisations, the study was able to explore multiple perspectives within a single methodological framework.

Öjeby Church Town in Piteå

This case study presents a participatory design method for integrating small-scale photovoltaic systems into designated heritage districts while accounting for cultural values, regulatory constraints, and residents' lived experiences. The method was developed and tested in Öjeby Church Town (Öjeby Kyrkstad), Piteå, in the Northernmost Part of Sweden. The district is legally protected under Sweden's Cultural Environment Act (Kulturmiljölagen). It is designated as a cultural environment of national interest (*riksintresse för kulturmiljövård*), meaning that the area is recognised as having national cultural heritage value and must be considered in spatial planning and protected from significant harm

(Piteå kommun, n.d.; Riksantikvarieämbetet, n.d.). The heritage district features wooden church cottages, varied ownership structures, and conservation regulations.

Church towns originated in the 17th century as seasonal settlements supporting mandatory church attendance at some annual services, accommodating visitors who travelled long distances and required overnight lodging. Over time, they evolved into multifunctional hubs for religious, social, and economic activities. Today, they are recognised as culturally significant landscapes, protected as heritage sites and, in some cases, designated as World Heritage Sites (UNESCO World Heritage Centre, n.d.). Their continued use during religious events, festivals, and markets underscores their role as living heritage, where traditions and collective memory remain active (Figure 8). However, it is not allowed for permanent residency.

Figure 8. *Aerial view of Öjeby Church Town and its surroundings (2003). Source: Piteå Municipality.*

Complex ownership arrangements characterise governance within Öjeby Church Town. Individual cottages are privately owned, often jointly by multiple stakeholders, while the Piteå parish owns the land itself. This system of co-ownership and shared responsibility for maintenance introduces challenges for coordinated interventions such as photovoltaic integration, highlighting the need for trust, participation, and collaborative decision-making frameworks to ensure sustainable management.

Typologically, the church cottages are defined by modest scale, simple design, and gable roof forms, creating a cohesive yet varied architectural landscape. Differences in size, height, and roof orientation contribute to a distinctive skyline, while dense spatial organisation reinforces their identity as communal dwellings. These architectural features are critical in determining both the technical feasibility and visual compatibility of photovoltaic systems, as interventions must remain discreet and reversible to preserve the historic character (Figure 9).

Figure 9. *The image depicts church cottages with modern adaptations, including new metal roofs alongside older, rusty ones. It also showcases a stretch of green fields that defines the boundary of the Öjeby village.*

Local climatic conditions in northern Sweden present both challenges and opportunities for integrating photovoltaic systems. The region experiences low winter sun angles and heavy snow loads, but benefits from high summer solar yields. To ensure optimal performance and cultural compatibility, small-scale photovoltaic systems must be tailored to local solar geometry and snow behaviour. Despite limited sunlight during winter, the abundant spring and summer sunlight can offset electricity production challenges. One effective integration method is installing *vertical bifacial photovoltaics (VBPV)* systems on facades, which can avoid conflicts with protected areas and reduce snow accumulation. VBPV systems are often more efficient than traditional mounts and can capture reflections from snow. Additionally, rather than attaching photovoltaic systems directly to buildings, alternatives include standalone installations like advertising signs or lampposts. Reversible artistic solutions, such as self-propelled advertising columns or *sun flags,* have also been explored near historic sites.

Identifying stakeholders is a crucial first step in any project or initiative because it sets the foundation for ensuring that all relevant voices and interests are considered. Stakeholders are individuals or groups affected by or who can influence a project's outcome.

Built artefacts should be considered actors as they influence decisions or are affected by them, which raises ethical considerations. The primary stakeholder is therefore the Church Town, which includes the heritage district, church cottages, and Öjeby Church (Figures 10 and 11).

Figure 10. *Street view of Öjeby Church Town showing traditional church cottages with later sheet-metal roof replacements, reflecting incremental material changes introduced during 20th-century renovation practices in the heritage environment. (Photo: Author, based on Öjeby Church Town building documentation, Piteå Municipality)*

Figure 11. *Street view of a church cottage in Öjeby Church Town showing a newly installed sheet-metal roof, illustrating recent material replacement within the historic built environment. (Photo: Author).*

The cultural district has multiple stakeholders who monitor and preserve the district. (1) The Church Town Council, composed of key stakeholders, focuses on preserving and developing the district, addressing various initiatives. (2) The

Church Town Cottage Owner Association represents residents, coordinating resources and resolving issues. (3) Piteå municipality is a crucial stakeholder, with authority over land use and development as well as building permissions. County Museums, like the (5) Norrbottens Museum, collaborate with local and national authorities to preserve heritage areas. (6) The Piteå Museum Association, supported by municipal funding, participates in local consultation processes. The Church of Sweden, through Piteå parish, manages activities in the area and plays a significant role in the Church Town Council. (7) The Solander Society, a non-profit, aims to preserve and develop the cultural environment in Öjeby Church Town, organising events like Church Town Day. Piteå's cultural environment programme (Husera) sets the strategic framework for cultural heritage preservation, identifying and describing environments of particularly high cultural value and guiding planning and development decisions (Piteå kommun, n.d.). The national significance of Öjeby Church Town is recognised in both municipal and regional cultural environment programmes and further formalised through its designation as an area of national interest (*riksintresse*) for cultural heritage (Piteå museum, n.d.). However, community members are vital stakeholders, as their acceptance is key to heritage significance. Therefore, stakeholders must have ownership and comply with conservation guidelines, meaning that potential prosumers are considered qualified stakeholders as they often view themselves as stewards of the cultural environment.

The methodological framework was created to address limitations in planning approaches for heritage areas, including the role of local knowledge, social values, and governance complexities. The approach integrates technical, spatial, heritage, regulatory, and social dimensions through a structured sequence of institutional engagement, stakeholder consultation, and resident-centred participatory design. The first phase consisted of institutional workshops involving municipal planners, heritage authorities, and energy and building experts. These workshops were used to identify formal regulatory constraints, heritage protection principles, and technical boundary conditions for photovoltaic integration. In parallel, semi-structured interviews and meetings were conducted with representatives of local councils, property associations, and community organisations to map governance structures, ownership arrangements, and decision-making processes specific to the church town. The second phase centred on a three-part participatory workshop with residents (Figure 12).

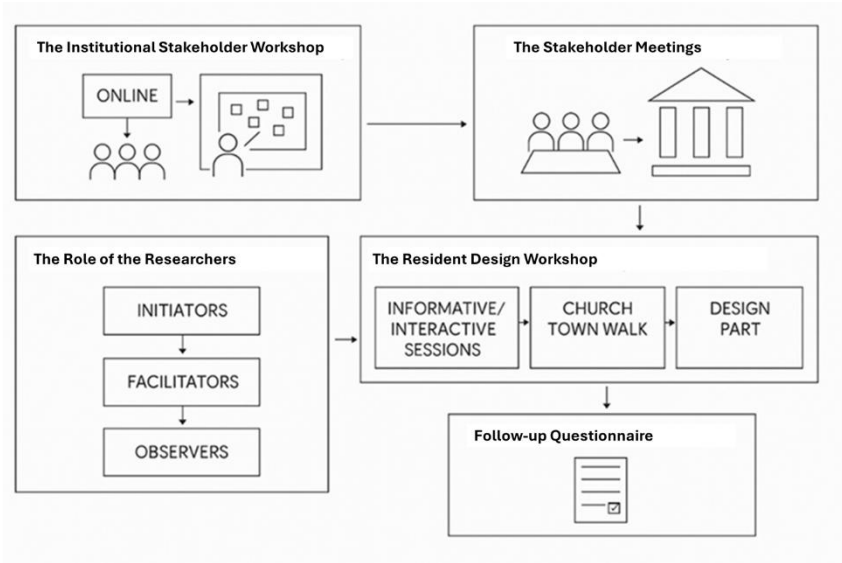

Figure 12. *The flowchart illustrates the customised participatory approach used in this study.*

The resident design workshop began with an introductory session providing accessible information on photovoltaic technologies, energy transition objectives, and heritage values relevant to the site. This was followed by a guided site walk, enabling participants to collectively observe and discuss spatial qualities, visual relationships, and sensitive heritage features. The final component involved hands-on design activities using physical models and visual simulations, through which participants explored and evaluated different photovoltaic placement strategies and design alternatives in relation to buildings, shared spaces, and sightlines (Figures 13, 14). These qualitative data were complemented by spatial and typological analyses of the built environment, including roof forms, orientations, material characteristics, visibility from key viewpoints, and exposure to climatic conditions such as snow loads and low winter sun angles (Figure 15).

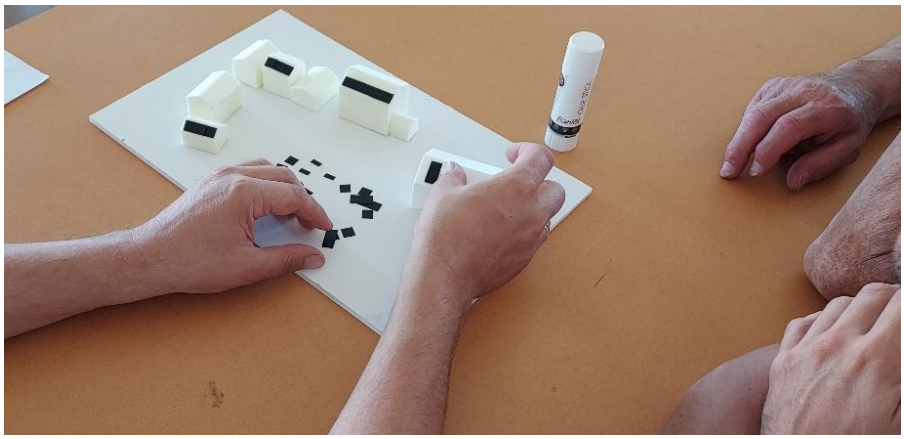

Figure 13 *shows the participants working with a physical model of one of the important historical views, applying photovoltaic panels. (Photo: Author)*

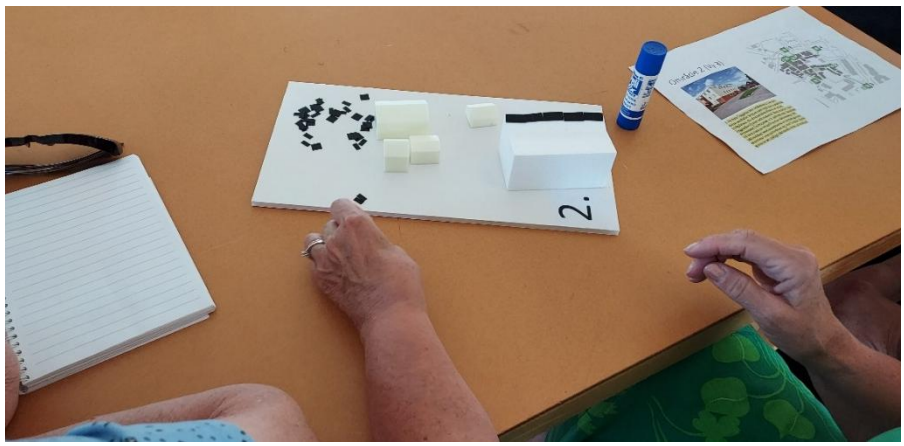

Figure 14 *shows another participant group working in the same way. In this view, the group also applies photovoltaics to modern surrounding structures. (Photo: Author).*

To assess learning outcomes and shifts in perspectives, pre- and post-workshop questionnaires were administered to capture changes in participants' knowledge, attitudes, and value priorities regarding photovoltaic integration in the heritage context.

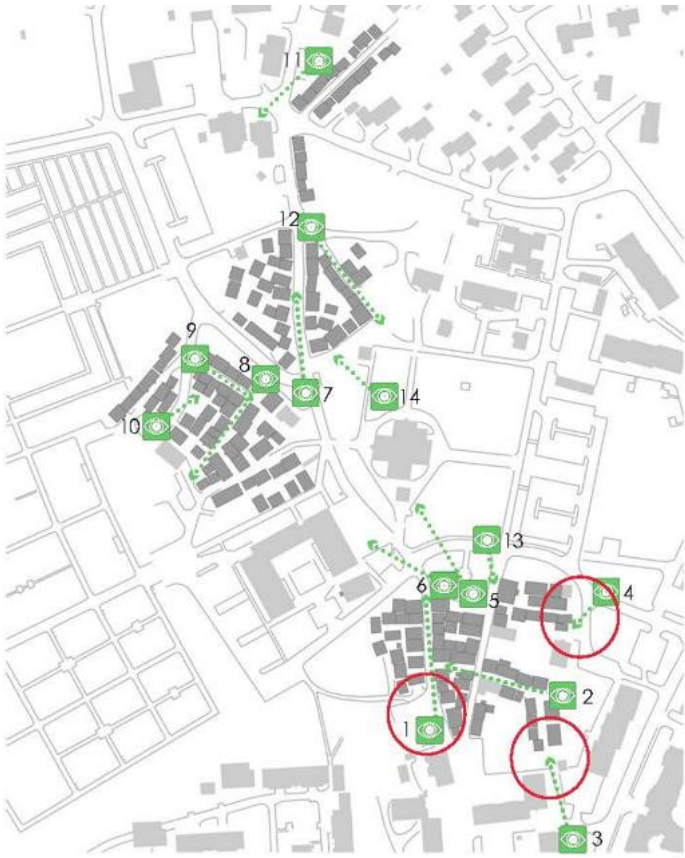

Figure 15 *shows the important historical views and the core of the heritage district of Öjeby Church Town. The selected views for the workhop is marked with red circles. The sight lines and street views around Öjeby church town each play a significant role in conveying important cultural and historical narratives. The sight lines offer a comprehensive understanding of how various locations within the church town interact with one another and their surroundings. They provide an overview of the area's character, emphasising similarities, differences, contrasts, and the experiential qualities of the physical environment. Source: Piteå Kommun.*

Södertorg in Visby, Gotland

Case Study Context

Visby, situated on the island of Gotland in the Baltic Sea, is recognised as one of Northern Europe's best-preserved medieval towns and was inscribed on the UNESCO World Heritage List in 1995 (UNESCO, 1995). The town's character

is defined by its intact medieval urban structure, narrow winding streets, and dense historic plots, all enclosed by the impressive 13th-century limestone city wall (Ringmuren), one of Europe's most complete medieval fortifications. As a major Hanseatic trading centre, Visby developed a network of open urban spaces and city squares, such as Stora Torget and the marketplace at Strandgatan, which historically served as hubs for trade, social life, and civic gatherings.

These squares remain central to the town's spatial identity, framed by medieval buildings, church ruins, and commercial façades that illustrate its vibrant mercantile past. Today, Visby is a dynamic cultural environment that balances heritage preservation with contemporary urban life, a tourist destination, offering a strong reference point for sustainable historic urban landscape management and heritage-led development in the Nordic region. Södertorg, located just inside Visby's southern gate, represents a key public space. Historically used as a marketplace and gathering area, and later as a parking space, the square has long served as a transitional and social hub in the medieval urban fabric (Figure 16).

Figure 16. *Street-level view of Södertorg in Visby, located just inside Söderport along the southern part of the historic town. Source: Wikimedia Commons.*

Today, the city square has strong solar exposure and potential for a renewed public place. Its open character, clear visual connection to the town wall, and surrounding heritage buildings make it an important testbed for exploring how

contemporary sustainability solutions can be integrated sensitively into historic environments.

The city square creates opportunities for shared or community-based solar installations, which can be integrated into pavilions, shading structures, or other public space elements. Such an approach would link energy transition goals with heritage-led urban development, demonstrating how public spaces in protected historic areas can serve as both social meeting points and contributors to local renewable energy production.

The case study was conducted in collaboration with researchers from the University of Uppsala Campus Gotland and officers from Region Gotland (it is a combination of region and municipality). It involved residents, heritage professionals, urban planners, and energy experts who sought new ways to discuss future development without compromising the town's valuable historical character.

Case Study Design

The Visby case aimed to explore how design workshops could facilitate shared understanding among diverse stakeholders in a heritage-sensitive energy transition context. This goal aligns with the broader thesis aim of examining how participatory design facilitates multi-stakeholder engagement in contested planning settings.

Therefore, the case study followed a constructive and participatory design approach, drawing on methods from co-design and scenario building. The intention was not to produce a final plan but to create a shared space for exploration (Binder et al., 2011) that could surface values, assumptions, and constraints related to the energy-heritage interface.

Data collection comprised of one institutional workshop with municipal and heritage professionals and a second participatory design workshop with community members. Empirical Materials gathered included audio-recorded workshop discussions, fieldnotes from observation and facilitation, and photographs and scans of workshop artefacts such as maps, sketches, and scenario configurations. Participants' reflections were collected through audio recordings and brief written prompts. All material was anonymised and stored in accordance with institutional ethical guidelines.

Sampling of Participants

A total of 16 participants, including the researchers, attended the workshop (Table 4). The participants were recruited through announcements on social

media and a local newspaper, and through contacts at the University of Uppsala, Campus Gotland.

The workshop was held at the Campus Gotland, part of Uppsala University. Participants worked in 4 groups of 3–4. Each researcher facilitated one group. Physical materials included base maps of the medieval core.
The facilitation team included the researcher (author of this thesis) and three research collaborators, who assisted in guiding discussions and documenting the process.

Group	Number	Affiliation
Residents	7	Residents in the medieval town of Visby
Heritage professionals	3	Professionals from the Region of Gotland and the University of Uppsala (Campus Gotland)
Municipal planners	2	Professionals from the Region of Gotland
Researchers	4	Researchers from the University of Uppsala (Campus Gotland) and Luleå University of Technology

Table 5 *summarises participant categories for the*

The Participatory Design Workshop

The structure of the workshop was chosen to balance cognitive, embodied, and relational aspects of participation, allowing stakeholders to articulate tacit knowledge. The objective was to use speculative design tools to develop and evaluate future scenarios involving building-integrated solar technologies. Speculative design tools are methods used to explore possible futures, encouraging reflection and helping designers and stakeholders envision and question alternative scenarios. These tools focus on "what if?" rather than "what is," aiming to provoke thought by challenging existing norms and assumptions. The design workshop was designed to combine analytical and imaginative activities. It followed a three-part structure:

1. **Grounding.** Introduction, shared vocabulary exercise, and presentation of existing constraints (e.g., city walks to the integration location). Sharing prompts, such as questions, statements, images, and tasks, designed to initiate, guide, and deepen thinking, discussion, or action.
2. **Making**. The study utilises a method called Participatory Utopian Sketching (Fig. 19), as discussed by Törnroth et al. (2022). This approach encourages

citizens to collaboratively envision alternative urban futures through guided prompts, group discussions, and collective sketching. By using sketching as a visual language, participants can express their values and aspirations, revealing shared priorities and imaginative possibilities. This exploratory and discursive method is especially suited to early-stage discussions of urban initiatives rather than to concrete planning outcomes.

3. **Reflection**, group discussion, identification of tensions, based on the participants' outcomes from the prompts, and capturing individual reflections.

The workshop focused on integrating small-scale photovoltaic systems into culturally significant public spaces, particularly in Södertorg Square. This strategy addresses strict regulatory constraints that apply within the historic core of Visby, a UNESCO World Heritage Site, where conservation plans and planning regulations limit alterations to façades and rooftops, thereby restricting the installation of conventional building-integrated photovoltaic systems (Region Gotland, 2010; UNESCO World Heritage Centre, n.d.). In response to these constraints, the workshop explored opportunities to incorporate small-scale photovoltaic installations into new or existing urban structures within the square itself. The intention was to ensure that such interventions would be functional, contribute added value, and enhance the spatial and social qualities of the site. Rather than treating energy infrastructure as a purely technical addition, the design approach sought to integrate renewable energy generation into elements that support everyday use and reinforce the identity of the square and advance urban renewal.

The broader objective was to upgrade Södertorg Square in ways that improve accessibility, functionality, and spatial coherence. At present, the square accommodates multiple and partly competing uses: it functions as a small city square, an open parking area, and a green space. This multiplicity results in a fragmented spatial character and underutilised potential (Figures 17, 18, 19).

Figure 17. *The small city square. (Source: Google Earth).*

Figure 18. *The parking lots. (Source: Google Earth).*

Figure 19. *The green field. (Source: Google Earth).*

The participants were divided into four groups and were guided through a city walk to the site designated for imagined integration. Each group could choose one of three areas for their integration project. Facilitators provided information and led group discussions based on key questions in each area. After the city walk, a creative session began, during which participants engaged in utopian sketching by designing their own concepts for the selected area. Each group then presented several design outcomes for the three separate squares within Södertorg Square (Figure 20).

At the final stage of the workshop, each group presented its design proposals, reflections, and technical considerations. The presentations included conceptual strategies, spatial visualisations, and explanations of how the proposals addressed heritage constraints, functional requirements, and energy performance. Emphasis was placed on how the interventions responded to the regulatory and cultural framework governing the historic environment of Visby, while simultaneously contributing to the ongoing renewal of Södertorg Square.

Figure 20. *The utopian sketching was used in the participatory design workshop.*

6
Results

This chapter first presents the empirical findings from the workshops, followed by an integrated analysis in which these results are compared and discussed in relation to the existing literature and the theories of complexity and value-sensitive design. This comparison draws on the distinct heritage characteristics represented in each context: post-war non-designated heritage in Porsön, designated heritage in Öjebyn, and the designated UNESCO-protected medieval heritage of Visby. The procedural logic of the analysis (Figure 21) is to relate the empirical material to the study's research questions and the reviewed literature. Stakeholder analysis, document analysis, and architectural site analysis provided complementary empirical input addressing participatory processes alongside the participatory design workshops.

The stakeholder definition process involves identifying individuals, groups, or organisations with an interest in the project. After identification, it's important to determine their level of participation; some may need only updates, while others require active involvement in decision-making. Prioritising participation helps allocate resources efficiently and ensures that the voices of those most affected are heard. Alongside stakeholder identification, document analysis plays a vital role in understanding the context and requirements of a project. This involves reviewing existing documents, reports, proposals, and any relevant data that can provide insights into the project's goals, challenges, and past experiences. Similarly, architectural site analysis is essential, especially in project planning related to construction or development. This analysis involves assessing the physical and environmental characteristics of the proposed site. Key factors include geographical location, zoning regulations, topography, climate, and the existing infrastructure. Understanding these elements helps in making informed decisions about design, sustainability, and the overall feasibility of the project.

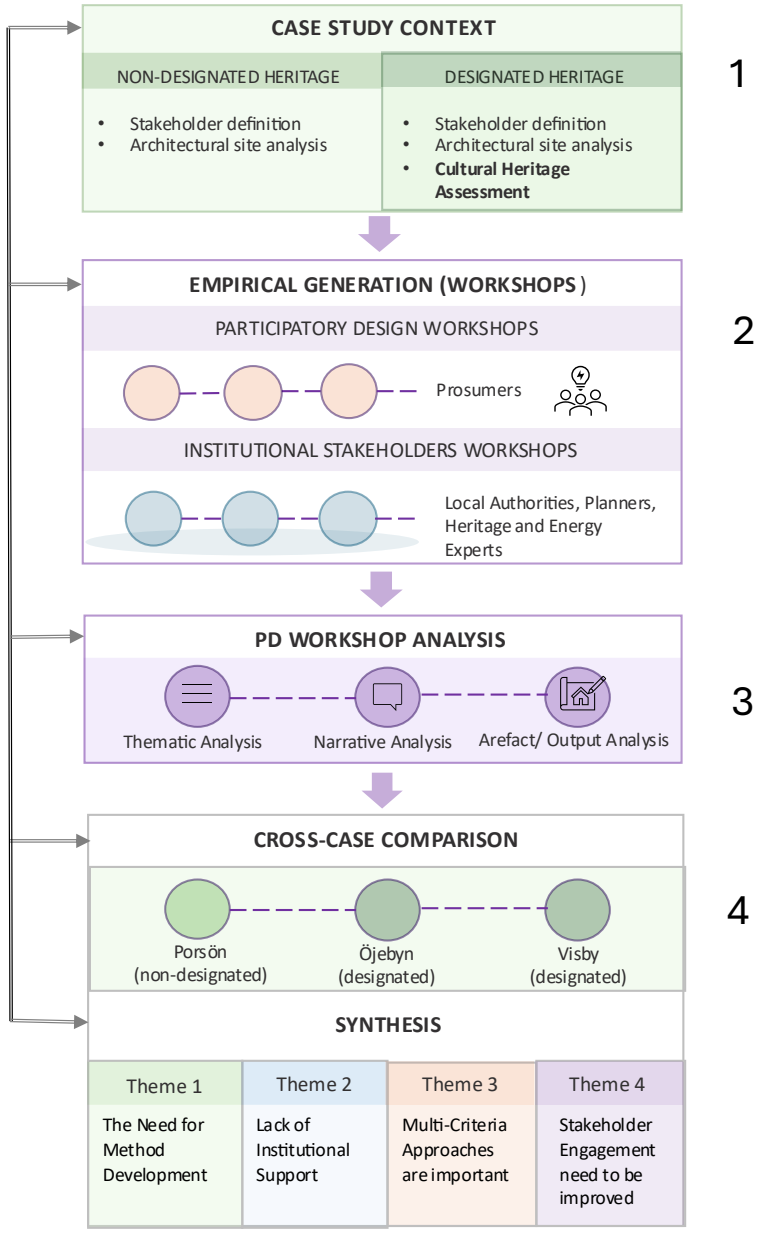

Figure 21 *illustrates the procedural logic through which empirical material was generated and analysed in direct relation to the study's research questions and the reviewed literature.*

Results from The Participatory Design Workshops

Porsö District in Luleå

The resident design workshop resulted in concrete spatial and conceptual design proposals that reflected both the residents' localised understanding of their built environment and their aspirations for integrating renewable energy infrastructure. The workshop produced three main design outcomes. These outcomes enhanced the understanding of how citizens envision small-scale energy transition interventions within their neighbourhoods.

The emphasis on concrete places and hands-on materials helped to translate abstract energy concepts into specific proposals that reveal how everyday practices shape residents' views on energy infrastructure, as the workshops allowed resident-generated ideas to precede institutional evaluation, and as stakeholders later assessed these ideas through scenario-based discussions that highlight regulatory, technical, and governance constraints. First, the workshop generated site-specific locational prioritisations for photovoltaic integration that diverged from conventional rooftop-centric approaches (Figure 22). Participants initially discussed a range of potential locations across the district, but ultimately converged on underutilised public spaces with strategic potential for dual functions. The extensive parking areas proximate to the university campus were identified as prime candidates for photovoltaic canopies that could serve as electric vehicle charging stations and solar-powered engine heaters. Likewise, a disused green field adjacent to a former football pitch was reimagined as a multifunctional public space incorporating a stand-alone, movable solar structure that doubled as a community seating and learning installation. These site choices reflect a prioritisation of communal utility and accessibility, rather than exclusive focus on private building envelopes.

Figure 22. *The participants' suggestions are indicated on the satellite map with notes on potential locations and post-IT patches. (Photo: Author).*

Second, the outcomes of the workshop showcased artefacts of functional energy infrastructure that also embody social and aesthetic values. In the 3D mock-up phase, residents expressed a clear interest in installations that extend beyond purely technical functionality to engage with everyday life in the neighbourhood (Figure 23). For example, the solar sculpture conceived for the park not only captures energy but also frames social interaction and play, suggesting that residents value energy interventions that contribute to the quality of public space and community identity. This synergy of energy and place-making underscores the capacity of participatory design to foreground soft values, such as engagement and inclusivity, alongside technical performance.

Third, the workshop revealed latent local knowledge and creative capacity that may not surface through traditional planning processes. Participants, although few (five residents), articulated nuanced insights into neighbourhood dynamics, such as the differential feasibility of photovoltaic installations on condominium versus rental building typologies, and the potential of campus areas to function as demonstrative sites for renewable innovation. This context-sensitive reasoning indicates that residents possess both situated expertise and design insight that can enrich formal planning deliberations, particularly when scaffolded through structured participatory methods.

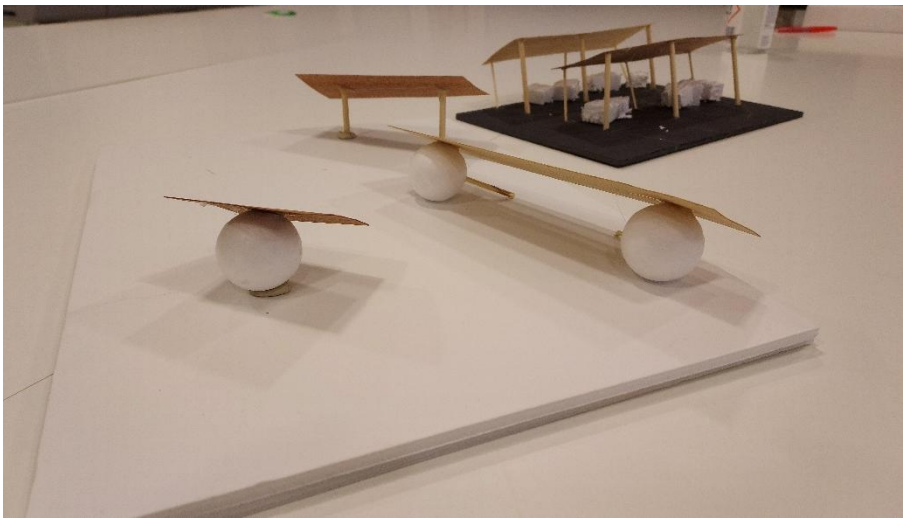

Figure 23. *The outcome of the modelmaking part. A stand-alone sun-following solar structure (in the foreground) and the solar car parking canopies (in the background). (Photo: Author).*

Collectively, these outcomes illustrate how resident engagement in early design phases can yield place-based, multifunctional, and socially embedded energy transition proposals. By privileging public space, integrating social values with technical solutions, and mobilising local experiential knowledge, the resident workshop outcomes provide a substantive evidentiary basis for arguing that co-design processes can generate contextually relevant and democratically infused design insights that extend beyond conventional expert-led planning models. Additionally, these outcomes underscore the potential for participatory design to surface synergies between energy transition goals and broader aspirations for improved built environments. In contrast, institutional stakeholders prioritised regulatory, technical, and organisational constraints. These included limitations regarding shared energy production, building structures, climatic conditions, and divided responsibilities among different actors. The comparison of these viewpoints revealed structural barriers that hinder the implementation of community-based photovoltaic initiatives. Overall, the application of participatory design methods yielded context-specific insights into local energy preferences and constraints, while also revealing discrepancies between resident aspirations and existing regulatory and institutional frameworks.

This study demonstrates that participatory design can be an effective method for uncovering alternative approaches to photovoltaic integration and guiding

more inclusive, locally grounded energy planning processes. This case illustrates a design-driven participation model that is effective for generating ideas and exposing issues but less suited for moving toward operational solutions or integrated governance arrangements. Therefore, approaches that include more iterative rounds, wider actor groups, or a greater integration of contextual factors, such as heritage considerations, are necessary. However, participation was limited and likely not representative. The absence of an iterative cycle means residents do not return to respond to stakeholder feedback, leaving many tensions unresolved. The proposals remain hypothetical due to the lack of technical modelling, prototyping, or long-term engagement. Power dynamics between residents and institutions are not explicitly addressed, and institutional perspectives risk dominating in the second workshop.

Öjeby Church Town in Piteå

The results indicate a consistent preference for low-visibility photovoltaic solutions, with residents favouring installations on green or grey infrastructure rather than on protected heritage buildings. Building-applied photovoltaics was considered only when visually discreet and compatible with the historic character. Participation increased residents' understanding of technological and heritage-related trade-offs, fostered a modest positive shift in attitudes toward photovoltaics, and strengthened their sense of agency.

The resident participatory design workshop generated a set of concrete, spatially articulated photovoltaic integration proposals that reflect both local heritage values and pragmatic considerations regarding energy production. These proposals challenged the assumption that heritage protection and renewable energy integration are inherently incompatible, illustrating instead how acceptable compromises can emerge through collaborative exploration. The workshop yielded a portfolio of design outcomes that collectively illustrate the range of socially acceptable and context-sensitive strategies for photovoltaic integration within Öjeby Church Town (Figure 24). A central outcome was the prioritisation of low-visibility and non-intrusive photovoltaic placements for the heritage. Participants consistently favoured installations that minimised visual exposure from primary important viewpoints, particularly the churchyard and key pedestrian routes. Photovoltaics on roof planes with limited public visibility, on secondary structures, and less symbolically charged buildings were identified as more appropriate locations, indicating a shared understanding of visual hierarchy within the heritage landscape. Another significant design outcome was the emphasis on collective and shared photovoltaic solutions over individual installations. Participants proposed the use of jointly owned systems serving

multiple properties or the wider community, including the potential placement of photovoltaics on communal buildings or peripheral structures. This approach was perceived to reduce cumulative visual impact, address fragmented ownership patterns, and distribute both benefits and responsibilities more equitably.

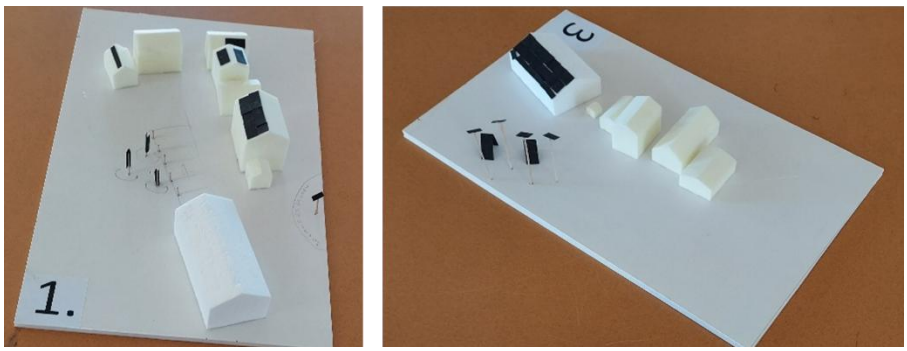

Figure 24. *The design outcome of the modelmaking part. (Photo: Author)*

Material and formal adaptation constituted a further outcome of the co-design process. Participants demonstrated a preference for photovoltaic technologies that align with existing roof geometries, colours, and textures, such as dark, matte panels integrated parallel to roof slopes. These preferences reveal an implicit design logic aimed at visual continuity rather than technological concealment, suggesting that acceptability is linked to perceived coherence with established architectural rhythms. The workshop also produced explicit design principles rather than solely site-specific solutions. Participants articulated criteria such as reversibility, minimal alteration to historic fabric, and adaptability over time. These principles reflect an awareness of heritage conservation ethics and suggest that residents can engage with abstract conservation concepts when supported by appropriate participatory tools. Furthermore, the design outcomes showed a conditional acceptance of photovoltaic integration. Through model-making and discussions, participants made negotiated solutions based on placement, scale, and governance. This shift to more acceptance highlights how co-design fosters informed judgment rather than just reflecting existing attitudes.

Finally, the workshop outcomes exposed the misalignment between resident-generated solutions and existing regulatory frameworks. While participants developed proposals they considered compatible with heritage values, many of these remained difficult to implement under current conservation rules. The findings underscore the structural nature of regulatory and governance barriers.

Restrictive conservation policies, fragmented ownership structures, and ambiguous institutional responsibilities were identified as major impediments to implementation. Although the participatory process contributed to legitimising certain forms of photovoltaic integration at a conceptual level, it had limited capacity to resolve these systemic constraints. This gap between socially acceptable design outcomes and regulatory feasibility highlights a key insight of the study: participatory design can generate viable and legitimate alternatives, but their realisation depends on parallel institutional adaptation. Overall, the case study demonstrated a replicable participatory design method for heritage energy planning. The method supports context-sensitive photovoltaic strategies by embedding resident perspectives within a structured planning process, while facilitating dialogue between communities, experts, and authorities. It offers a practical framework for mediating between conservation objectives and sustainability goals in complex heritage districts.

Södertorg in Visby, Gotland

Some of the participants' design outcomes were suggested on the green field, a playground designed by children, on the parking lot, and upgraded lampposts on the small city square (Figure 25). The Visby case shows how participatory design workshops can support dialogue in heritage-sensitive energy transition contexts. It highlights the value of tangible artefacts for mediating differences between stakeholder groups and offers methodological learnings that strengthen the thesis's contribution to participatory design research. The study revealed three main insights: the need for expert technical knowledge in the design and planning process, the importance of assessing which locations in the settlement are most suitable for photovoltaic integration, and the perceived absence of a shared platform for community exchange and decision-making.

Figure 25 *displays some of the design outcomes of individual participants from the four groups. The figure to the upper left shows upgraded photovoltaic lampposts. The figure to the upper right shows a children's playground with integrated photovoltaics, and the figure at the bottom shows small cages for parking cars.*

These findings became evident through participants' expressions of uncertainty about technical or regulatory feasibility, which underscored the need for specialised input; through the consistent clustering of preferred or excluded photovoltaic locations, which pointed to the value of broader spatial assessments; and through the ways participants depicted shared spaces or collective processes, which highlighted an underlying desire for a community forum.

Cross-Case Comparison

This section presents a cross-case comparison of the three case studies to examine how participatory design methods function within different heritage and governance contexts in urban energy transition processes. Cross-case

comparison is employed to move beyond single-case insights and to identify patterns, divergences, and conditional relationships across contexts. By systematically comparing cases with varying degrees of heritage protection, institutional involvement, and methodological structuring, the analysis aims to clarify how participatory design contributes to social acceptance, methodological development, and decision-making capacity. The analytical dimensions applied in this comparison are derived from the analytical framework in Chapter 4 and the literature review presented in Chapter 2.

Participatory Design as a Dynamic Method in Complex Systems

Across the three cases, participatory design workshops functioned as key arenas where participatory dynamics within complex systems were enacted and observed. These workshops not only translated abstract energy transition goals into place-specific design considerations but also revealed how stakeholder composition, facilitation structures, and modes of knowledge integration shape participatory outcomes.

In Porsön, participatory design operated as an exploratory and design-driven process characterised by open-ended stakeholder engagement. The use of visual and physical tools supported inclusive dialogue and enabled the articulation of resident perspectives. However, the absence of technical expertise and institutional actors limited the diversity of knowledge inputs and constrained the process to idea generation. As a result, participatory dynamics remained relatively informal, with limited capacity to influence decision-making processes or extend beyond initial exploration. In Öjeby Church Town, participatory design was embedded within a more structured and interdisciplinary framework, enabling richer and more balanced interactions among stakeholders. Workshops were integrated with spatial analysis, institutional interviews, and evaluative tools, facilitating more knowledge exchange between participating lay persons and experts. This configuration supported reflexive dialogue, where heritage values, visual impacts, and feasibility considerations could be collectively negotiated. Consequently, participatory dynamics in this case were more deliberately configured, allowing for emergent outcomes that were both context-sensitive and aligned with institutional and regulatory conditions. In Visby's Södertorg, participatory design workshops enabled participants to articulate shared spatial preferences regarding suitable locations for small-scale PV integration in public spaces, demonstrating the capacity of participatory processes to generate collective insights. However, the lack of expert facilitation and methodological scaffolding limited the depth of interaction and constrained

participants' ability to critically assess feasibility or further develop proposals. This illustrates how insufficiently structured participatory dynamics can restrict the progression of ideas beyond initial consensus.

Across the cases, participatory design consistently generated qualitative insights into spatial values and priorities, highlighting its role in fostering dialogue and surfacing local knowledge within complex systems. At the same time, the findings demonstrate that the effectiveness of participatory processes depends on how stakeholder roles, facilitation methods, and institutional integration are configured. Without these elements, participatory design risks remaining exploratory and disconnected from decision-making, limiting its capacity to produce actionable and implementable outcomes.

Value Articulation and Knowledge Negotiation

All three cases confirm that non-technical barriers, particularly regulatory ambiguity, institutional complexity, and unclear responsibilities, outweigh technical constraints, consistent with barrier-focused studies in the literature.

In Porsön, barriers were primarily procedural and organisational rather than regulatory. The lack of technical assessment, economic analysis, or long-term engagement meant that resident proposals remained hypothetical. While the participatory design tools effectively surfaced tensions and trade-offs, they were not embedded within a multi-criteria decision-making framework capable of balancing feasibility, visual impact, and governance constraints. Öjeby Church Town more explicitly integrated multi-criteria considerations by combining resident preferences, spatial analysis, and institutional input. Participants demonstrated the ability to weigh visual integrity, reversibility, and technical feasibility, producing context-sensitive proposals, such as shared- or secondary-structure photovoltaic installations. Nevertheless, the case also illustrates a key limitation identified in the literature: even well-structured multi-criteria approaches are constrained by local governance conditions and cannot override restrictive heritage policies (Akbarinejad et al. 2023; Akbarinejad et al. 2024; Tsoumanis et al. 2021). The Södertorg case further reinforces the importance of spatial prioritisation as a decision-support tool. Participants' consistent clustering of preferred and excluded photovoltaic locations suggests that participatory workshops can contribute valuable qualitative input to spatial suitability assessments. However, without integration into formal planning or decision-making frameworks, such insights remain underutilised.

Heritage Values within Socio-Technical Systems

Governance conditions emerged as a decisive factor shaping the scope and effectiveness of participatory design across all cases, reinforcing the literature's conclusion that heritage-compatible photovoltaic integration is primarily a socio-institutional challenge (Lucchi 2022; Bianco, Cascetta, & Nardini 2021; Lucchi et al. 2020; Lucchi et al. 2022; Rosa 2020; Formolli et al. 2021; Legnér & Fermenías 2022).

In Porsön, the non-designated heritage status allowed greater conceptual freedom, but governance fragmentation and the sequencing of workshops ultimately reinforced institutional dominance. Resident-generated proposals were subjected to institutional assessment without reciprocal dialogue, illustrating how participatory processes can inadvertently reproduce existing power asymmetries when not embedded within supportive municipal routines or iterative governance structures. Öjeby Church Town exemplifies the strong influence of regulatory frameworks and ownership structures on participatory outcomes. Despite a well-designed participatory process and constructive engagement with heritage authorities, restrictive conservation policies and complex shared ownership arrangements significantly constrained implementation. The case confirms findings from comparative governance studies that clear authorisation procedures and adaptive guidelines are essential, and that participatory design alone cannot resolve structural regulatory barriers. The method used suggested transition toward a Living Lab governance model, which reflects a broader need for institutional innovation beyond project-based participation. In Södertorg, participants' emphasis on the absence of a shared decision-making platform points directly to a governance gap. The workshops revealed latent demand for municipal facilitation and coordination, aligning with the literature that identifies municipalities as key mediators between conservation and sustainability objectives. Where such platforms are lacking, participatory initiatives risk remaining fragmented and inconclusive.

Design Outcomes and Spatial Imaginaries

Across the three case studies, participatory design workshops generated various degrees of social acceptance and engagement with photovoltaic integration in heritage districts.

In the Porsön case, the workshop increased awareness and engagement during the sessions. However, participation was limited to a small number of residents, and no mechanisms for follow-up dialogue were established. As a result, expressions of engagement remained confined to the workshop setting.

Öjeby Church Town provides stronger empirical evidence of how participatory design can enhance legitimacy, learning, and acceptance in heritage districts. Pre- and post-workshop questionnaires demonstrated shifts in knowledge and attitudes, while design activities revealed strong preferences for discreet proposals. However, this result could not be validated due to statistical limitations, as it involved a small number of participants and different individuals answering before and after the intervention. At the same time, the case highlights that increased acceptance does not automatically translate into implementation when institutional barriers persist. In Södertorg, participants expressed a desire for a shared community platform, which underscores the relational dimension of social acceptance. Rather than opposition to photovoltaic integration per se, uncertainty and hesitation were linked to a lack of collective deliberation and expert support. This finding aligns with the literature's emphasis on transparent communication and inclusive engagement as prerequisites for acceptance in heritage settings (Schaffer and Brun 2015; Bottino-Leone et al. 2024; Lucchi, Adami, & Stawinoga 2023; Polo López & Frontini 2014; Haukkala 2015; Karjalainen & Ahvenniemi 2019).

7
Discussion

Cross-Case Comparison

Reconfiguring Participatory Design in Complex Systems

The cross-case comparison demonstrates that participatory design should not be understood as a neutral or universally applicable method, but rather as a contingent and dynamic practice shaped by its context. Its outcomes are closely tied to its embeddedness within broader socio-technical systems, including governance structures, stakeholder configurations, and institutional processes. In this sense, participatory workshops can be interpreted as a small-scale representation of these wider systems, where the dynamics of participation, decision-making, and knowledge exchange are both enacted and revealed. The effectiveness of participation in creating meaningful change depends less on the specific methods used in the workshops and more on how well these methods are incorporated into existing institutions, the arrangement of stakeholders involved, and the underlying knowledge structures (Björgvinsson, Ehn, & Hillgren, 2012). A central insight is that participatory design operates along a spectrum ranging from exploratory engagement to structured co-production. In Porsön, the process remained situated at the exploratory end. This reflects a common limitation in participatory practice: when detached from decision-making frameworks, participation risks becoming consultative rather than transformative (Arnstein, 2019/1969). The Södertorg case reinforces this point, demonstrating that even when collective spatial preferences emerge, the absence of facilitation and methodological structure constrains the progression from consensus to implementation.

By contrast, the Öjeby Church Town case illustrates how participatory design can approach a co-productive model when embedded within an interdisciplinary and multi-scalar framework. Here, the integration of spatial analysis, institutional dialogue, and evaluative tools enabled a more balanced negotiation between lay and expert knowledge. However, the case simultaneously exposes the limits of such co-production: even well-configured participatory processes remain bounded by regulatory regimes and governance structures that they cannot, on

their own, transform (Akbarinejad et al., 2023; Akbarinejad et al., 2024; Tsoumanis et al., 2021).

Taken together, the cases suggest that the effectiveness of participatory design in complex systems is relational rather than intrinsic. Its capacity to influence outcomes depends on three interdependent conditions: (1) the inclusion of diverse and relevant knowledge actors, (2) the presence of facilitation and decision-support structures that enable meaningful knowledge integration, and (3) the alignment with institutional processes that can carry outcomes forward. Where these conditions are absent or only partially met, participatory design tends to remain exploratory, producing insights without impact (Sanders & Stappers, 2008; Ehn, 2008).

From Value Articulation to Knowledge Co-Production

A second contribution concerns the role of participatory processes in value articulation and knowledge negotiation. Across all cases, workshops successfully surfaced spatial values, preferences, and trade-offs, confirming their strength as tools for eliciting qualitative knowledge. However, the findings also demonstrate that such articulation does not automatically translate into decision-making capacity. In Porsön and Södertorg, the lack of integration with multi-criteria frameworks limited participants' ability to assess feasibility or prioritise between competing considerations. In Öjeby, this limitation was partially addressed through structured evaluation, yet even here, decision-making remained constrained by external governance conditions.

This highlights a critical tension identified in the literature but further substantiated here: while participatory design can enrich decision-making by introducing context-specific and socially embedded knowledge, it cannot substitute for formal governance mechanisms. Instead, its role is better understood as complementary, informing, challenging, and potentially reshaping decision criteria, but not determining outcomes independently (Healey, 1997; Innes & Booher, 2004). The implication is that participatory processes must be deliberately linked to planning instruments, regulatory procedures, or experimental governance formats if they are to produce actionable results.

Governance Constraints in Heritage Socio-Technical Systems

The prominence of non-technical barriers across all cases further reinforces the argument that heritage-integrated photovoltaic transitions are fundamentally socio-institutional challenges. Regulatory ambiguity, fragmented responsibilities,

and rigid conservation frameworks consistently outweighed technical constraints. This finding not only confirms existing literature but also nuances it by demonstrating how such barriers are experienced and negotiated within participatory settings (Lucchi, 2022; Bianco, Cascetta, & Nardini, 2021; Legnér & Fermenías, 2022).

In Porsön, institutional dominance emerged through the sequencing of engagement, effectively positioning residents as idea generators rather than co-decision-makers. In Öjeby, restrictive policies limited implementation despite high-quality participatory outputs. In Södertorg, the absence of a coordinating municipal platform prevented the consolidation of stakeholder input into a shared direction. These dynamics point to a structural mismatch between participatory aspirations and governance realities. While participatory design is often framed to democratise planning, its impact remains contingent on institutional receptiveness and adaptability, as suggested by work on empowered participatory governance (Fung & Wright, 2003). The suggestion of transitioning toward a Living Lab model in Öjeby reflects an attempt to address this mismatch by creating iterative, experimental governance environments where participation, evaluation, and implementation can co-evolve. Such models may offer a pathway for overcoming the limitations of project-based participation by embedding it within longer-term institutional processes.

Social Acceptance and the Formation of Spatial Imaginaries

Finally, the findings from the case studies contribute to ongoing debates on social acceptance in heritage contexts by reframing it as a relational and processual outcome rather than a static attitude. Across the cases, resistance to photovoltaic integration was not primarily aesthetic or ideological, but linked to uncertainty, lack of information, and absence of collective deliberation. Participatory workshops played a crucial role in addressing these factors by enabling dialogue, increasing awareness, and fostering shared spatial imaginaries. However, the durability of these effects depended on the continuity of engagement and the presence of institutional support. In this sense, social acceptance emerges not as a fixed endpoint but as a dynamic and evolving condition shaped by ongoing interactions between stakeholders, knowledge systems, and governance structures (Wolsink, 2007; Devine-Wright, 2011).

Participatory design can catalyse this process, but only when it is sustained, structured, and meaningfully connected to decision-making arenas. Without such continuity, as observed in Porsön and Södertorg, engagement remains episodic, and its effects are limited.

Cross-Case Synthesis

Taken together, the cross-case comparison demonstrates that participatory design workshops are most effective when embedded within structured, iterative, and institutionally supported frameworks. While all three cases confirm the value of participatory design for eliciting local knowledge, shaping social acceptance, and revealing value tensions, their capacity to influence outcomes depends heavily on governance conditions, methodological integration, and the ability to connect participation to decision-making processes. The findings reinforce the results from the literature that heritage-compatible photovoltaic integration requires not only technical and design innovation, but also adaptive governance, clear municipal roles, and sustained stakeholder engagement (Schaffer and Brun 2015; Bottino-Leone et al. 2024; Lucchi, Adami, & Stawinoga 2023; Polo López & Frontini 2014; Haukkala 2015; Karjalainen & Ahvenniemi 2019).

In conclusion, this study advances the understanding of participatory design in complex socio-technical systems by demonstrating that its transformative potential lies not in participation per se, but in how participation is configured, mediated, and institutionalised. For heritage-compatible small-scale energy transitions, this implies a shift from isolated participatory events to integrated, iterative, and governance-linked processes that bridge the gap among local knowledge, expert assessment, and regulatory frameworks.

Study Limitations

Multiple Qualitative Approaches used instead of a Mixed-Method Study

Mixed-method approaches refer to research designs that deliberately integrate qualitative and quantitative methods within a single study. The rationale for employing such approaches lies in methodological triangulation: the use of multiple data sources or methods to enhance the reliability (consistency) and validity (credibility and accuracy) of the findings. By combining different forms of evidence, researchers can corroborate results across methods, thereby strengthening the robustness of the conclusions and reducing the risk of systematic bias associated with relying on a single data source (Creswell, 2018).

In the present research project, the case study workshops primarily employed qualitative methods. These included facilitated group discussions, participatory design exercises, and interactive stakeholder activities to elicit experiential knowledge and collective reflections. The design encouraged dialogue, co-

creation, and the articulation of diverse perspectives, consistent with participatory research traditions. However, quantitative instruments were not incorporated into the workshop design. Consequently, although multiple qualitative approaches were applied, the methodological approach does not constitute a fully integrated mixed-method design in the conventional sense of combining qualitative and quantitative data strands. Although in these case studies, there were limited resources of time, money, and equipment to conduct a mixed-method study, such a study is necessary to be able to validate the design and create approaches for future implementation.

Challenges to engage the broader community in the participatory design workshops.

The case studies initially aimed to include more members from the broader community in the design workshops. However, this was a difficult task for several reasons, and this may have resulted in a small sample size. Announcements for the three workshop events were made through social media, newspapers, and posters, but they revealed a level of scepticism among the public about participation. Particularly on social media, some users expressed critical views, stating that the introduction of photovoltaics would harm the Öjeby church town. They perceived the initiative as a top-down decision. However, it was clarified that this was ongoing research aimed at assessing the values involved, rather than a finalised decision to implement the changes. Alterations to heritage buildings, including photovoltaic integration, are frequently met with social resistance because such transformations are perceived as threatening the integrity of historically significant structures. These findings align with observed dissensus in public discourse, including social media responses, where opinions regarding photovoltaic integration in cultural heritage districts appear divided and contested. Such explanations are also in line with previous research that shows that social acceptance is not uniform and is often shaped by cultural, aesthetic, and heritage-value concerns, leading to significant public scepticism and contested views. For example, surveys conducted in Italian heritage contexts demonstrate that cultural concerns, particularly the perceived impact of photovoltaic installations on historical and landscape identity, constitute key barriers to acceptance (Bottino-Leone et al., 2024).

The lack of interest in participating may align with Udoewa (2022), who argues that participatory design processes that invite community members to participate only in certain activities or phases (e.g., single workshops) do not grant them genuine leadership or decision-making power. This limitation could have reinforced the sense of consensus evident in the workshops. Udoewa

(2022) continues to argue that outside of community-led initiatives, participatory design processes often maintain or strengthen existing power imbalances, limiting genuine community inclusion and reinforcing designer control over decisions and participation. "If designers invite community members to participate, they are reinforcing the power differential … they have the power to choose who, when, where, how, and if to invite".

Practical Implications

Democratic participation through energy communities and economic associations

Energy communities are collective, citizen-centred forms of energy organisation that enable individuals, local authorities, and small enterprises to jointly produce, manage, and consume energy. They are formally recognised in the European Commission's Clean Energy for All Europeans package, which establishes a legal framework to support citizen participation in the energy transition (European Commission, 2022; 2024). Based on this regulatory framework, this research case study indicates that democratic participation is not just a normative aspiration; it is a crucial requirement for successfully integrating photovoltaic systems into heritage-sensitive environments. Although policy and literature emphasise decentralisation, participation, and prosumerism, the findings indicate that heritage-sensitive planning contexts require more in-depth forms of co-design and stakeholder dialogue to align climate objectives with heritage preservation. The participatory design workshops experienced limited engagement in the activities, particularly when discussions were abstract and not connected to concrete implementation paths, as energy communities and economic associations may provide. Therefore, providing a clear and realistic scenario that outlines implementation steps, governance, and expected outcomes could enhance willingness to engage, especially when tangible financial incentives and economic benefits are presented.

Models like economic energy associations (ekonomiska föreningar) could enhance interest in active participation by promoting shared ownership and risk distribution. Participatory processes require not only deliberative spaces but also credible institutional and economic frameworks to transform latent interest into meaningful civic engagement. This resonates with international evidence highlighting how locally organised energy communities enhance social cohesion, reduce energy costs, and strengthen collective responsibility for sustainability (European Commission, 2022; 2024).

The need for multidisciplinary professionals to negotiate dissensus

For residents directly affected within a specific neighbourhood, meaningful participation in the integration of photovoltaic systems should extend beyond consultation to include influence and a mandate to "own" the issue as co-decision-makers. The empirical findings demonstrate that participating residents were able to enhance design proposals, contribute locally grounded ideas, and propose contextually aligned photovoltaic solutions sensitive to architectural character and everyday practices. This confirms Eric von Hippel's (2005) argument on user-centred innovation, which highlights the epistemic value of users as co-creators rather than passive recipients of technology. In heritage-sensitive environments, residents possess situated knowledge of building traditions, aesthetic norms, and social practices that technocratic planning alone cannot replicate. Such intersubjective knowledge production resonates with Jürgen Habermas's theory of communicative action, where legitimacy emerges through inclusive dialogue rather than expert authority. At the same time, the historical dominance of expert-led conservation, described by Salvador Muñoz Viñas (2005) as restricted arguability and by Laurajane Smith (2006) as the Authorised Heritage Discourse (AHD), demonstrates how layperson perspectives have often been marginalised in heritage decision-making.

This study's participatory design workshops showed that all participants agreed on aesthetic preferences and principles for preservation; there was no disagreement observed. The participatory design workshops conducted in this study revealed that all participants reached a consensus on aesthetic preferences and principles for preservation. However, the workshops were not linked to any ongoing institutional workshops, which means that the findings do not reflect any disagreements or diverse viewpoints. Additionally, the absence of iterative discussions, where participants could revisit and refine their ideas, indicates that the workshops did not effectively address criticisms of consensus-based planning. Scholars argue that such approaches can often overlook important dissenting opinions (Mouffe, 2005; Hillier, 2003). This lack of connection and iteration likely limited the richness and diversity of perspectives that could have emerged. Instead, they resonate with Patsy Healey's (1997) perspective on communicative planning, which emphasises dialogue in formal contexts. This suggests that while local communities may have a sense of "ownership" over the integration of photovoltaic systems, this doesn't mean everyone is in total agreement; rather, there should be structured spaces where differing opinions can be recognised and discussed. Consequently, while citizen participation is indispensable (Forester, 2020), the empirical material also underscores the need

for additional experts, heritage professionals, energy engineers, and planners to mediate conflicts, articulate technical constraints, and support informed deliberation.

Transdisciplinary approaches go beyond the academic realm by incorporating non-academic stakeholders, such as community members, policymakers, and a variety of experts, in both the framing of problems and the creation of knowledge. This approach emphasises co-creation, collaboration, and a focus on real-world impact (Nicolescu, 2002; Sanders & Stappers, 2008). A transdisciplinary design process may require both resident design and design proposals, as well as design legibility. Resident design, which refers to the notion that local inhabitants play a primary role in articulating their vision for the future of their community (Rosetti, 2022).

Drawing on Michael Polanyi (2015), expert knowledge involves tacit dimensions that extend beyond explicit articulation, and, as John Friedmann (2020) argues, planning is inherently normative and political rather than value-neutral. Thus, a democratic process for photovoltaic integration in heritage contexts should combine empowered local participation with professional facilitation capable of negotiating dissensus. Such a model recognises participation not as the replacement of expertise, but as a reconfiguration of authority in which residents and experts jointly shape context-sensitive, socially legitimate, and technically sound energy transitions (Figure 26).

A transdisciplinary initiative should engage a diverse range of stakeholders within an Urban Living Lab environment.

This initiative should include:

1. Prosumers from the heritage district (D).

2. Local authorities (M), including urban planners and officials responsible for building permits.

3. Experts in heritage conservation (E), such as representatives from local and regional museums, as well as conservationists of the built environment.

Other experts who should be involved include:

4. Photovoltaic (PV) developers, who are responsible for the technical implementation of solar energy systems that are adapted to the climatic and architectural conditions of the district.

5. Researchers with expertise in facilitating design processes.

6. Architects who can contribute to spatial and typological analysis.

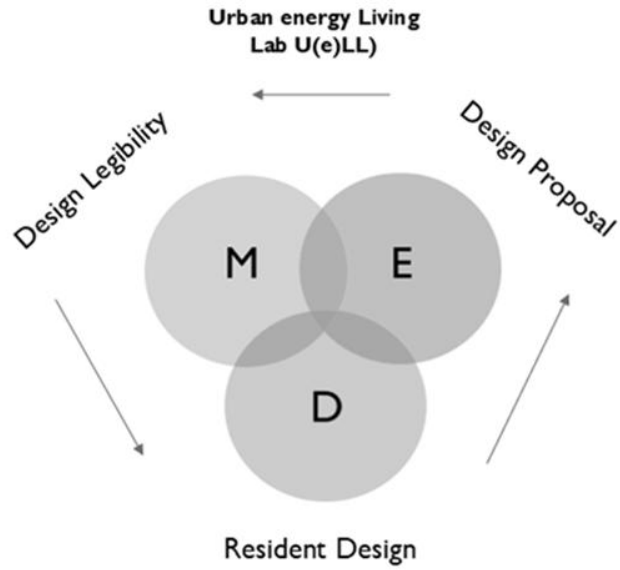

Figure 26. *The diagram displays a proposed transdisciplinary approach for value-sensitive integration of small-scale photovoltaics.*

Resident design emphasises ownership of the process at the earliest stage, ensuring that design interventions respond to community needs, aspirations, and socio-cultural identities. The design proposal represents an intermediary product that bridges residents' visions and the practical requirements of implementation, while balancing innovation with contextual appropriateness. Design legibility entails visual and narrative coherence, demonstrating how interventions respect cultural landscapes while meeting contemporary energy demands.

Coordinated Participatory Processes through Local Authorities

The Swedish decentralised approach, where municipalities have a planning monopoly, allows them to tailor planning processes to meet local needs. However, it can result in inconsistent assessments of heritage values and the integration of renewable energy sources (Riksantikvarieämbetet, 2023). Municipal urban planning departments may play a crucial role in coordinating the integration of photovoltaic systems in areas sensitive to heritage. While

participatory design methods are essential for ensuring democratic legitimacy and contextual sensitivity, they must be adapted to different architectural, geographical, climatic, and socio-political conditions. Consequently, municipal coordination is not merely administrative but normative: it structures how competing values, heritage preservation, energy efficiency, architectural quality, and local development priorities are balanced within specific territorial contexts.

The Historic Environment Act (Kulturmiljölagen, SFS 1988:950) establishes that the stewardship of cultural heritage is a shared national responsibility, while delegating key decision-making powers regarding listed buildings (byggnadsminnen) to County Administrative Boards. In practice, this creates a multi-level governance structure in which municipalities must navigate both designated and non-designated heritage assets. The distinction is critical, as designated heritage is subject to statutory protection, whereas non-designated heritage, although often locally valued, relies primarily on municipal planning instruments for its safeguarding. Moreover, Sweden's practice embeds cultural heritage considerations within everyday spatial planning processes. This integration allows municipalities to align photovoltaic deployment with local development strategies but simultaneously demands institutional capacity to manage complex trade-offs (Riksantikvarieämbetet, 2026). Central coordination by municipal planning departments, therefore, becomes essential to ensure that participatory design initiatives align with statutory obligations, professional conservation standards, and broader sustainability objectives.

This research case demonstrated that while coordinated municipal oversight is institutionally embedded within Swedish planning frameworks, its effectiveness depends on how coordination is operationalised in practice. Within the Swedish planning system, municipalities are assigned primary responsibility for spatial planning and permitting, which necessitates coordination across administrative functions according to the Plan and Building Act (2010:900). The establishment of consistent procedures may contribute to more standardised permitting processes, reducing uncertainty and administrative complexity for both residents and developers. In addition, coordinated municipal practices contribute to transparency and accountability. Swedish planning legislation emphasises public participation, consultation, and access to information throughout the planning process. It can also ensure that participatory methods are not applied uniformly but calibrated to the specific urban morphology, climatic conditions, and socio-political dynamics of each neighbourhood. By incorporating collaborative processes into statutory planning and aligning them with the Comprehensive Plan and Planning and Building Act, municipalities can promote context-sensitive photovoltaic integration that safeguards architectural and cultural values while supporting climate transition goals.

Future Work

Advancing a Value Sensitive Design Framework for Urban Living Labs

The value-sensitive design framework, originally developed by Batya Friedman and Peter Kahn, provides a foundation for integrating human values into design processes (Friedman et al., 2013). Its tripartite structure, (1) identification of stakeholders and values, (2) investigation of stakeholders' perceptions and prioritisation of these values, and (3) evaluation of how design choices shape and are shaped by these values, offers a systematic approach to embedding ethical considerations in technological development.

Future research should extend and operationalise this framework within the context of Urban Living Labs, particularly in heritage-sensitive environments undergoing energy transitions. While the present study focuses primarily on the first two components of value-sensitive design, subsequent work will further develop the third component by examining how specific design interventions and policy decisions materially influence value realisation in practice (Figure 27). A direction may be the adaptation of value-sensitive design from a focus on technological artefacts to complex socio-technical systems. Urban Living Labs are inherently experimental, iterative, and collaborative environments that involve multiple stakeholders, including residents, planners, policymakers, and photovoltaic technology developers. As such, the framework should be expanded to account for dynamic interactions, feedback loops, and evolving value configurations over time. This shift aligns with insights from complexity theory and participatory design, which emphasise emergence, co-creation, and the situated nature of knowledge production (e.g., Sanders & Stappers, 2008).

Iterations of the framework can more explicitly integrate principles from communicative planning theory. By embedding deliberation, argumentation, and reflexive dialogue throughout the design process, the revised framework seeks to operationalise the concept of communicative rationality as articulated by Jürgen Habermas (Habermas, 1984; Healey, 1997; Forester, 1999). This perspective foregrounds the importance of inclusive discourse, critical reflection, and co-experimentation in navigating ethically complex and value-laden decisions, particularly in contexts where competing interests and interpretations of heritage and sustainability coexist.

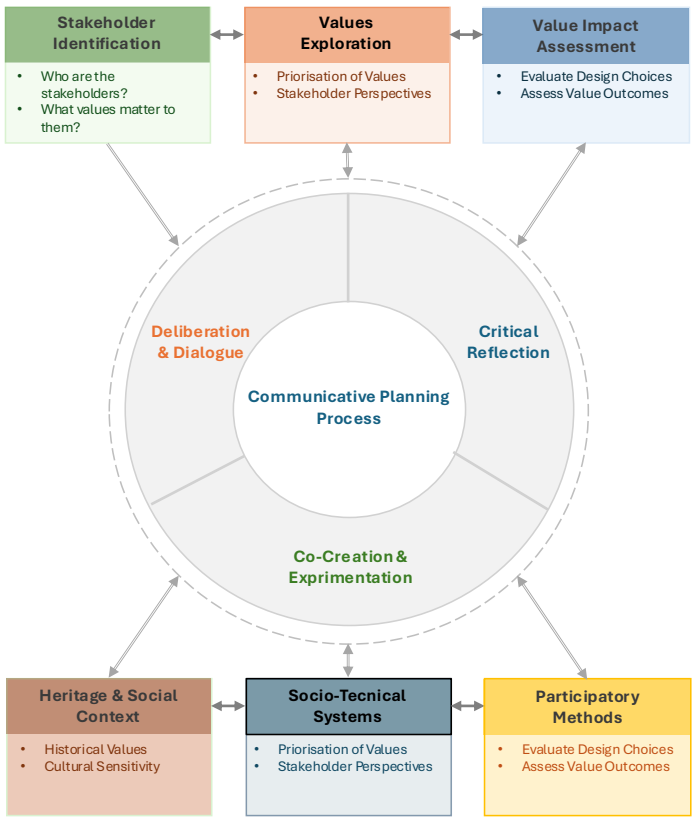

Figure 27. *The adapted VSD framework and participatory process.*

In heritage districts undergoing energy transitions, technological interventions, such as photovoltaic systems, cannot be treated as neutral or purely functional solutions. Instead, they are understood as carriers of normative assumptions that prioritise certain values while potentially marginalising others. Future research will therefore focus on developing methodological tools within the framework to make these embedded values explicit, open to contestation, and actionable within planning and design processes. This includes the development of participatory instruments, visualisation techniques, and evaluation metrics that can support stakeholders in articulating, negotiating, and revising value priorities over time.

Ultimately, the proposed adaptation of the framework for Urban Living Labs aims to contribute a theoretically grounded and practically applicable framework for managing the ethical, cultural, and socio-technical complexities of energy transitions in heritage contexts. By bridging design theory, planning practice, and participatory methodologies, future work will seek to enhance the capacity of Living Labs to function as arenas for informed, inclusive, and value-conscious innovation.

A Participatory Process using the VSD Framework in an Urban Living Lab Environment

This research project opens several avenues for further investigation into participatory urban planning processes grounded in the Value Sensitive Design (VSD) framework within Urban Living Lab environments. Future work should focus on operationalising and validating the proposed approach in real-world contexts (Figure 28).

First, a pilot research initiative could be established by forming a prosumer-driven energy community. This would serve as a real-life urban test environment, enabling the exploration of participatory processes and energy transitions within a controlled yet contextually grounded setting. Second, further research is needed to integrate participatory design methodologies with technical and spatial analyses. This integration would enhance the practical applicability of the framework, particularly in culturally sensitive urban areas. Emphasis should be placed on embedding subjective and collective values into planning processes within cultural heritage districts. Third, the development and application of *3D parametric modelling tools* present a promising direction. Such models could support the monitoring and evaluation of urban interventions, including renovations, restorations, and infrastructural upgrades at the district- or neighbourhood-scale. This would facilitate more informed and transparent decision-making processes.

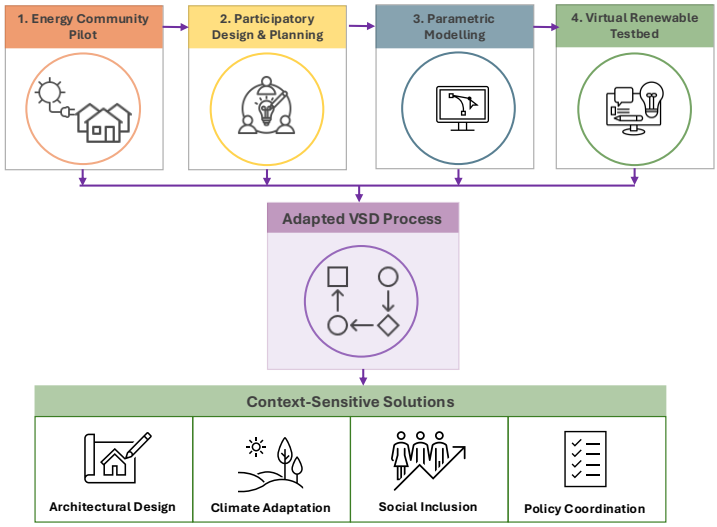

Figure 28. *An adapted VSD process towards Context-Sensitive Urban Planning Solutions in Urban Energy Living Labs.*

Finally, the implementation of a virtual testbed for renewable energy systems, photovoltaic installations, should be further explored. This environment would allow for simulation, validation, and optimisation of design solutions before physical implementation, thereby improving efficiency, feasibility, and stakeholder confidence. Overall, future research should aim to establish a comprehensive, context-sensitive participatory planning framework that bridges social values, technological innovation, and urban sustainability goals

8
Conclusions

This thesis aimed to present an investigation into how participatory design can support urban energy transitions in cultural heritage districts, with particular attention to the inclusion of prosumers as active stakeholders. Through a comparative analysis of three case studies of Porsön, Öjeby Church Town, and Södertorg, these studies demonstrate that participatory design is not a neutral or universally effective method, but a context-sensitive practice shaped by governance structures, institutional conditions, and stakeholder configurations. Its capacity to influence outcomes depends less on the design of individual workshops and more on how participation is embedded within broader socio-technical systems.

By situating energy transition within lived heritage environments, the study contributes an empirically grounded understanding of how participation, design practice and institutional frameworks intersect in practice. However, in the case studies, participation was limited to isolated workshops or lacked institutional support, which resulted in temporary engagement with minimal impact outside the specific project context.

Addressing the Research Questions:

1. How can participatory design methods be created to address barriers and facilitators when prosumers are included in urban energy transitions within cultural heritage districts?

The findings presented in this thesis suggest that participatory design can play a critical role in addressing both the barriers and facilitators of energy transitions in heritage contexts, but only under specific conditions. Its effectiveness is relational, emerging from the interaction between stakeholders, knowledge systems, and governance frameworks. Participatory design is most impactful when it operates as part of an integrated system, linking local knowledge with expert analysis and institutional processes, rather than as a standalone activity. Understanding the perspectives of stakeholders is essential for the successful integration of photovoltaics in cultural heritage districts. Participatory design methods should transition from exploratory engagement to structured, iterative processes that are integrated into institutions to effectively involve prosumers. First, methods should be designed to incorporate diverse

knowledge actors, including potential prosumers, municipal planners, heritage authorities, and technical experts, ensuring that prosumers are positioned not merely as informants but as contributors to decision-making processes. Second, participatory formats require facilitation and decision-support tools, such as multi-criteria evaluation frameworks, that enable participants to engage with trade-offs, feasibility, and regulatory constraints. Third, and most critically, participatory processes must be aligned with formal planning and governance structures. Without such alignment, prosumer involvement is more likely to be consultative in nature rather than contributing to substantive or transformative outcomes.

The findings also point to the importance of scale. This scale provides a pragmatic entry point for municipalities to support energy communities and to align participatory processes with planning authority and policy instruments. District-level engagement proved particularly productive as it allowed residents to relate energy transition to shared spaces, collective benefits and local identity. However, limited participation and resource constraints remain persistent challenges affecting representativeness, continuity and long-term impact. Therefore, prosumers should be able to build energy communities that successfully integrate small-scale photovoltaic systems into their neighbourhood. This allows the most relevant stakeholders within a heritage neighbourhood or district to engage with the issue actively, ensuring that those most impacted by these measures have a voice. By involving prosumers in participatory design, energy initiatives can take on greater ownership. This collective effort may enhance the quality of design outcomes and lead to more effective and sustainable practices in urban development. Integrating these perspectives promotes innovative solutions and ensures that the resulting developments respond more to the community's needs and aspirations.

Workshops design artefacts and situated dialogue enabled residents to express spatial preferences, aesthetic concerns and everyday practices that are typically marginalised in expert-driven assessments. Across all cases, participants consistently favoured photovoltaic solutions that were discreet, reversible and collectively oriented, which indicates that heritage sensitivity and renewable energy ambitions are not inherently incompatible.

Future research should aim to establish a comprehensive, value-sensitive, and participatory planning framework that is both theoretically grounded and practically applicable. Such a framework must be capable of operating across scales, integrating diverse forms of knowledge, and adapting to evolving governance conditions. By embedding Value Sensitive Design within Urban Living Labs, and by equipping these environments with the necessary methodological and technological tools, it becomes possible to move beyond

exploratory participation toward sustained, actionable, and institutionally embedded processes. Ultimately, successful energy transitions in cultural heritage contexts depend not only on technological innovation but on the ability to align values, stakeholders, and governance structures within coherent and adaptive systems. Future work on VSD and Living Labs has the potential to provide this alignment, transforming participatory design from a supportive method into a core infrastructure for managing complex socio-technical change.

2. *What are the barriers and facilitators of urban energy transition in cultural heritage districts?*

The findings demonstrated that the challenge of integrating renewable energy into heritage environments is not primarily one of technology, but of coordination, governance, and knowledge integration. Participatory design holds significant potential to address these challenges, but only when it is carefully configured, institutionally supported, and continuously maintained as part of a broader transition process.

Across all three cases, the research identifies that the most significant barriers are socio-institutional rather than technical. Key barriers include regulatory ambiguity regarding photovoltaic integration in heritage contexts, fragmented governance structures with unclear distribution of responsibilities, and rigid conservation frameworks that limit adaptive interventions. These barriers often manifest as uncertainty among stakeholders, delayed decision-making, and limited implementation capacity. Additionally, the lack of structured coordination platforms, particularly evident in Södertorg, prevents the consolidation of stakeholder input into actionable strategies. At the same time, several facilitators of urban energy transition emerge. Participatory processes themselves act as important enablers by fostering dialogue, increasing awareness, and surfacing shared values and spatial imaginaries. The inclusion of prosumers contributes local, experiential knowledge that can enhance the contextual relevance of proposed interventions. Furthermore, the presence of interdisciplinary collaboration, structured evaluation tools, and supportive municipal engagement significantly strengthens the potential for implementation. The Öjeby case demonstrates that when participatory processes are embedded within a multi-scalar and institutionally connected framework, they can facilitate more informed and collectively supported outcomes.

The result suggests that participatory design can improve social acceptance and facilitate stakeholder learning in urban energy transitions within cultural heritage districts. However, achieving acceptance does not guarantee implementation or ongoing engagement. Facilitators are only effective when they are sustained over time and connected to decision-making processes.

Without continuity and institutional backing, the positive effects of participation, such as increased social acceptance and shared understanding, tend to remain temporary.

Given the absence of comprehensive guidelines, local authorities play a pivotal role in facilitating stakeholder engagement and collaboration to develop effective integration strategies. Local authorities can contribute to creating more effective solutions and regulatory frameworks by fostering collaboration and promoting inclusive decision-making. Consequently, implementing these guidelines should employ transdisciplinary approaches to ensure their success.

9
Designing with Stakeholders: Pathways to Effective Participatory Practice

Developed Participatory Methods Linked to the Theory of Complexity

Building on the VSD Framework, future research should prioritise the development of participatory methods informed by complexity theory. A series of structured participatory workshops should be tested to deepen understanding of the case study context and to support the co-production of knowledge for decision-making. In contrast to linear planning approaches, these methods should acknowledge cities as complex adaptive systems in which outcomes emerge through dynamic interactions among stakeholders (Table 5).

Contextual Mapping

The first step to be tested can involve a contextual mapping workshop, in which participants will collectively identify and analyse the area's cultural heritage assets, existing uses and activities, infrastructure and environmental conditions, and social tensions and opportunities. To facilitate this process, participatory tools such as mental maps, historical timelines, and urban diaries will be employed.

Complexity Feature	Application to Participatory Design
Emergence	Stakeholder solutions and insights arise from interaction, not top-down imposition. Planners must create environments that foster the emergence of new ideas and configurations.
Non-linearity	Design interventions have unpredictable outcomes; small actions (e.g., prosumer workshops) can trigger significant shifts in local governance or energy use behaviour.
Feedback loops	Iterative design processes facilitate ongoing learning and adaptation. Regular participant feedback should be used to refine objectives.
Distributed agency	Prosumers, experts, and planners all contribute to shaping outcomes through collective agency. No single actor can control the outcome.
Case-based reasoning	Local knowledge and experience matter. Emphasise learning from place-specific practices instead of generalising from abstract models.

Table 5. *How Complexity Theory is linked to participatory design challenges.*

Casual Loop Diagrams

Building on the previous foundation, a second workshop will address complexity by applying Causal Loop Diagrams (CLDs) (Figure 29). CLDs are widely used across research, policy, and planning to visualise interdependencies within complex systems, to support shared understanding among diverse stakeholders, and to identify potential leverage points for change (Uleman et al., 2024; Pluchinotta et al., 2022).

In participatory modelling contexts, stakeholders are engaged in the collaborative construction of CLDs to externalise their assumptions, uncover hidden feedback structures, and make explicit diverse perspectives on systemic dynamics (Pluchinotta, Salvia, Zimmermann, 2020).

The iterative mapping of causal relationships between variables enables participants to negotiate how different elements influence one another and provides a tangible analytical foundation for subsequent scenario development and co-analysis (Uleman et al., 2024). In addition, participatory CLD exercises have been shown to support the identification of feedback loops and leverage points that are central for understanding complex problems and designing interventions (Uleman et al., 2024; Pluchinotta et al., 2022).

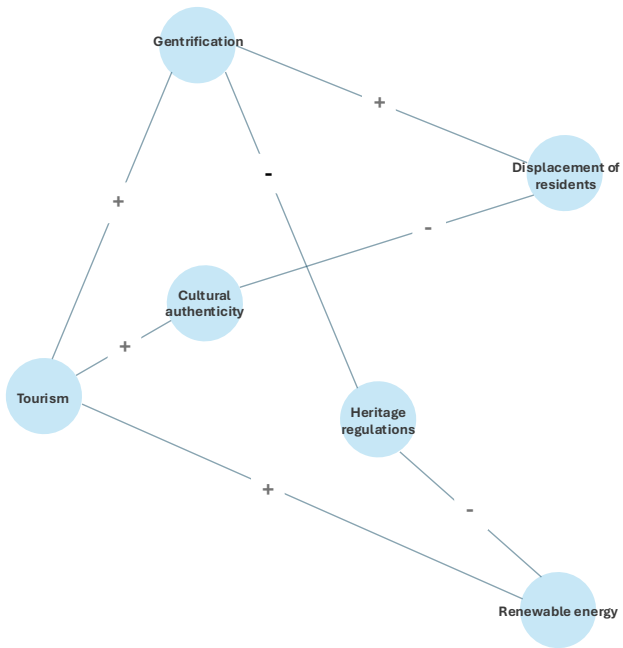

Figure 29: *Example of a causal loop diagram illustrating the relationships between, e.g. tourism, gentrification, displacement, cultural authenticity, protection rules and renewable energy in a heritage-sensitive area.*

The lines indicate cause-and-effect relationships between the variables, where "+" denotes that an increase in one variable tends to reinforce the other, while "–" denotes a dampening or counteracting relationship. The diagram highlights how tourism can reinforce gentrification and thereby contribute to the displacement of residents, which in turn can reduce the cultural authenticity that attracts tourists, a potential negative feedback loop. Protective rules can curb gentrification, while the introduction of renewable energy can both increase tourism and affect the application of protective rules.

Participatory Scenario Developments

The final stage of testing should consist of participatory scenario development workshops. The proposed workshops tested will draw on principles of scenario planning and participatory scenario processes to co-produce exploratory future

narratives that examine potential interactions and tensions between energy transition objectives and cultural heritage values (Figure 30).

Scenario planning is widely recognised as a structured approach for engaging with uncertainty, enabling the exploration of multiple plausible futures rather than the prediction of a single anticipated outcome. As conceptualised by Paul J. H. Schoemaker (1993), it supports strategic thinking by challenging underlying assumptions and broadening consideration of alternative developments. In sustainability and conservation contexts, Gary D. Peterson, Cumming, and Carpenter (2003) further demonstrate that scenarios provide a systematic means of linking complexity with decision-making under conditions of uncertainty. Additionally, it is argued that participatory scenario processes can enhance shared understanding among stakeholders, surface conflicting priorities, and contribute to reflexive and adaptive planning practices.

The implications of this approach are twofold. First, it positions participatory scenario development as a methodological bridge between analytical research and strategic action, strengthening the capacity of stakeholders to navigate deep uncertainty in complex socio-technical systems. Second, it contributes to emerging scholarship at the intersection of sustainability transitions and heritage governance by testing how scenario-based deliberation can inform the identification of possible strategies.

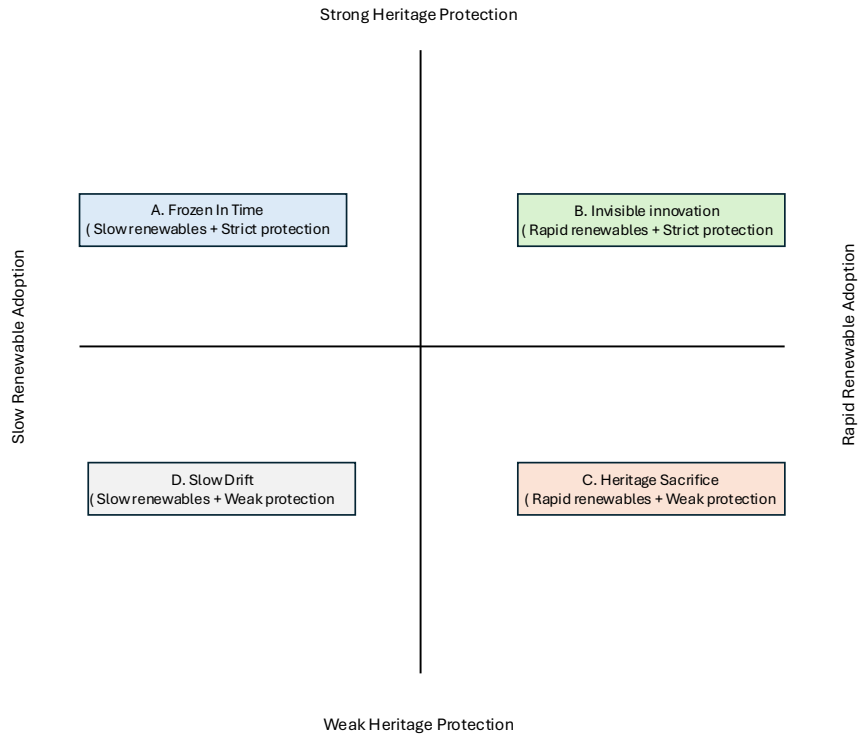

Figure 30: *2×2 Scenario Matrix (Heritage Protection vs. Renewable Adoption).*

In examining the relationship between cultural heritage and renewable energy systems, it is important to create scenarios that illustrate a range of potential future landscapes. Each scenario acts as a model to help us understand how various policies and design approaches can influence our environments and social structures. To effectively develop these scenarios, participants should focus on five key dimensions:

(1) Narrative. This dimension focuses on the overarching story or theme of the scenario. It sets the tone for the vision of the future. Participants should consider questions like: What are the driving forces behind this scenario? How do cultural heritage and renewable energy interact in this narrative? (2) Built Environment: Here, participants should think about what physical spaces and

structures exist within the scenario. This includes considerations of architecture, public spaces, and infrastructure. How do these elements reflect cultural heritage while integrating renewable energy technologies? What innovative designs could support sustainability and historic preservation? (3) Energy: This dimension examines the energy systems in place within each scenario. Participants should outline the sources of energy, how they are harnessed, and the technologies used. Are there specific renewable energy solutions that dominate, such as solar, wind, or bioenergy? How do these solutions impact the local culture and community practices? (4) Governance and Conflict. This aspect explores the policy frameworks and governance models that guide decision-making. It also addresses potential conflicts that may arise, whether between different stakeholder interests or between modern and traditional practices. How are conflicts resolved? What governance structures support a synergistic relationship between cultural heritage and renewable energy?

Both qualitative and quantitative indicators play a crucial role in evaluating the success and impact of various scenarios. Participants need to pinpoint specific metrics that can effectively illustrate how policies perform over time. These metrics might include measurable improvements in energy efficiency, which reflect how well resources are being utilised and how costs can be reduced. Additionally, assessing economic benefits can provide insight into the financial advantages brought about by these policies, such as job creation or increased revenue for local businesses.

Furthermore, tracking levels of community engagement is vital, as it indicates how well the policies resonate with the public and foster participation. High engagement levels often correlate with greater support for initiatives and a stronger sense of community. Finally, it's essential to measure the preservation of cultural practices, which helps ensure that policies not only drive modernisation but also respect and maintain the unique traditions and values of the community. By utilising a combination of these indicators, participants can gain a comprehensive understanding of the policies' effectiveness and their overall impact on society.

To bring these scenarios to life and encourage participation, several creative and participatory tools can be employed: (1) Storyboarding. In participatory design, storyboarding helps bridge gaps between designers, stakeholders, and non-experts. Not everyone is comfortable with technical language, but most people can engage with simple visuals and narratives. It makes ideas tangible and easier to discuss, critique, and improve together. (2) Visual Collages. A visual collage is a collection of cut-outs (from magazines, photos, maps, drawings, materials) arranged by participants to represent how they see a place now, how they imagine its future, what they value, fear, or desire. (3) Participatory

Prototyping. Involving stakeholders in the design process helps ensure that all voices are heard and considered. Participants can build prototypes of physical spaces or systems, allowing for hands-on experimentation and refinement of ideas based on collective feedback.

By weaving together these dimensions and tools, participants can create multifaceted scenarios that illuminate potential futures, encouraging reflection on the complex relationship between cultural heritage and sustainable energy systems.

Future Research

Expected Results and Significance

The complete suggested participative project is expected to generate three primary outcomes when practically implemented.

First, detailed and visually represented scenarios will be developed for integrating renewable energy in heritage-sensitive districts. These scenarios will include narrative descriptions, illustrative visualisations, and concrete examples of how different technical and social solutions may be applied under varying conditions. They are intended to serve as a basis for discussion and decision-making among both local stakeholders and planning authorities.

Second, the planned project will foster a shared, cross-sectoral understanding of stakeholder priorities, conflicts, and opportunities. Through participatory methods and dialogical processes, a collective knowledge base will be created that not only reveals diverse values, interests, and potential goal conflicts but also identifies areas for collaboration and joint problem-solving.

Third, the work will result in a set of qualitative and quantitative indicators to support anticipatory governance and long-term planning. These indicators will operationalise the scenarios and provide tools for monitoring developments over time, identifying early warning signals, and assisting decision-makers in balancing the demands of the energy transition with the preservation of cultural heritage values and social sustainability.

Taken together, these results are expected to advance knowledge on how energy transition can be integrated into heritage environments in socially inclusive and place-sensitive ways, while also providing practical tools for policy, planning, and design. To support knowledge transfer and decision-making, the project will also produce concrete outputs. An interactive format could be created to engage, explore, and sometimes allow for influence, such as a scenario book or digital map. This format will present the scenarios and their implications in an accessible and educational manner for relevant stakeholders. It will build on previous guidelines that can be adapted to various formats.

In addition, the project will generate policy recommendations based on the trade-offs and conflicts identified during the process, thereby supporting political and administrative decision-makers in making more informed and sustainable long-term choices.

Future research should be conducted to answer the following questions: 1) How can multi-stakeholder collaborations be fostered to address the barriers to renewable energy deployment in heritage sites? 2) What role can local communities play in decision-making for renewable energy projects in culturally sensitive areas?

Summary of Papers

Statement of Author Contribution

I contributed to all stages of the research presented in the three papers included in this thesis (Table 6). I was responsible for the conceptualisation of the case studies, including the formulation of research aims, theoretical framing, and overall research design. I developed the methodological approaches and selected the analytical strategies applied in the papers. I carried out the main part of the empirical investigation and conducted the formal analysis, including data collection, organisation, and interpretation.

The analysis was undertaken in relation to the research questions and theoretical framework. I prepared the original drafts of the paper manuscripts and was responsible for revising and editing the texts following feedback from co-authors, reviewers, and editors. I also produced the visual materials included in the papers, such as figures and diagrams used to support the analysis and presentation of results. The contributions of co-authors consisted primarily of discussion, feedback, and collaboration. Their specific roles are described in the respective papers.

Papers	Type	Status
Paper 1	Systematic Review	Submitted 2026 (Journal of Heritage Management and Sustainable Development)
Paper 2	Case Study Paper	Published 2024 (Cities)
Paper 3	Case Study Paper	Published 2025 (LAND)

Table 6. *The articles published and submitted.*

Paper 1 “Photovoltaic Integration in Heritage Districts: A Systematic Review of Challenges, Opportunities, and Practices” (Appendix I)

The first article investigates the integration of photovoltaic (PV) systems into heritage districts, asking how renewable energy technologies can be implemented without undermining the cultural, architectural, and historical values of protected environments. Based on a systematic literature review conducted in accordance with the PRISMA 2020 framework, the study synthesises research published between 2019 and 2024, with particular attention to European and Nordic contexts. It argues that PV integration in heritage settings is not solely a technical matter of energy generation, but a complex socio-technical challenge shaped by aesthetic considerations, conservation principles, governance structures, and public acceptance.

A central tension emerges between the technical requirements of photovoltaic efficiency, such as orientation, visibility, and material performance, and the preservation of authenticity, visual coherence, and material integrity in historic urban environments. At the same time, the article highlights the growing potential of building-integrated photovoltaics (BIPV), including transparent, semi-transparent, organic, and perovskite-based technologies, which offer more discreet and context-sensitive alternatives than conventional add-on systems. These innovations suggest that heritage conservation and sustainability goals need not be mutually exclusive if interventions are carefully designed and evaluated within their specific architectural and cultural contexts.

The review organises its findings into four major themes: methodological and design-oriented frameworks, policy and governance, local barriers and multi-criteria decision-making, and social acceptance. Across these themes, the article shows that successful photovoltaic integration depends on more than technical feasibility; it also requires clear regulatory procedures, coordinated municipal and institutional guidance, and active stakeholder involvement. Studies reviewed in the article demonstrate that fragmented legislation, uncertain approval processes, and inconsistent planning practices often obstruct implementation, whereas transparent and adaptive policy frameworks enable more effective and heritage-sensitive solutions.

Equally important is the role of public perception, as acceptance is strongly influenced by visual impact, cultural meaning, and trust in decision-making processes. The article, therefore, concludes that sensitive photovoltaic integration rests on three interdependent dimensions: technical sensitivity,

regulatory integration, and participatory governance. Interventions must be reversible, minimally intrusive, and tailored to the values of each heritage context, while municipalities, conservation authorities, designers, energy experts, and local communities must collaborate in shaping acceptable outcomes. Ultimately, the study positions heritage districts as potential laboratories for sustainable transformation, arguing that future research should prioritise district-scale, context-specific, and longitudinal approaches capable of integrating technological innovation with cultural continuity and climate resilience.

Paper 2 "Co-designing the urban energy transition: A resident-based approach" (Appendix II)

The second paper examines how participatory design methods can support more democratic and socially accepted pathways for the urban energy transition, with a focus on small-scale renewable electricity production, particularly photovoltaics, in Porsön, Luleå, Sweden.

The district's mixed building types and social challenges make it a relevant testbed for community-driven energy planning. The research investigates how citizens can be involved in planning to democratise and increase the acceptance of the transition, what incentives may motivate them as prosumers, and how they can become drivers of future energy development. The theoretical foundation combines participatory design, public acceptance of renewable energy, and democratic planning. Originating in Scandinavia in the 1970s as a tool for worker empowerment, participatory design has since expanded to urban and energy planning, positioning citizens as co-creators rather than passive end-users.

This challenges technocratic models by valuing local knowledge alongside technical expertise. While large-scale renewable projects often require only passive consent, small-scale solar initiatives depend on active engagement, yet Sweden's planning frameworks privilege property owners, excluding tenants and non-owners. Co-design is therefore presented as a means to achieve higher levels of participation, in line with Arnstein's ladder of citizen involvement, and to strengthen legitimacy by including marginalised voices. The neighbourhood scale is identified as suitable for such engagement, enabling both identity-building and collective initiatives such as shared photovoltaics.

Workshops with residents and stakeholders revealed complementary insights. Residents demonstrated creativity and preferred photovoltaics in public spaces, such as carports or educational "solar sculptures", which were seen as

more inclusive and less constrained by ownership. Institutional stakeholders, however, highlighted barriers including restrictive laws on shared energy communities, technical challenges such as roof strength and snow loads, and fragmented responsibilities between municipal and energy actors.

The findings suggest that participatory design empowers residents, fosters ownership of energy issues, and enhances acceptance of renewable integration. Incentives should extend beyond individual subsidies to neighbourhood-scale benefits, ensuring inclusion of disadvantaged groups. District-level co-design offers contextual specificity, inclusivity, and tangible impacts, while iterative collaboration between residents, stakeholders, and experts is essential for equitable outcomes. Overall, participatory design can democratise energy transitions by embedding citizens' knowledge, creativity, and values into planning, thereby enhancing legitimacy, learning, and more context-sensitive solutions. Municipalities are well-positioned to lead such initiatives, and policy should support transdisciplinary, action-oriented approaches to expand community-based energy projects and prosumer participation.

Paper 3 "Participatory Design for Small-Scale PV Integration in Heritage Districts: The Case of Öjeby Church Town, Piteå, Sweden" (Appendix III)

The third paper examines how small-scale photovoltaic systems can be integrated into heritage districts in a manner that respects cultural and aesthetic values, ownership and regulatory constraints, while actively engaging residents as prosumers.

The case study is Öjeby Church Town (Öjeby Kyrkstad) in Piteå, northern Sweden, a nationally significant heritage site characterised by wooden church cottages, shared ownership structures, and strict cultural heritage protection. Such contexts pose challenges for energy transition, as frameworks are typically expert- or regulation-driven and often neglect residents' lived experiences and tacit knowledge.

The study asks how residents' perspectives can be effectively incorporated into photovoltaic planning for heritage areas. A transdisciplinary participatory design orientation was developed, combining technical, heritage, regulatory, and social dimensions. Institutional workshops with authorities and heritage experts clarified constraints, while interviews and meetings with local councils and associations revealed governance complexities.

A three-part resident workshop introduced photovoltaic and heritage values, included a site walk, and engaged participants in design activities with models and visual simulations. Pre- and post-workshop questionnaires captured changes in knowledge, attitudes, and values. Spatial and typological analysis assessed physical constraints, including roof shapes, sightlines, and materiality.

Findings highlight residents' strong concern for preserving visual integrity, favouring unobtrusive and reversible photovoltaic installations. Preferred solutions included non-heritage or secondary structures, shared or public infrastructure, and carefully colour-matched building-applied photovoltaics with minimal intrusion. Regulatory frameworks often restrict even modest interventions, while the complexity of ownership complicates implementation. Technical issues such as snow loads and winter sun angles limit roof-based solutions, leading to interest in alternatives like vertical or freestanding photovoltaic. Paradoxes also emerged, such as the acceptance of metal sheet roofs as part of heritage identity, while more visibly modern PV elements remain contested.

The participatory process enhanced awareness, legitimacy, and agency among residents, while also exposing regulatory gaps and value tensions that were not evident in technical assessments alone.

The study contributes a replicable framework for integrating residents into heritage energy planning, combining institutional workshops, stakeholder engagement, participatory design, and visual analysis. It also provides insight into acceptable photovoltaic strategies in heritage contexts, emphasising non-intrusive, reversible, and context-sensitive solutions. Policy implications include the need for adaptive and transparent guidelines for heritage districts, as well as stronger roles for local councils in mediating between conservation and sustainability goals.

Appendices

Appendix I (Paper 1)

Vikström, L., Luciani, A. *Photovoltaic Integration in Heritage Districts: A Systematic Review of Challenges, Opportunities, and Practices*. Submitted. Emerald Publisher. Journal of Heritage Management and Sustainable Development. April 2026.

Appendix II (Paper 2)

Vikström, L., Ek, K., Luciani, A., Rizzo, A. *Co-Designing the Urban Energy Transition: A Resident-Based Approach.* Elsevier Journal. Cities. January 2025

Appendix III (Paper 3)

Vikström, L., Luciani, A., Rizzo, *A. Participatory Design for Small-scale PV Integration in Heritage Districts: The Case of Öjeby Church Town, Piteå, Sweden.* MDPI, LAND. September 2025.

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