Financing smart local energy systems: a conceptual framework and research agenda

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Abstract

Smart local energy systems (SLES) are expected to contribute to meeting net zero carbon emission targets, as well as enabling energy decentralisation, democratisation and digitalisation. There are, however, unresolved questions about finance. We extend the existing corporate governance and risk management model CLASS to a new CCLLASS model. The model is used to explore pathways to SLES investment through securitising future cash flows. Case study evidence is used to explore governance and risk management practices suited to building investor confidence in securitisation. Several governance and risk management measures already in place support implementation and operation of securitisation, and should strengthen investor confidence. There is however scope for improvement in several elements, including final market architecture and explicit characterisation of benefits to localities. Further research is needed to test feasibility of a SLES future cash flow securitisation mechanism, including quantitative asset aggregation and systematic comparison of securitisation and other financial instruments.

Keywords: smart local energy systems, asset securitization, corporate governance

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1. INTRODUCTION

The integration of different energy vectors across electricity, heat, transport and storage is underway [1]. In combination with digital or 'smart' technology and local energy production, such integration can be characterised as smart local energy systems (SLES). Although this concept is predominantly utilised in the United Kingdom (UK), it shares features with other conceptualisations, such as smart energy systems, urban energy, and multi-carrier energy systems [2].

SLES are expected to contribute to climate protection by providing whole system efficiencies and carbon savings from locally-integrated, renewable, and responsive energy services, as well as local economic and welfare benefits [3,4,5,6,7,8]. In a centralised system such as that in Britain, however, the integration of heat, power, transport and storage at local scale entails complex socio-technical changes, and SLES have not yet been widely implemented and commercialised [9,10]. New entrants, end users, investors, regulators, and incumbent energy companies, need to collaborate, but are likely to have different motivations, priorities, and experience in energy systems and markets [11,12,13,14]. Technical challenges include the particular configurations and combinations of physical and digital infrastructures entailed in constituting SLES, as well as uncertainties in design and operation of the various energy(-related) services to be provided [15]. In addition, there are distinctive financial-economic challenges to returns on investment; these relate to risk management and cash flow estimation and fulfilment, which will be explored in this article, as well as mismatches between project *"aggregability"*, [1] scalability, replicability and longevity (lifespan). These elements, inherent in relatively novel and complex SLES, can potentially hinder attractiveness to investors, and

[1] Aggregability refers to the optimal number of assets (or installed capacity), part of the SLES project, which enables a return aligned with investors' expectations.

access to finance [16]. Likewise, inadequate policy environments and financial-economic stimuli can obstruct investment in key constituents of these systems [17,18,19], hampering replication and/or scale-up.

One route to manage complexities of SLES finance and investment is securitisation. Securitisation enables the conversion of a financial agreement (e.g. loans, imports, future payments, mortgages, etc.) into a transaction (e.g. sale/purchase of bonds) [20] as a means of raising funds. Securitisation may be relevant to financing SLES for the following reasons. First, securitisation provides opportunities for managing risks by pooling diverse and complex assets (and their cash flows); these are reduced to a simple unit of analysis, money, to reduce the complexity of financial assessments. Second, securitisation can facilitate the standardisation (i.e. similarity and comparability) of intricate transactions that involve the generation, management and payment of cash flows for different assets. Third, as a consequence, securitisation can attract varied investors through the sale of asset-backed instruments in financial markets. Securitisation can therefore help enhance access to finance and overcome financial complexities of SLES. A number of countries, including the UK, Denmark, Portugal, and Greece, have worked to develop, test and implement SLES with diverse organisations, assets, energy services and (potential) forms of cash flow generation and collection. This existing work has not resolved uncertainties over financing a group of SLES assets, justifying our focus on securitisation as one potential mechanism.

Securitisation was, however, instrumental in the 2007/08 financial crisis, notably in the ‘subprime’ domestic mortgage market. Causes of the crisis were numerous, including poor corporate governance and risk management [21]. A pathway to avoiding further financial crises associated with securitisation is the use of standardised corporate governance and risk management frameworks [22,23]. Robust corporate governance and risk management practices can entail positive impacts on diverse aspects, including loan contracting [24], cost of debt [25], circular economy strategies [26], and financial performance [27]; yet the latter relationship still needs to be confirmed [28,29]. Hence, there is a need to explore the potential fit between such frameworks and emerging SLES. For example, it would be necessary to delve into the configurations (i.e. organisations, assets, energy services, technologies, etc.) currently used in implementation and operation of SLES. Better understanding of the potential for these configurations to be integrated into suitable forms of asset securitisation would also be fundamental. Furthermore, examination of risk management, governance, and cash flow estimation methods would be important for enabling effective securitisation schemes for SLES finance.

This article therefore develops, and tests, a novel corporate governance and risk management conceptual framework aligned with securitisation principles. We then integrate the framework into an initial securitisation scheme, which would use future cash flows to support investments in SLES, whilst addressing the financial intricacies. The conceptual framework encompasses key elements of, and questions about, effective risk management, governance, and cash flow estimation. As previously noted, the term SLES is commonly used in the UK, but different terms used elsewhere share elements in common. This investigation uses the term SLES as shorthand for models of integrated local energy systems, and examines the fit between two emerging SLES and the proposed governance and risk management framework. It identifies the missing elements to be addressed before the framework could be used as foundation for a securitisation mechanism. Consequently, the paper aims to address the following research questions:

a) How are SLES configured?

b) Could SLES be framed as *securitisation-orientated structures* to help secure and scale-up financing?

c) What aspects of risk management, governance and cash flow estimation need to be addressed to enable effective securitisation schemes for SLES finance?

Accordingly, this article is intended to reach researchers, practitioners and policymakers whose interest is in delivering financing mechanisms to help accelerate the energy transition and achieve net zero. In this vein, this work draws on tools from both finance and the social sciences to propose an original conceptual framework for corporate governance and risk management, grounded in asset securitisation to support the financing of SLES.

The remainder of the article is structured as follows. Section 2 provides the theoretical background. Section 3 characterises the corporate governance and risk management approach, and the resulting conceptual framework. The fourth section applies the framework to two case studies as a means to explore governance and risk management strengths and limitations of the cases, and pathways to implementing securitisation. Section 5 presents a future research agenda and the sixth section concludes.

2. ASSIMILATING SLES CONFIGURATIONS TO SECURITISATION

Before developing the conceptual framework, we discuss the concept of SLES and the relationship with securitisation, as well as potential pathways for SLES financing and investments while avoiding risks of the kind associated with the subprime crisis.

2.1 Theoretical and empirical background to SLES

The concept of a smart local energy system (SLES) encompasses local energy production, supply and demand management across multiple vectors (integration), using digital, or ‘smart’, technologies, and potentially enabling local energy trading and system balancing [2,13,15]. Studies of SLES demonstrators describe systems with several energy assets that are: a) owned by various organisations grouped in multi-stakeholder consortia; b) located at different sites, inside a system-defined perimeter; and c) digitally managed [11,14].

Figure 1 portrays a generic conceptualisation of SLES, regardless of the specific composition of consortia, which is useful to explore corporate governance and financial intricacies. This Figure 1 indicates that the SLES is part of, within a larger energy system, either regional or national. Thus, the size of the SLES in the image, reflected by its boundary, does not indicate its relevance, in terms of, for instance, components or assets, installed capacity, etc., in relation to the regional or national system. Of course, we acknowledge that a SLES could also be the only energy system providing services in a specific (isolated) location. Likewise, as shown in this figure, numerous local energy assets, comprising different technologies, energy sources and installed capacity, interact in provision of a range of energy services, predominantly electricity, storage, heat and transport. Clean fuel production, for example hydrogen, might also be a system component. Physical infrastructure (e.g. pipes, wires and routers) in combination with digital infrastructure (e.g. artificial intelligence software, firmware, and operating system) allow smart management and monitoring of assets and their integration, with the aim of effective and efficient operation with minimal supply interruption. The integration of physical and digital infrastructures is intended to facilitate the recording and quantification of energy inflows/outflows within the SLES, and between the SLES and the wider system. The SLES is thus identified by a boundary based on physical and non-physical factors, such as number, installed capacity, technology and location of assets. Scale of digital-smart infrastructure, local commitment and regulation are also defining factors. The design, implementation and operation of a SLES involves diverse actor partnerships or consortia. Parties may have differing aims and have either the (shared) propriety or a concession contract conferring the responsibility to operate specific assets on behalf of their owner(s). In addition, other (local) stakeholders may have rights to obtain (some) monetary and non-monetary benefits from the system.

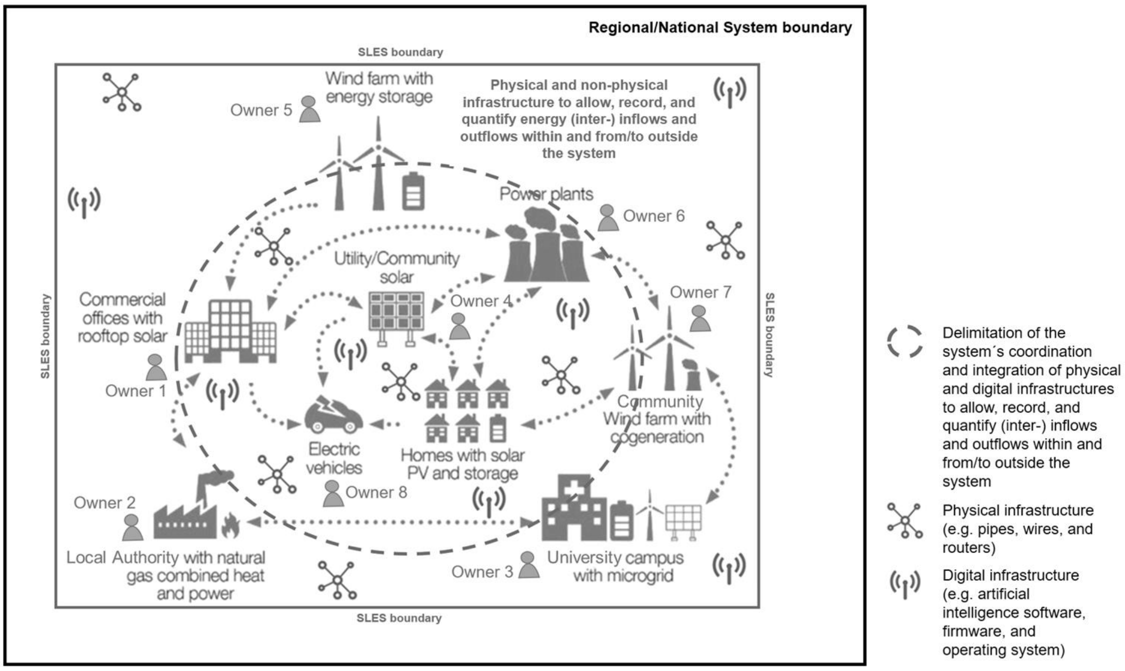

Figure 1. Generic conceptualisation of SLES - Adapted from [30]

The above conceptualisation depicts the economic characteristics of SLES while avoiding their characterisation as solely vertical or horizontal structures. It allows us to propose the following definition: a *SLES comprises a social, technical, and organisational arrangement of energy infrastructure, which supports and integrates multiple members, assets, sources and technologies, interconnections and interactions. It aims to provide smartly-managed-*

and-monitored energy services, with monetary and/or non-monetary benefits to (local) stakeholders. This definition is used in developing our proposed conceptual framework.

The above definition is also useful as a means to identify examples of SLES tested in different locations. For instance, the UK Industrial Strategy Challenge programme provided investment in the Prospering from the Energy Revolution (PFER) Challenge [31,32,33,34], enabling development and evaluation of several SLES demonstrators [35] and designs [36]. Another example is the Smart Islands Energy System (SMILE) project, funded by the European Union´s Horizon 2020 research and innovation programme, with the aim of demonstrating distinctive smart energy projects in three different locations, i.e. Orkney in Scotland, Madeira in Portugal, and Samsø in Denmark, and promoting the market introduction of related technologies [37]. Table 1 depicts the main features of these programmes, two examples of SLES supported by such initiatives, and their correspondence with our definition of SLES.

	Project overview	Example of supported SLES	Alignment with the definition of SLES
PFER Challenge programme	Over 50 SLES initiatives, including demonstrators, around the UK with the aim of providing an understanding of what is possible, what works, and where support/help can be found for the implementation and operation of more integrated, local, and smarter energy projects.	Demonstrator / ReFlex Orkney: this project seeks to unify local electricity, transport and heating into a single, manageable system that links distributed renewable energy sources with flexible demand. Given the importance of flexibility, the project incorporates battery storage, electric vehicles, smart charging systems and smart meters. This integrated energy system will cater to the needs of local households and businesses, offering leasing options and other financial solutions to help avoid substantial upfront expenses.	The projects, depending on the local specificities, conditions and existing infrastructure, test combination(s) and integration of different technologies, such as grid balancing and frequency control mechanisms, smart metering roll out, demand side management systems, electrical storage, electric vehicle network and smart charging, heating systems, hydrogen electrolysers and renewable generation. Benefits for local stakeholders are expected yet not fully characterised. Projects are managed by cross sector consortia usually formed by local authorities, universities, community organisations and private companies.
Smart Islands Energy Systems (SMILE) project	Large-scale pilots or demonstrators in three European locations with similar characteristics, but distinctive policies, regulations and markets. The goals are: evaluating solutions, handling issues, learning and exploiting the experience curve, and providing appropriate guidance for project replication/scale-up.	Demonstrator / Madeira: the project aims to enhance Madeira Island's energy grid by implementing an intelligent control and automation system to improve distribution management, reliability, and resilience. This includes integrating smart metering, grid balancing, demand-side management strategies, and storage solutions to accommodate more renewable energy generation. Moreover, the project aims at assessing the integration of battery electrical storage systems (BESS) using existing micro-generation sites and expand the electric vehicle network through smart charging technology, ultimately advancing electric mobility on the island.	

Table 1. Examples of SLES initiatives

These initiatives (shown in Table 1) have relied on a significant component of grant funding. Other finance sources will then be needed to help reach commercialisation stage, justifying our focus on future finance options for these examples of SLES. Our conceptual framework can be applied to any (smarter, more local) energy project located in any place, as long as such a project is aligned with the definition in the previous paragraph.

2.2 Main aspects of securitisation and the relationship with SLES

Securitisation is the process of pooling and converting assets and their cash flows into standard securities offered to investors, usually in the form of bonds, as a means of financing and (re-)allocating and managing risks. The securities are repaid to investors only through the pool of securitised assets [38,39,40]. The security is defined as an *"asset-backed security"*

(ABS); other denominations are based on the underlying asset, e.g. mortgage-backed security (MBS). An example is shown in Figure 2.

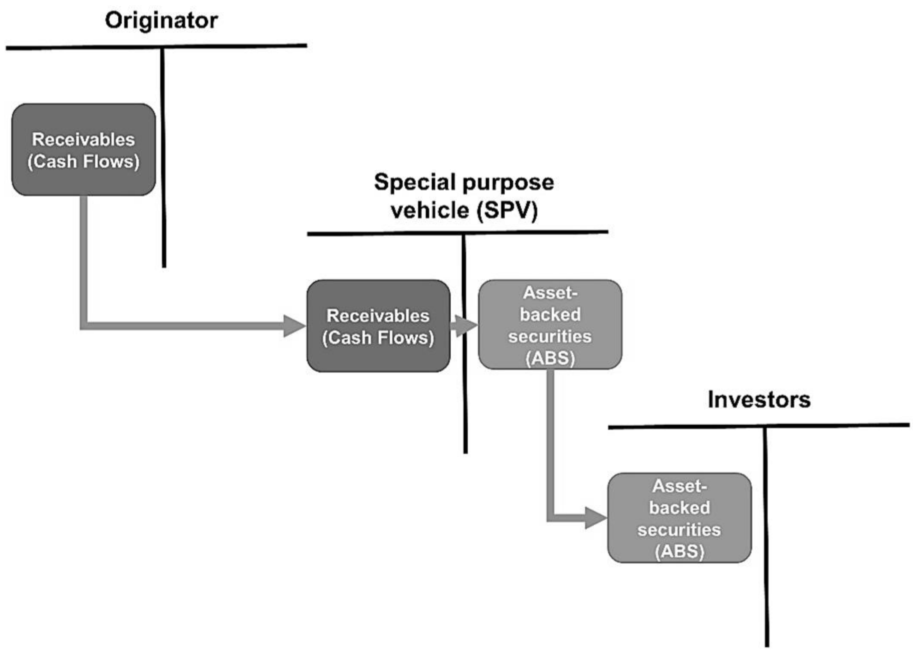

Figure 2. A basic securitisation process - Adapted from [41]

Although popular securitised assets are mortgages, loans and receivables associated with financial and retail sectors [39,40], potential for securitisation has been acknowledged in the energy sector, both before [42,43], and after, the 2007/08 financial crisis [44,45,46,47]. The diversity of securitised assets and their associated risks enables the promotion of capital markets and resource usage integration [20], and access to a variety of risk and (expected) return alternatives [48], which can help encourage a critical mass of investors to devote money to specific projects, businesses. The above can be particularly relevant in the context of the necessary financing in intermediate (and, perhaps, earlier) stages of project development.

Securitisation has been used, for example, to increase lending to green initiatives, including energy projects [49]. In this vein, even financial schemes for off-grid solar energy projects, based on asset securitisation, have been implemented to help accelerate the energy transition and obtain competitive financing costs whilst managing risks appropriately in non-industrialised markets [50]. Likewise, the financing of photovoltaics irrigation systems, which aim at decreasing inefficient water consumption and pollutant emissions, has been schematised encompassing both blockchain technology and asset securitisation to enhance transparency, complete asset standardisation, collateral validation and measures to strengthen the repayment capacity of the financing scheme [51].

Future cash flow securitisation, alternatively future flow securitisation, involving future cash flows typically related to intellectual property and royalties, and rights to either future income streams or future receivables, have been acknowledged in the literature, particularly for the entertainment and sports sectors [39,40,52]. Likewise, this asset securitisation variant has been recognised as a potential pathway for boosting the finance of energy projects, especially for both high-rated utilities and companies with unsatisfactory creditworthiness and high-quality assets subject to credit and statistical examinations [42]. In the context of breaking through sovereign credit ceilings and/or accessing affordable finance, a typical future cash flow securitisation model can be conceptualised as follows. An originator, typically based in a developing country, sells future receivables in hard (stable) currency to an offshore SPV, which issues the securities to investors. Offshore customers agree to send direct payments for the goods they import to the originator via an offshore account managed by a trustee; the money collected is later allocated to the SPV, which in turn pays principal and interest to investors. Surpluses are directed to the originator [53].

Financial risk management can be more standardised when future cash flow securitisation is used with commodities in high demand like oil or gas, because a significant volume of cash flows is likely [53]. This could be applicable to the electricity and other energy services provided by SLES, where significant demand for commoditised energy services from the locality is expected. Since new system configurations have no historical cash flows, future cash flow securitisation could play a central role in financing SLES; reliable methods for estimating cash flows would however be critical.

2.3 An initial securitisation-based structure for SLES

Based on the above asset securitisation conceptualisation, we design a potential future cash flow securitisation for SLES, as illustrated below (Figure 3). SLES are comprised of diverse locally-integrated energy assets, which can be owned by different actors/organisations. Energy inflows and outflows from these assets need to be quantified and recorded; by pricing such energy flows, each SLES component (cash flow unit or CFU) will contribute to estimating a *systemic future cash flow structure,* which can be a fundamental factor when securitising SLES.

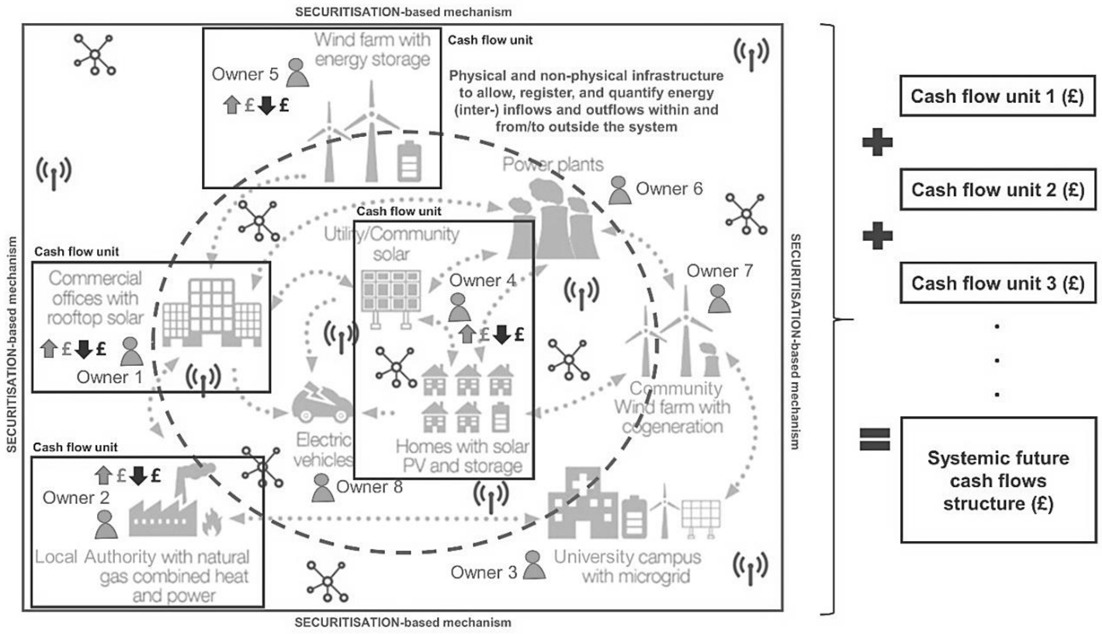

Figure 3. SLES and future cash flow securitisation

If a SLES offers varied energy services and needs funding as a whole, and there are complexities that shape estimation of cash flows for each asset within the system, then a well-defined systemic structure of future cash flows could make financing easier. Such a structure could reduce complexities into a single monetary element for analysis and, therefore, facilitate standardisation, pricing and securitisation for the whole SLES. This systemic structure relies on adequate estimations of cash flows for each asset (CFU), including an accurate net balance that comprises all inflows and outflows of cash, as well as prospects for frequency and size of payments (customers' financial behaviour), where a critical mass of customers provides ample incomes. The above is made tangible through explicit energy service agreements, such as power purchase agreements (PPAs), pay-as-you-go plans, annual/monthly subscription plans, etc. These contracts comprise the future receivables and future income rights, i.e. assets, to be sold to the SPV.

As detailed in Figure 4, the consortium or joint venture responsible for SLES development and operation determines the structure as a basis for sale of assets to a SPV. The SPV - typically a private or public limited company, or a limited liability partnership, owned by a charitable trust, and managed independently by a trustee - then issues and sells SLES-backed bonds to investors. As in any other asset-backed security, structuring such a SLES-backed bond will typically require financial engineering via a specialist or arranger. A (third-party) servicer has to be included in the scheme to support future income rights/receivables management and timely cash flow collection to pay back investors, via a specific account.

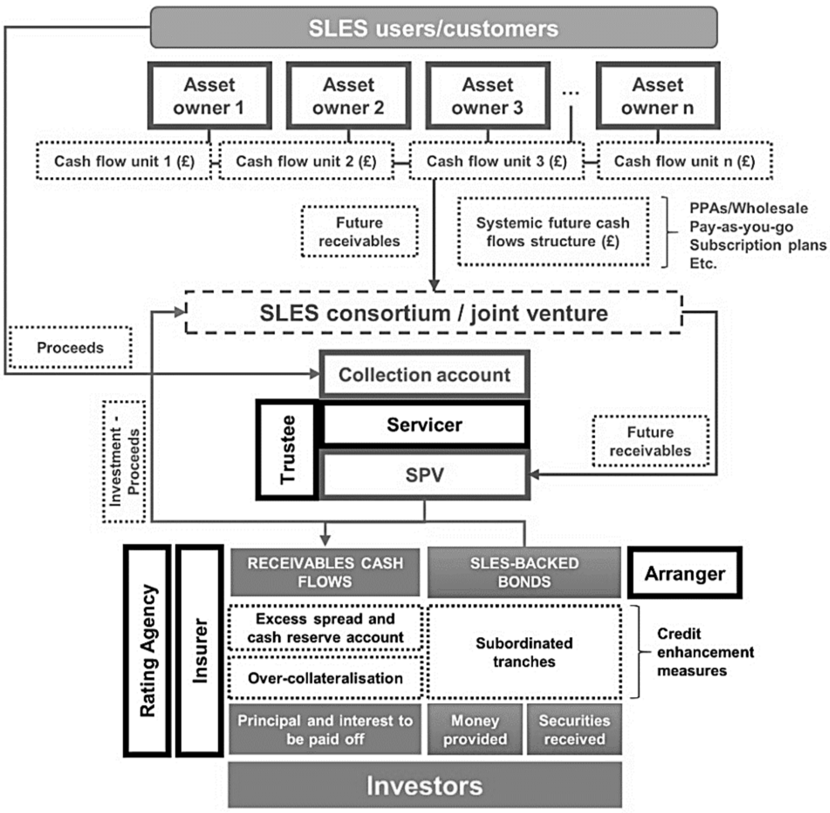

Figure 4. An initial structure for a SLES Future Cash Flow securitisation scheme

In comparison with familiar assets such as mortgages, a SLES is likely to entail greater uncertainty and risks for investors, even when such systems are expected to meet an important demand for energy services, such as electricity, heat, transport and clean fuel.

Although this work primarily focuses on the cash flows towards the project and investors to help finance SLES initiatives, it is important to consider when the money might flow towards the real assets owners and (local) stakeholders. This can occur either after the securitisation mechanism has compensated investors or during the implementation and operation of this financing mechanism. The former may not meet the expectations of real assets owners and (local) stakeholders in the context of the expected monetary and non-monetary benefits to be delivered by SLES. The latter, nevertheless, chiefly depends upon two factors. First, the forecasted cash flows from the project and how the SLES-backed bond is structured. The project could potentially compensate not only investors, but also originators, i.e. real assets owners, through cash surpluses available after repayment to investors. Such surpluses can be achieved if the project generates sufficient cash flows, and the structuring of the bond allows for raising funds without exceeding actual financing needs. Second, the financial regulation related to SLES securitisation; this regulation should allow for redirecting cash surpluses, when available, to originators, provided that coupons are paid as promised and that credit enhancement measures, such as overcollateralisation, are operating properly. Since this work focuses on financing SLES, addressing some aspects that could facilitate cash flows towards the project and investors to support SLES scale-up and replication, a detailed exploration of the timing and factors behind cash flow allocation to asset owners is beyond the scope of this article and left for further research.

Credit enhancement measures are a common means of strengthening future cash flow securitisations [54]. For example, a SLES can establish an excess spread (i.e. the excess between the interest received by the SPV and the interest paid to investors) for deposit in a cash reserve account to address any difficulty in servicing debt. Some SLES participants are likely to have stronger finances; extra value (money) could then be added to assets to be securitised via an over-collateral transferred to the SPV, i.e. the action to make the value of the issuer's assets (future income rights/receivables) higher than the value of the issuer's liabilities (SLES-backed bonds). Furthermore, the issuer could specify tranches to offer senior and junior securities; the former are prioritised when repaying debt and will not absorb any initial losses or credit enforcement measures. It may also be optimum to define explicit covenants, e.g. an excess of cash flows collected, over and above debt to be repaid, which should be met throughout the securitisation lifespan. Insurance may be difficult due to the complex nature of the scheme. On the other hand, credit rating agencies appraise future cash flow securitisations using diverse factors, such as the originator's liquidity and credit evaluation; business continuity; cash flow collection and recovery mechanisms; changes in recovery volumes and legal and regulatory reforms [54]. A well-managed SLES could appropriately address these factors and potential transaction costs.

Hence, SLES could be framed as *securitisation-orientated structures*, as they consist of multiple energy assets, which may be owned by diverse actors, whose (future) cash flows could be estimated, recorded, and offered to investors through SLES-backed bonds. Assets, owners and cash flows then need to become part of a legal, organisational structure operating a future cash flows securitisation mechanism.

2.4 Advantages and disadvantages of securitisation, and lessons from subprime crisis

Securitisation and, more specifically, the mechanism proposed in the previous subsection possesses several advantages. It can ease access to capital markets, as cash flows are decoupled from the (potentially unworthy) condition of originators and only then offered to investors. This benefits not only originators, as they can transfer risks to the SPV (without revealing sensitive information), but also capital markets and the investors who participate in them. Diverse (greener-assets-backed) securities, with varied combinations of risk, return and maturities, can then be offered to investors [55,56], allowing portfolio diversification and potentially appealing returns. Illiquid assets, including SLES assets that are (indirectly) related to service provision, can be converted into cash.

Disadvantages need to be acknowledged. Securitisation mechanisms can entail the participation of several third-parties (e.g. servicer, credit rating agency, and external auditors) who may not perform duties appropriately due to factors such as weak internal controls, lack of relevant information to support the securitisation scheme, and inadequate knowledge or experience in securitisation, among others. Zhang et al. [57], concerning asset securitisation for renewable energy firms in particular, highlight the importance of avoiding inopportune governmental subsidies and patents as underlying assets, managing uncertainty of renewable energy sources, and strengthening institutional mechanisms for effective securitisation market operation. This emphasises the need for expertise in securitisation before assessing, implementing and operating such a scheme; this includes efforts to avoid undervaluation or underestimation of risks. Furthermore, recent evidence has suggested that securitisation may require the master-limited-partnerships tax regime established in the United States to engage investors [46], as such investors could be taxed only on distributions. Complex securitisation-based arrangements may also weaken due diligence and risk management, including cash flow recovery (from customers, debtors) and debt servicing [58,59].

Some of the above disadvantages materialised during the 2007/08 subprime crisis. This crisis has been attributed to poor corporate governance [60], including inappropriately permissive corporate culture; overvalued risk-management tools; inadequate compensation mechanisms [61]; misaligned interests between users and governance arrangements [62], and poor monitoring in vertically integrated structures [63]. The consequences include greater caution in use of securitisation [39]. These lessons suggest that corporate governance and risk management standards will be a key element when designing, implementing and operating any securitisation scheme.

Corporate governance and risk management practices, including appropriate cash flow management in the context of complex, diverse SLES, are key to an environment of trust, transparency and accountability for long-term investment [64]. They can also be imperative for UK investors, who actively engage with companies [65]; for stimulating greater willingness to pay due to governance-related attributes of companies [66]; and for ensuring financial security [67,68]. Appropriate business and financial disclosure, well-defined roles and responsibilities, adequate monitoring and feedback, fluent communication with stakeholders, a vision focused on organisational longevity and growth [69,70,71,72], among other measures, could then facilitate effective operation of a SLES and any related securitisation scheme.

3. CONCEPTUAL FRAMEWORK

Robust governance and risk management are fundamental to designing, implementing, and operating a future cash flow securitisation mechanism for diverse SLES. Accordingly, we use and extend Drew et al's. [73] work to propose a conceptual framework, with the objective of supporting investments in SLES, whilst addressing financial intricacies.

3.1 A conceptual framework to support investments in SLES

Drew et al's. [73] CLASS model (*Culture, Leadership, Alignment, Systems, and Structure*) is an integrated, five-element conceptualisation of corporate governance and risk management. CLASS proposes five questions for a company board or senior management to use in assessing each element. The aim is to support a robust approach to corporate risk and then anticipate and mitigate inherent risks of meeting strategic objectives [73]. This model relies on a previous work that examines the external and internal forces that shape firms' approach to risk exposure, establishing the critical organisational factors to properly manage risk exposures [74]. This model is selected because, from our perspective, it contains the basic governance and risk management elements that any company, or organisation, including SLES, should consider when meeting strategic goals. Furthermore, the CLASS model has recently been acknowledged as part of a set of tools that can strengthen risk culture, which can in turn enhance value creation for firms [75]. Both risk culture and value creation, we conjecture, will be critical for commercially-deployed SLES initiatives in the context of asset securitisation.

In the context of financing and investing in newly-conceptualised SLES, we extend the model and rename it CCLLASS, incorporating two new elements *"Cash-Flow-Lock"* and *"Localism"*, and adjusting another element, i.e. *"Systems"* changes to *"Smartness"*. Such extensions are needed to broaden the scope of governance and risk management to encompass implementation and operation of SLES and corresponding securitisation mechanisms. They also guarantee that the model includes the following governance and (financial) risk management dimensions routinely recognised as critical for securing finance – the "*6Cs*".

First, *Character* is defined as the honesty and reliability of the parties; second, *Capacity* is the ability to fulfil obligations; third, *Conditions* signal a favourable context for finance(-related) activities; fourth, *Capital* is defined as interested parties showing financial commitment through appropriate investment and risk exposure. Finally, *Collateral* is defined as the availability of valuable assets to counterbalance financial risks. These determinants are associated with common quantitative indicators used to assess access to finance. For instance, *Capacity* can be linked to financial leverage ratios; *Conditions* can be related to competitiveness, productivity, and national/foreign investment indicators [76,77,78,79]. A further *"C"* may be *Clarity* in the terms and conditions for financing, investment arrangements and activities.

Securitisation can also be made compatible with key determinants of business access to finance *(the "6Cs")* mentioned above. Implementing a securitisation scheme could help establish accurate and clear levels of investment, expected return and risk exposure (*Capital & Clarity*), as well as introduce different forms of *Collateral* (i.e. items, assets of value). These factors can signpost the scheme's *Capacity* to repay SLES-backed bonds, as well as the honesty and reliability of those behind the scheme (*Character*). Appropriate governance and risk management can help manage adverse (market) *Conditions* potentially faced by such a scheme.

The extension of the CLASS model, i.e. our CCLLASS model, comprises the new "Cash-Flow-Lock" element, which refers to the governance, risk management, and cash flow management activities that any SLES needs to account for when providing energy services and financing the system, either partly or completely, through future cash flow securitisation. This element incorporates, explicitly and implicitly, the *6Cs* mentioned above; following this idea, each element of the CCLLASS model can be linked, directly and indirectly, with at least one of the *6Cs*. The novel “Localism” element refers to the specific governance and risk management activities that any SLES needs to deal with when engaging with localities, and (local) stakeholders. The “Smartness” element acknowledges the role of more advanced forms of digitalisation, such as machine learning (ML) and artificial intelligence (AI), as well as “smartness governance”.

The remaining elements (and related questions), i.e. Culture, Leadership, Alignment, and Structure, are slightly adjusted to align our extended governance and risk management model to SLES implementation and operation. Thus, our (extended) CCLLASS model consists of the following elements: *Culture, Cash-Flow-Lock, Leadership, Localism, Alignment, Structure, and Smartness*, as detailed in Figure 5.

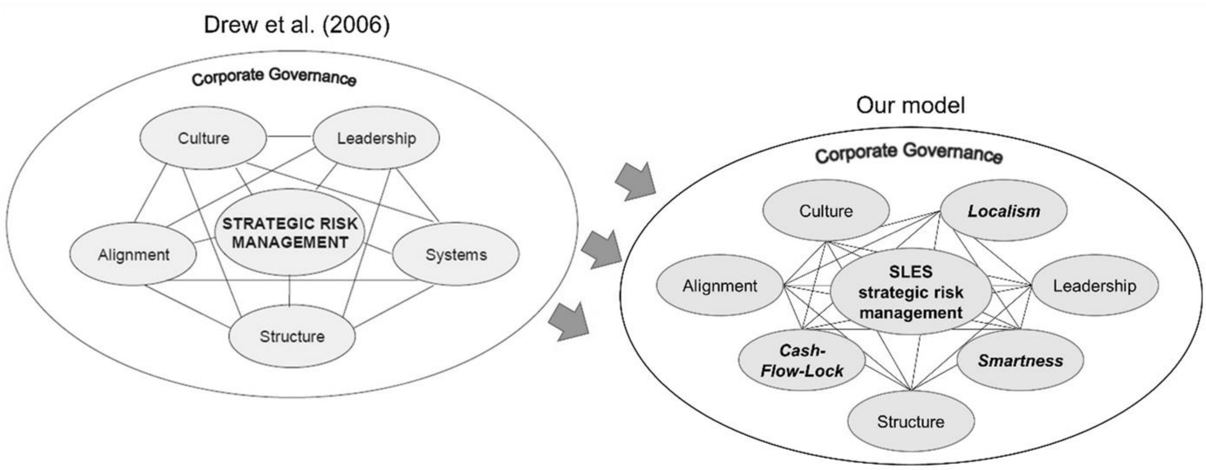

Figure 5. CLASS model and our extended version, CCLLASS

Drew et al. [73] explain the relationships between the elements, which, in the context of SLES management and financing, would be as follows. *Leadership* is necessary to shape business *culture* (e.g. customs, beliefs, behaviours, etc.). The degree of *smartness* can support or leverage the way the SLES *structure* is implemented and operates in the market. The above elements, i.e. *leadership*, *culture*, *smartness*, and *structure*, can help define the strategies and actions to engage *local* stakeholders. In combination, these elements shape the pathways to estimate and secure cash flows, i.e. *Cash-Flow-Lock*, which are key to strengthen the financial condition of the SLES; the proposed securitisation mechanism shown in section 2.3 is an example of such pathways. When the above elements (i.e. *Leadership, Culture*, *Smartness, Structure, Localism, and Cash-Flow-Lock*) are *aligned*, the vision and mission, principles and values, members, assets and obligations, interactions and engagements with either internal or external actors, and decision-making, monitoring, accountability, and improvement processes do not contradict each other. Each element is then reinforced, supported by the action of other elements. The inter-relationships between elements could be stated in different ways, but all the constituent elements remain inter-dependent. The proposed conceptual framework to help secure, scale-up financing/investments in SLES, in the context of a securitisation mechanism, is depicted in Figure 6. The lines in Figure 6 show the association between the CCLLASS model elements and 6Cs, which is also shown in the supplementary material to this document; these factors shape the governance, risk and cash management activities in the context of financing SLES through securitisation.

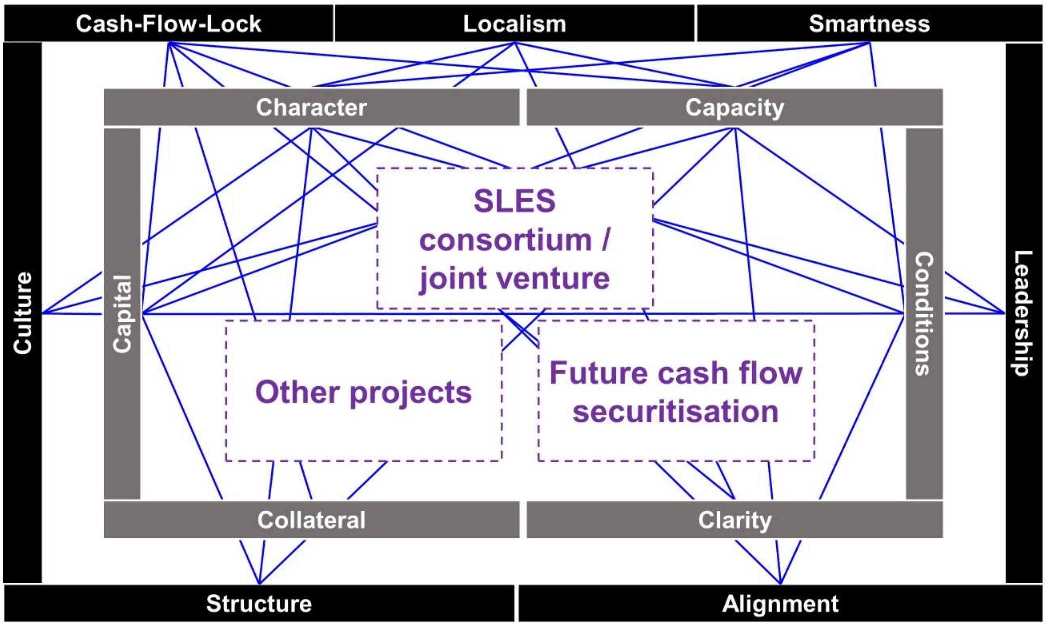

Figure 6. Conceptual framework based on securitisation and CCLLASS model

3.2 Application of the conceptual framework

The CCLLASS framework set out above is used to explore the elements of risk management, governance and cash flow estimates to be addressed to ensure effective implementation of securitisation. We use two case studies of SLES initiatives, namely the UK SLES demonstrator Local Energy Oxfordshire (LEO) and the pilot SMILE project tested on the Danish island of Samsø (Samsø–SMILE). For qualitative analysis utilising our conceptual framework, we draw on a consolidated report on LEO [80], and the SMILE project's website [81], alongside Marczinkowski et al. [82,83,84], Østergaard et al. [85], and Pramangioulis et al. [86].

The rationale for selecting these projects is twofold. First, both projects entail participation of diverse actors and assets, as well as testing, and potential implementation, of various energy(-related) services. They also include specific activities focused on engaging with localities, including deprived communities. Second, both projects possess a body of publicly available information that delivers valuable insights into project characteristics, initiatives tested and implemented, and plans, or at least ideas, for the future. These two reasons for selection denote that these SLES demonstrators or pilots are a robust means to explore existing roles, responsibilities and activities relating to risk management, governance and cash flow estimates, and their alignment with each element of the CCLLASS model.

The qualitative analyses used a 5-point assessment scale as follows: *5-Significantly, 4-Suficiently, 3-Moderately, 2-Marginally, and 1-Insignificantly*. Using the evidence detailed above, we then estimated the degree of alignment with, or implementation of, governance, risk and cash flow management measures, defined in our CCLLASS model. As exemplified in Figure 7, each question in this model was answered using both a summary narrative and a 5-point-scale.

Nomenclature
1-Insignificantly, 2-Marginally, 3-Moderately, 4-Suficiently, and 5-Significantly

Element: Culture	**Narrative / Analysis**	**1**	**2**	**3**	**4**	**5**
(1) Are the SLES consortium beliefs and values openly articulated in mission statements, and do these include ethical concerns? ** Related 6Cs: Character **	The organisational components of LEO shape its governance. LEO has a clear vision highlighting the role of provider of insights to support the UK's energy transition. Key objectives, aligned with this vision, are defined as: develop and test flexibility; inform the energy transition based on evidence, and understand potential benefits for non-energy actors. Neither vision nor key objectives incentivise, or put pressure on short-term earnings, or a strong drive for success without tolerance of failure (Culture: *Question 2, Question 4*). An ethical framework containing the following principles reinforces the above claim: - A service co-designed with communities, which considers the minimisation of barriers for benefits delivery; - A fair distribution of created value and costs amongst stakeholders; - A minimisation of risks, so that no one is materially worse off; - Adequate and clear information about service benefits, costs, and risks is available, and informs decisions on participation in the project; - Anyone who is affected by service design or provision will be treated with respect and					●
(2) Does the culture in the SLES consortium or its members temper a drive for success with a tolerance for occasional failure? ** Related 6Cs: Character **					●	
(3) Do SLES consortium members, employees feel free to bring problems to senior executives, or even to the board, without fear of adverse consequences? ** Related 6Cs: Character **				●		

Figure 7. Example of the application of the conceptual framework based on securitisation and CCLLASS model

This approach to presenting results eases the process of assessing the degree of alignment with, or implementation of, governance, risk and cash flow management measures. It enables us to propose potential pathways to implement a securitisation mechanism with robust governance, risk and cash management, in an environment of trust, transparency, stability and investor accountability. The detailed findings from the qualitative analyses, including the narratives and scale-based assessments for LEO and Samsø–SMILE case studies; questions from the CCLLASS model, and links with the *6Cs*, are detailed in the supplementary material to this article (two files available online; one file for each case study). The main results are discussed in the next section.

4. CASE STUDIES OF SLES INITIATIVES: TOWARDS A SECURITISATION MECHANISM WITH ROBUST GOVERNANCE, RISK AND CASH FLOW MANAGEMENT

4.1 LEO project description

LEO tested flexibility services, mainly using existing energy assets, as the basis for developing a transformative SLES, whilst understanding routes to a clean energy transition involving local energy markets, and benefits for non-energy actors.

LEO flexibility market trials relied on local electricity generators (wind, hydro, and solar), storage (including electric vehicle batteries), heat pumps and smart technologies (e.g. Internet of Things) to monitor and control small energy assets and manage network balancing and demand side response.

Consortium partners are from universities (Oxford and Oxford Brookes), industry (SSEN, Nuvve, Piclo, Equiwatt and EDF), community-oriented entities (Low Carbon Hub) and local authorities (Oxford City and County Councils). These organisations were involved in overlapping tasks addressing diverse topics, such as energy flexibility and demand-side management, community engagement, vehicle-to-grid and smart charging technologies, data analysis and energy system planning. In addition, six local communities were involved in the aforementioned trials, which were characterised as Smart and Fair Neighbourhoods. Funding is from both public sector, via Innovate UK, and project partners covering a project cost of circa £ 33.94 million [87,88].

4.2 Samsø–SMILE project description

Samsø–SMILE was a pilot project that aimed at advancing the market introduction of innovative energy systems technologies and configurations to contribute to the energy transition.

Samsø–SMILE was planned as a “real-time” system integrating electricity, heating and (partially) transport. This included testing a storage system and a dynamic pricing control system, levelling out fluctuations in supply from renewable power generation, and setting up a new market model for electric vehicles, including boats. The main equipment comprises a battery system, photovoltaic panels, heat pump and charging connection points for boats.

Consortium partners are from universities (Aalborg University and Danish Technological Institute), industry (Samsø Elektro, Lithium Balance, Route Monkey, and Vcharge), communities (Samsø Energy Academy) and local authorities (Samsø Municipality). This demonstrator was organised by Samsø Municipality, Samsø Energy Academy and Samsø Elektro; Danish Technological Institute and Lithium Balance were chiefly involved in the battery storage system; Aalborg University dealt with simulation and control issues; and, Route Monkey and Vcharge were in charge of the demand response method. Samsø–SMILE was funded by the European Union’s Smart Islands Energy System (SMILE) initiative and

Samsø Municipality; equipment and installation costs were the most significant financial component with circa € 239,000 [89].

4.3 Missing elements and potential pathways to a securitisation mechanism for SLES based on the experiences of LEO and Samsø–SMILE projects

The qualitative analyses, detailed in the supplementary material, found evidence of various good governance and risk management practices, as well as useful work that could be further enhanced to implement more robust practices. Such work would in turn help to specify routes to reasonably secure cash flows, which are likely to be critical to use of securitisation as a means of financing SLES. We summarise the key points of the analyses in the Appendix A to this article.

Some essential elements of good governance and risk management, potentially critical for securitisation, were missing. Neither LEO nor Samsø–SMILE had institutionalised CEO and Chairperson roles, or the internal audit function, including (independent) control evaluation. Both projects exhibited particular risk management functions, usually as a work package requirement. Such functions did not appear to be constituted as staff functions providing specialised advisory and support independently from the core functions. Limitations of existing governance and risk management were offset to some extent by specialist expertise of project leaders and consortium partners with responsibility for specified technical tasks or work packages and deliverables. Furthermore, both SLES pilots were subject to a fixed budget and end date, which governed the rationale for their particular organisational structures.

Further missing elements were the lack of explicit and complete characterisation of monetary and non-monetary benefits for localities. Neither were there appropriate mechanisms for allowing localities to have a stake in the SLES and its benefits and costs (and risks). A clear, unambiguous characterisation of benefits would be useful for quantification and monitoring, so that cash outflows derived from such benefits, potentially critical when fulfilling securitisation obligations, are properly controlled. Such monitoring processes should not only quantify, but also assess the nature, extent and timing of any benefits provided to localities. The design and implementation of appropriate (ownership) mechanisms to allow localities to participate effectively in decision-making, and to share benefits and costs (including risks), should also improve local engagement and acceptance, local welfare and environmental conditions. The above points are important contributors to decentralisation, democratisation and decarbonisation of energy systems.

Some missing elements relating to Cash-Flow-Lock are also evident in both projects. Explicit, shared energy provision, or service, agreements and (fair) pricing and remuneration mechanisms should be implemented to secure sufficient cash flows. This should strengthen both capacity to fulfil obligations and attractiveness to investors, who may be willing to devote financial resources via a securitisation scheme. Likewise, collateral and financial models which capture and assess risks systematically should be implemented. These measures should ease cash flow generation, collection and payback. Addressing the above missing elements should support the definition and implementation of the (final) market architecture necessary for SLES operation, as well as the adequate legal, corporate, and organisational structures to scale-up and/or replicate both SLES.

Overall, as discussed above, the cases show comparable, and incomplete, degrees of alignment with, and implementation of, governance, risk and cash flow management measures defined by the CCLLASS model. This is shown in Table 2 below, which summarises the results from the qualitative analyses. Both qualitative analyses used the following 5-point assessment scale: 5-Significantly, 4-Suficiently, 3-Moderately, 2-Marginally, and 1-Insignificantly (numbers shown on the left-hand side of the table). The degree of alignment with, or implementation of, governance, risk and cash flow management measures, as stated in our extended CCLLASS model through both constituents elements and corresponding questions (shown at the top and bottom of the table, respectively), is then estimated for both LEO (o) and Samsø–SMILE projects (*). Details are found in the supplementary material to this paper.

	Culture					Leadership					Structure					Localism					Cash-Flow-Lock					Smartness					Alignment				
5	o					* o	* o																												
4		* o		* o				* o	* o	o		o				o		* o	o												* o	* o			* o
3	*		* o		* o					*	* o	*		* o	* o	*			*		* o		*				*	* o		* o			* o	* o	
2																	* o			* o		*		*	* o	* o	o		* o						
1																						o	o	o											
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5

Table 2. Summary of results from the qualitative analyses following CCLLASS framework

From qualitative analysis (Table 2), both SLES projects demonstrated more progress in the Culture, Leadership, Localism, and Alignment dimensions. There were some differences between the projects in explicit incorporation of values and beliefs in strategic statements (Culture), and availability of financial information, both potentially useful for future implementation of a securitisation mechanism (Cash-Flow-Lock). Since the projects are not identical, there were other (immaterial) differences between them. Their organisational components were however similar: both are consortia comprising varied partners; work packages with analogue functions and roles; state funding and well-defined allocation of tasks and deliverables.

Although there is uncertainty about whether these SLES demonstrators will be replicated and/or scaled up [2] in the future, Figure 8 specifies potential pathways to a securitisation mechanism using a CCLLASS governance and risk management perspective. The pathways are intended to address the missing governance elements outlined above in order to develop a robust securitisation mechanism. The pathways and their implications require further investigation to test viability.

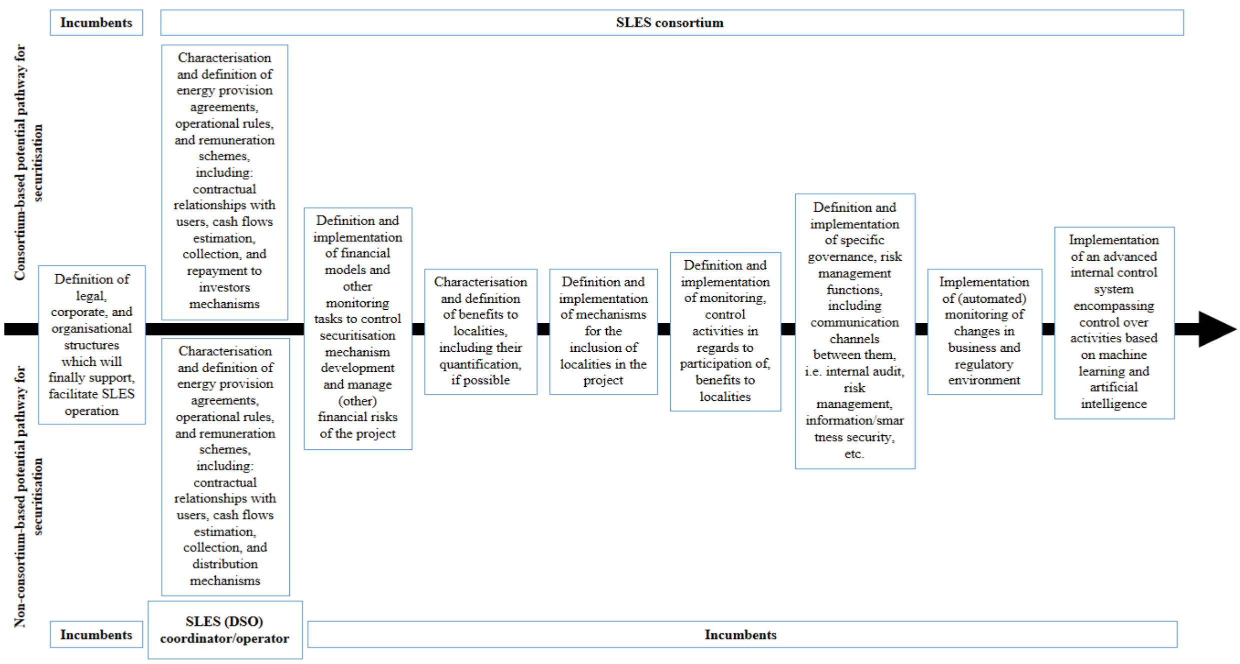

Figure 8. Potential pathways to a securitisation mechanism from a CCLLASS model point of view

[2] Both projects are currently closed, having completed their planned activities and promised deliverables. See https://project-leo.co.uk/ and https://cordis.europa.eu/project/id/731249/results. Although the case studies explored in this work are demonstrators, the main goal behind their implementation is making way for SLES effectively operating in the market in the forthcoming years. Our work proposes a particular pathway to finance complex SLES projects via securitisation, based on the insights delivered by the case studies analysed in this article, which can therefore help to implement, replicate and/or scale up such initiatives in the (near) future.

For example, a starting point could be defining and implementing the specific (definitive) legal, corporate and organisational structures to govern provision of energy services. This may result in the constitution of a SLES consortium with control over the constitutive elements of the CCLLASS model. Alternatively, it may result in a SLES functioning as a subsystem of a regional or national system, with decentralised control over the constitutive elements of the CCLLASS model. This subsystem would be embedded in a higher level system comprised of diverse actors with no direct involvement in SLES operation and strategic development, but importantly affected by the requirements of the local distribution system operator (DSO). A DSO can be understood as the managers (possibly owners) of electricity networks usually operating at low and medium voltage levels. The DSO roles would at least entail acting as neutral market facilitator and procurator of energy services from (local) providers, among others.

5. ANSWERS TO RESEARCH QUESTIONS AND KEY ASPECTS TO CONSIDER FOR THE FUTURE

5.1 Research questions and answers

The first research question, on the configuration of SLES, is addressed by demonstrators and pilots explored in this work. Cross sector consortia, comprising businesses, local authorities, community organisations and universities, are developing and testing SLES business and market models and future investment options in several locations, including the UK and Denmark.

In relation to the second research question, the evidence suggests that it is feasible to frame SLES as securitisation-oriented structures. SLES comprise multiple assets, potentially owned by different actors, whose (future) cash flows can be utilised to offer SLES-backed bonds to investors. Assets, owners and cash flows can then become part of a legal, organisational structure operating a securitisation mechanism.

Our third research question concerns the missing elements, according to our extended CCLLASS model, of governance and management of risks and cash flows, which would need to be addressed before securitisation could be implemented. The application of the CCLLASS model to both case studies identified some missing elements, which are likely to stem from their time-limited pilot project status. More detailed investigation of governance and risk management, using the CCLLASS model, is needed to clarify current gaps and ways to address these; this is beyond the scope of the present work. Governance and risk modelling and management functions needed prior to any securitisation scheme are: legal corporate and organisational structures sufficient for SLES operation; rules for inclusion of local stakeholders (including low income groups); characterisation and monitoring of local benefits; remuneration schemes, operational rules and service agreements; and development of machine learning or artificial intelligence systems for monitoring business strengths, weaknesses, opportunities and threats. From the CCLLASS model perspective, the board or senior management should address such gaps during development of projects into businesses suited to replication or scaling up. This would strengthen the viability of the enterprise and provide assurance to investors and financiers that integrated financial, operational, regulatory, technical and social goals can be achieved. Addressing the gaps would usually entail a coordinated plan, aligned with available resources and priorities. This ideal-typical model of robust governance may be impossible to achieve in the short term. Hence, professional expertise would be needed to identify the critical factors to be addressed first, in order to secure and scale-up financing through securitisation.

We conjecture that an effectively-implemented securitisation mechanism could (indirectly) provide more than monetary benefits to investors by creating value for society and the environment. In these terms, securitisation is expected to facilitate full implementation and operation of low-carbon SLES, which contribute to reducing greenhouse gas emissions in the energy sector. Since these systems are expected to provide both monetary and non-monetary benefits to localities, including local ownership shares and access to decision-making, securitisation could support local regeneration and welfare, and help to reduce fuel poverty. The conjecture has various socio-economic implications that need to be specified and tested appropriately. This requires further investigation and debate, which is however beyond the scope of this paper. SLES are intended to create synergies between experienced and new energy market actors and low-carbon energy sources and technologies, with benefits accruing to interested parties through a sustainable business model.

5.2 Limitations and suggested further steps

We acknowledge the following limitations of the securitisation framework proposed in the paper. First the CCLLASS model needs to be tested further, using either quantitative or mixed-quantitative-qualitative data and tools, in the context of SLES implementation and operation. The aim should be to test the robustness of findings from this exploratory work, including whether the CCLLASS model provides sufficient assurance of good governance for business development and investment. Our qualitative analysis and questions provide the necessary foundation; robust testing would also require specific indicators for financial ratios, local engagement and board and senior management diversity. Second, neither project has reached commercialisation stage and financing and investment plans are uncertain. There is no assured pathway to securitising future cash flows.

Nevertheless, our work can stimulate further examination of securitisation as a means of funding SLES and evidence to inform decision-makers. Finally, the organisational and operational structures of the case study pilots are tightly coupled to funders' rules and regulations. Effective implementation of either the CCLLASS model or securitisation mechanisms may therefore be constrained by additional factors not accounted for in this analysis. It has however helped to identify necessary steps to facilitate innovative financing mechanisms such as securitisation.

5.3 Key uncertainties to be clarified

There are a number of uncertainties to be addressed. The project consortia observed here may or may not be managing SLES future strategic development; this potentially affects overall goals and investment, including types of financing and opportunities for replication and scale-up. In practice, any SLES could also operate as a subsystem embedded in a multi-level system, governed by actors without direct involvement in strategic development and operation of a specific SLES. New energy assets may need to be included in a fully-operational SLES, indicating the need for a remuneration mechanism capable of funding most assets. Reviews and updates of current regulatory and legal frameworks may also influence future cash flow potentials and remuneration schemes. Regardless of the detailed structure and financing mechanisms of a fully-operational SLES, its technical systems must reliably measure and record energy inflows/outflows and corresponding cash flows in order to secure investment. These areas of uncertainty can inform decisions on legal/corporate structures, with robust governance and risk management. One option is creation of a Special Purpose Vehicle (SPV) to facilitate securitisation. This would in principle provide financing for SLES assets and shape the way that assets and their cash flows are pooled or aggregated.

Although securitisation provides potentially valuable opportunities for establishment of SLES, there are also uncertainties and criticisms. Opportunities centre on enhanced access to finance via standardisation of financial transactions, risk management, asset pooling/aggregation (regardless of size and complexity, unless ample cash flows are not provided), alignment with investors' expected returns, and incorporation of diverse investors. Uncertainties concern the impacts of potential regulation on (future) incomes. If such regulations help to secure the income to be generated from SLES, reducing variability and increasing cash flow receipts, then a mechanism for future cash flow securitisation may be further enhanced, improving its appeal to investors. Moreover, based on the experience during the subprime crisis, it may be argued that securitisation lacks adequate management of risks to cash flows, compared to other financing mechanisms; any business financing mechanism (project finance, equity, etc.) is however subject to risks that cannot be eliminated completely. Based on McInerney and Bunn [46], as well as Bertoldi et al. [90] and Daszyńska-Żygadło et al. [91], financing mechanisms in early and comparatively riskier stages of project development would chiefly entail - leaving grants aside - venture capital and private equity. These mechanisms, in principle, encompass a comparatively higher cost of capital, yet they could provide a critical mass of investors willing to devote resources at early stages. Once a complex energy project reaches a more mature stage of project development, project finance, (more conventional) debt and equity could play a part. Securitisation could contribute to financing SLES, at a larger scale, either during intermediate and advanced stages of project development or after corroborating that SLES demonstrators have delivered good outcomes for (future) project replication, scale-up. We note that SLES project scale may impact transaction, friction costs when financing via securitisation. Yet, when utilising any form of securitisation, the focus is primarily on the asset's cash flow generation and forecasting capacity, rather than its size and complexities. As pointed out by some experts in

1985, in the midst of securitisation consolidation in the market, in principle, "virtually every asset with a payment stream and a long-term payment history is an eventual candidate for securitization", considering investments "… sold in minimum denominations of just $1,000" [92]. It can be argued, however, that SLES do not present long-term payment history; this could be handled, for instance, with appropriate forecasting models based on stochastic processes widely used in finance. These criticisms of securitisation for SLES should be investigated and evaluated further. However, as noted at the end of Section 5.1, an effectively-implemented securitisation mechanism may overcome these uncertainties and criticisms, and create value beyond monetary returns to investors, in line with sustainable business models.

5.4 A research agenda

Further research is imperative. We propose a research agenda that prioritises the following points. Firstly, future research is needed to design and evaluate a suitable cash flow pooling/aggregation mechanism using quantitative data. This may include determining the systemic structure of future cash flows for numerous SLES assets, aiming at ensuring a sufficient income stream to support both the SLES project and its financing mechanism. It is also necessary to explore the timing of cash flows reaching real asset owners and (local) stakeholders, considering mechanisms to direct these cash flows during the operation of a SLES securitisation scheme. Secondly, theoretical and empirical evaluation of traditional discounted-cash-flow methods for pricing assets, including securitised assets, is needed to determine their relevance to assets subject to rapid technological change and other sources of uncertainty. Thirdly, further research should assess the implementation of a securitisation mechanism for SLES using quantitative data such as: number and value of assets; cash flow projections and associated service agreements; variability and potential shocks. The results should be compared with other investment mechanisms, such as equity or project finance. Future research should also investigate the related transaction and organisational costs, as well as deliver insights into the most convenient way of raising funds for novel or complex SLES. Fourthly, a qualitative study should explore the willingness of investors and customers to participate in a SLES securitisation mechanism, and the challenges to implementation. Finally, regulatory and legal implications of a securitisation mechanism for SLES should be investigated, including options for suitable legal, corporate and organisational structures.

6. CONCLUSIONS

Energy systems with a high degree of local integration across heat, power, transport and storage are being tested in several places. Their poor fit with centralised systems in regulated markets results, however, in SLES facing diverse barriers, including finance, which constrain wider development. In this article, therefore, we have explored the potential for securitising SLES assets to help secure and scale-up finance and investment. Legal and corporate aspects of SLES management and operation, as well as specific strategies for cash flow management, remain to be defined. However, current practices of governance and risk management in some SLES pilots and demonstrators could improve access to finance in the future through improved governance and risk management standards. The main objective is to improve qualitative aspects of SLES projects that help ensure trust, transparency, stability and accountability to investors, who may be reluctant to participate in less orthodox financing mechanisms such as the securitisation of future cash flows. It is important to note that the case studies' ratings revealed in this work can be improved after reviewing our analysis, i.e. the results are not set in stone. Given the complexity around appropriate financing mechanisms for SLES and the need for robust corporate governance and risk management, a future research agenda was proposed. Such research may be crucial to meeting expectations that SLES will be fundamental to achieving net zero targets while addressing questions about decentralisation, democratisation, and digitalisation.

APPENDIX A

Table A1. Summary of the key points derived from the qualitative analyses of LEO and Samsø–SMILE projects

	LEO	**Samsø–SMILE project**
Culture	The evidence suggests that LEO has a clear definition of principles, values, and beliefs, which include ethical standards and reasonable risk tolerance; there is no indication of a culture based on *"short-termism"* about benefits or targets, nor overwhelming pressure about missing goals.	The project does not present a specific vision, though it is part of a wider initiative with a vision and ultimate goal. Some activities/tasks and objectives include ethical concerns. These represent project values and beliefs and suggest a culture with appropriate risk tolerance; there is no indication of *"short-termism"*, nor inappropriate pressure to meet targets and goals.
Leadership	Leadership is oriented to collaboration, rather than charismatic authority, and opportunities and limitations appear to be assessed in accordance with leadership style. The evidence also suggests concern for localities and reasonable commitment to good governance and risk management practices. Diverse metrics, beyond finance and operations, are utilised to evaluate performance; this suggests that leaders have wider motivations than the criteria governing conventional energy projects.	A collaborative approach towards project management and operation is observed. The evidence also suggests awareness of limitations and challenges from project leaders and managers. Project visions, specialised functions with specific roles and responsibilities, and centrally embedded objectives denote (some) adherence to good governance and risk management practices. Several specific needs of local stakeholders are acknowledged in the project and various indicators, beyond finance and operations, are available for project management.
Structure	There are no Chairman and CEO roles, but LEO's organisation encompasses specialist roles and functions for project and risk management, monitoring, improvement, and strategic decision-making. Likewise, the diversity of actors involved in LEO, including community organisations, suggests, in principle, adequate management of conflicts of interest, and localities' interests and concerns. As the project is still under development, LEO has no specific internal audit function, nor more independent assessments of internal controls.	No Chairman and CEO roles are defined, but the organisation comprises various work packages with specialised functions and tasks, which relate to project management, monitoring, improvement and strategic decision-making. Diverse actors are involved in the project, which suggests, in principle, appropriate conflict of interest management and proper handling of localities' interests and concerns. No specific internal audit function, nor more independent internal controls evaluations were observed. There are however specific functions/tasks relating to project risk management and ethical issues.
Localism	LEO addresses Localism using specific principles, which discourage unethical, and illegal behaviour. In addition, a Stakeholder Advisory Board, knowledge about stakeholders' characteristics and potential influence over the project, and varied communication activities are part of the LEO's localism commitments. Consequently, LEO's engagements with localities seem to be aligned with a long-term vision, which could support project growth and longevity, and help manage or avoid conflicts of interest between LEO and localities. However, there is significant scope for explicit characterisation of the benefits to localities; these benefits could affect the mechanisms to be used for financing SLES assets (and their owners). Explicit characterisation of benefits provided to localities can facilitate their quantification, as well as the implementation of monitoring and mechanisms to allow (more deprived) local stakeholders to have a stake in the project and its benefits.	The project addresses localism through a series of engagement activities, including public meetings, hearings and committees. It is however less clear how these initiatives discouraged unacceptable, unethical, and illegal behaviours, or governed conflict of interest. The above activities include an anthropological study, identification of critical stakeholders, collaboration among organisations affected by the project, and a workshop between project managers and key stakeholders. Following the engagement activities, some public opposition resulted in aspects of the project being abandoned. There is, therefore, evidence of a long-term vision that seeks to consolidate systemic growth and longevity beyond the Samsø–SMILE Project. However, there is significant scope for improvement in relation to specification of benefits for localities, as well as inclusion of more local actors through appropriate local ownership mechanisms with explicit benefits.

Table A1. Summary of the key points derived from the qualitative analyses of LEO and Samsø–SMILE projects (continued)

	LEO	**Samsø–SMILE project**
Cash-Flow-Lock	There is significant scope for defining: the energy provision agreements that will shape the relationship between the SLES and its users; mechanism(s) by which cash flows will be estimated; financial models that capture or assess risks appropriately, and mechanisms for monitoring cash flow generation and collection (including market conditions). These definitions are related to the final market architecture, and corresponding cash-flow-remuneration mechanisms, which will be critical to the legal, corporate, and organisational structures of LEO, as a fully-operative SLES, and the mechanisms for fully or partially financing the system.	Some work on cash flow analyses and simulations for different Project scenarios has been completed. Furthermore, a basic examination of financing mechanisms and sources was observed, but specific energy provision agreements and pricing mechanisms are needed to replicate and/or scale-up the project. This includes examining the potential role of collateral for strengthening project finance. Evidence suggests that current market conditions were properly analysed and possible pathways for amelioration and extension of the project were adequately outlined.
Smartness	The evidence suggests links between project activities and good practice in risk management, which may constitute embryonic forms of a smartness-IT-based framework. Examples are a Data Sharing Agreement; shared datasets linked with a data certificate to improve data attribution and traceability; a Dashboard and Data Health Tool for detecting and fixing corrupt or inaccurate data; KPIs for monitoring and improvement. There is, however, ample scope for implementation of systems that allow identification, assessment and mitigation of risks, including the monitoring of threats from business and regulatory changes. Standardised internal control systems that consider (future) activities based on ML or AI are also part of the potential measures to be implemented.	There was no standardised system of internal controls, or a risk identification and management system in the project. Instead, specific and, to some degree, isolated risk management and control mechanisms are found. Concerning assessments of changes in the business and regulatory/legal environments, one work package performed an analysis and released a series of reports which address not only legal and regulatory requirements, but also the business implementation and operation of smarter, more local energy systems. No specific system for a smartness-based, IT-based governance was found. The evidence nevertheless shows that some particular measures, aligned with good risk management practice, are implemented.
Alignment	The evidence suggests an understanding across LEO of good governance, risk management, and reporting practices; this denotes an Alignment (to some extent at least) with all elements of the CCLLASS model. Project management and leadership seem to encourage balance between conservatism and risk appetite or opportunity seeking, and LEO's plans do not suggest an unfocused, misaligned prioritisation of activities and aims. There are however opportunities for establishing more specific functions related to governance, risk, and cash flow management, including explicit communication channels between them. Implementation of these functions will depend on how LEO commences delivery of energy services, which would require a specific legal structure, remuneration scheme, and decision-making agreements for all project members.	There is an understanding of good governance, risk management, and reporting practices. An Alignment with all elements of the CCLLASS model therefore exists, at least to some degree. In relation to project implementation and operation, managers and leaders seem to have a balanced view of conservatism and risk appetite or opportunity seeking. In this vein, plans for Samsø–SMILE do not denote an unfocused, misaligned prioritisation of activities and aims. There is however scope for improvement in the institutionalisation of specific functions related to governance, risk, and cash flow management, including explicit communication channels between them. Their implementation will however depend on whether Samsø–SMILE project is (finally) scaled up or replicated, which would require a specific legal structure, remuneration scheme, and decision-making agreements for all project members.

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