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# PROJECT FINANCING FOR GENERATION INTEGRATED ENERGY STORAGE: A U.K. CONTEXT

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**ABSTRACT**

Large-scale of intermittent renewables such as wind and solar are used to reduce carbon emission. Energy storage is needed to provide controllability of power flows for the energy system. Specifically, Generation-integrated energy storage (GIES) systems store energy at an instance during the transformation between the primary energy (e.g., kinetic or thermal) form and electricity. The successful deployment of GIES systems requires a financing method to minimize investment risk. This includes identifying the role and interactions between stakeholders. A contract is a legally-binding agreement, which recognizes and governs the duties and rights of the contracting parties (e.g. stakeholders) to the agreement. Despite the importance of contracts, there is a limited amount of literature on project financing and the contractual models for renewable energy projects, in particular for energy storage and GIES systems. Project financing is the long-term financing of infrastructure using the projected cash as collateral. In this paper, the public private partnership (PPP) schemes for financing renewable energy projects are reviewed. This work presents a generic contractual model for the GIES system in the U.K. context. The challenges in contractual agreements between contracting parties are described.

**Keywords:** Project finance, generation integrated energy storage, public private partnership

## 1. INTRODUCTION

Reducing carbon emission is a national agenda for many countries to mitigate global warming [1, 2]. As such, natural renewable energy resources such as wind and solar are increasingly adopted. However, the renewable power generation is highly dependent on atmospheric and weather conditions [3]. There is limited controllability (apart from curtailment) for renewable sources. Electrical energy storage (EES) can be used to store surplus renewable generations for later use [4]. Energy storage can enhance grid performances and commonly used with intermittent renewables [5, 6]. As such, generation-integrated energy storage (GIES) systems store energy at an instance during the transformation between the primary energy form (e.g., heat) and electricity [6]. The exergy efficiency can be maximized by retaining the primary energy form. Wind-TP is a type of GIES system with a wind turbine air compressor generator and pumped heat EES [7]. Concentrating solar power with thermal storage is a common form of GIES [8].

This paper focuses on the financial aspect of GIES. Contractual models and interactions between stakeholders for renewable energy sector are presented in academic literatures [5, 9-11] and industrial reports [12-15]. However, seldom literatures discuss the contractual model and project financing (PF) for EES, in particular for GIES. A contract is a legally-binding agreement, which recognizes and governs the duties and rights of the contracting parties to the agreement. Contract is a key aspect in finance. Finance has an important role in energy transition but receives little attention [11, 16]. PF refers

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to the long-term financing secured only (or mostly) by the assets and revenue stream generated by the project [10, 13, 17]. Therefore, the revenue generated by the project must be sufficient to support the financing. PF refers to the long-term financing using the projected project revenue stream as collateral. Once the project is completed, the assets generated by the project (e.g. infrastructure, intellectual propriety) are also used as collateral for financiers.

This paper presents a contractual model with PF for GIES systems and examines the role of stakeholders. The motive is to maximize the likelihood of GIES project success and to minimize dispute between stakeholders. Section 2 presents a literature review on PF for renewable energy and EES systems. Section 3 presents a review on the public private partnership schemes for financing renewable energy projects. A generic contractual model for the GIES system is presented based in the U.K. context. The challenges in contractual agreements between contracting parties are described. Section 4 concludes the paper and future works on expanding the study of contractual model are highlighted.

## 2. LITERATURE REVIEW

There is a growing importance and interests in examining the financing of renewable energy systems and EES.

Lam and Law [9] examined the developmental phases of renewable energy projects and examining the inter-relationships with stakeholders, affected by "technology push" (i.e., a new invention is "forced" through research and development (R&D), production and sales and enters into the market without considering whether or not it satisfies the user requirement) and market pull (product that has been developed by the R&D in response to a clear market need). Government has a critical role to play (via funding) to facilitate financing in most stages. Funding can be in the form of subsidies, feed-in tariffs, or regulatory arrangements (e.g., carbon trading).

Steffen [10] examined the importance of PF for renewable energy projects in investment-grade (high credit rating) countries e.g., Germany, Chile, and Australia; and the reasons to use PF. PF is not used to reduce project risk, but motivated by "debt overhang" of non-utility sponsors (e.g., independent project developers). PF is often justified because it allows to leverage vast debt capital with no (or limited) collateral for their sponsors. Usually lenders provide between 80-95% of capital investment in PF.

Miller and Carriveau [5] reviewed innovative financing models for EES to facilitate EES deployments. Power purchase agreements (PPAs) and long-term contracts for the energy delivery, are created to include both energy storage and delivery. Contract for difference (CFD) is a long-term contract that enables the power producer to stabilize its revenues at a pre-agreed price. Contracts have been awarded consist of both energy storage and electric generator, such as the solar plus storage PPAs delivered in Hawaii and Arizona. In these innovative contracts, the cost of energy (accounting for demand charges) is used as the PPA price. The PPA terms are more favorable by having controllability of electricity generation. Due to storage capability, GIES can obtain such favorable financing terms.

A business model explains how an entity creates, delivers, and captures value. Krupa et al. [11] described the appropriate business model (which is guaranteed by a PPA) for renewable projects is a function of a financial market pull, government's renewable policies, or a combination of the two. A supportive financial infrastructure and the presence of creditworthy "engineering, procurement, and construction" (EPC) contractor are also crucial. EPC contractor enables the project to be built on time and on budget. It will also effectively be responsible for all activities including design, procurement, construction, commissioning and handover of the project to the project company (PC).

The Environmental Protection Agency in United States established the solar power purchase agreement (SPPA) [18]. SPPA is a financial arrangement in which a solar service provider (i.e., EPC) operates, maintains, and owns the photovoltaic (PV) system; and a host customer (e.g., homeowner) concurs to site the system and procures electricity from the solar services provider for an agreed period. The host customer receives a stable and inexpensive electricity, while the solar services provider receives valuable financial benefits (e.g., income generated from the sale of electricity and tax credits). Similarly, the PC receives payments from electricity sale. In addition, the PC distributes depreciation, tax benefits, ownership, and leasing between investors and solar services provider [19]. The contractual structure for SPPA can be found in [18]. In the model, it is unclear how the PC interacts with the investors, solar services provider, and the host customer.

In summary, the above literatures seldom discuss the key challenges of PF and contractual agreement for EES technologies. The following section examines the private sector participation schemes as they are the important contractual arrangement for renewable energy infrastructure. A generic contractual model for the GIES system is presented based on the U.K. context.

## 3. PRIVATE SECTOR PARTICIPATION AND PUBLIC PRIVATE PARTNERSHIP

The public and private sectors have different objectives in a renewable energy project development when both sectors are involved. This section presents the general knowledge in contractual agreements for renewable and energy storage system. This is followed by presenting a contractual model for GIES.

Private stakeholders can engage with the public to deliver a public sector, commonly known as private sector participation (PSP) [20]. There are different contractual and business models enabling the public and private sector to partner, which are regrouped under the general name of public private partnerships (PPPs). The purpose is to deliver a service or public asset for the public benefit. The private sector commits to a financial investment in the project. There is a substantial risk sharing between the private and public sectors [20]. Ref. [19] presents the different PSP structures for wind, photovoltaic, and concentrate solar power projects in Libya.

PPP can involve a variety of business and contractual models, including ad hoc instruments such as public concessions, PCs, and power purchase agreements [20]. The purpose of the PPP is to enable the partnering between private stakeholders and the public to deliver a public service, e.g. electricity generation. Private stakeholders include contractor, private utilities, and financial institutions. In the renewable energy sector, commonly, there are five types of independent power producer (IPP) cooperative arrangement in PPP. The government offers a contract to the private investor to invest and operate an infrastructure project during the concession period. In a concession period and subject to agreements, the PC has the right to operate a specific business within the government's jurisdiction.

In a PPP, the public sector can be a joint venture partner with the private sector in the PC. There are several kinds of concession schemes that determines the nature of PPP, some common concession schemes in renewable energy projects include [19-21]:

- Build operate transfer (BOT): The facility is owned by the PC and pays for construction, concession, and is allowed to operate during the concession period. The facility is transferred to the government entity at the end of the concession period;
- Build own operate transfer (BOOT): Similar to BOT but the PC retains ownership during the concession period;
- Build own operate (BOO): Similar to BOOT but no need to transfer the facility to the government entity after the concession period;
- Build lease transfer (BLT): The PC builds, leases, and transfers assets to government entity after concession period; and
- Build lease own (BLO): Similar to BLT but facility remains with PC.

Fig. 1 presents the contractual model for the GIES system based on the above PPP discussion. Due to the nature of the specific type of GIES (e.g., wind with pumped heat EES or concentrating solar power with thermal EES), the detailed contractual model will be dif-

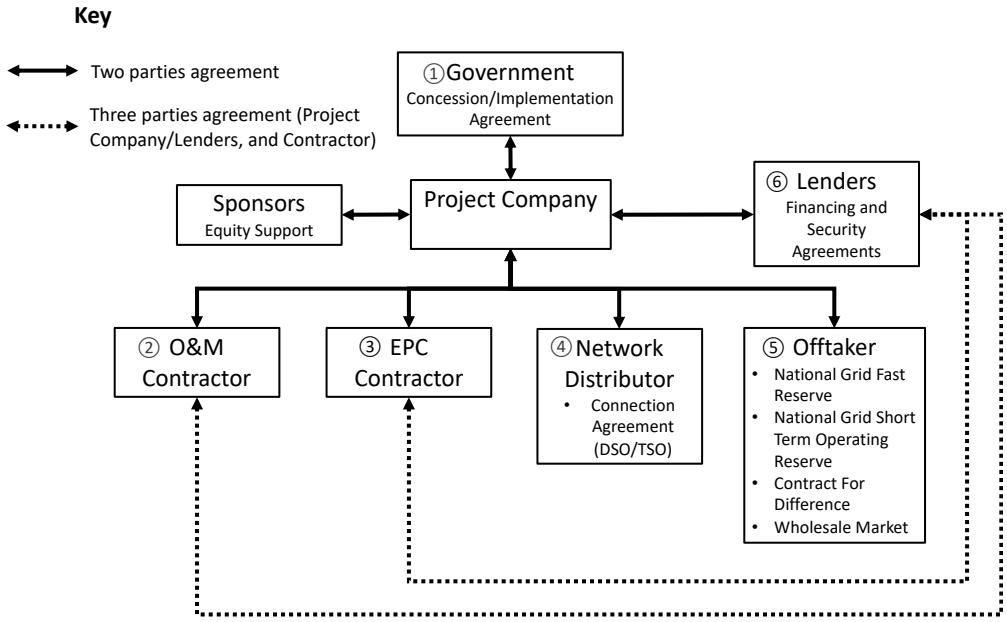


Fig. 1. Contractual model for GIES.

ferent for each type of GIES. The contractual model is derived from the power [12] and energy [13] sectors; including solar [14] and wind [15] projects.

The PC is the "central" entity and enters contractual agreements with other entities, described as follows:

① **Concession agreement:** Depends on the concession scheme, the government entity may give concession to a PC for the right to construct, operate, and sell electricity generated by the GIES system. This agreement typically lasts for 15 years to 25 years, and at the end of project life the GIES system is transferred to the government. This agreement forms a PPP. However, merchant power plants (MPPs) are now being planned and constructed following the deregulation of electric power systems [21]. MPPs do not necessary require a concession agreement. MPPs are projects which sell electricity into a wholesale market at market price (e.g., spot price). Typically, MPPs need the required, environmental, planning, and building agreements. Also, the PC will need to secure the necessary licenses to sell electricity into the market.

② **O&M agreement:** This agreement governs the operation and maintenance of GIES. This is usually a long-term agreement with an operator. The operator is typically a sponsor. Therefore, this agreement will likely match the term of the PPA/concession agreement. The lenders require the PC to operate the GIES in some financing structures. In this situation, the O&M agreement will be replaced with a technical services agreement under which the PC supplies the employees for GIES operation. In an alternative scenario, the PC will enter into a fixed short-term O&M agreement with the manufacturer and supplier of the major equipment, e.g., wind turbine generators during which the designated operator will train the staff of the PC. The PC will resume the GIES operation after the O&M agreement expires. The O&M agreement typically concerns with three parties.

③ **Construction agreement:** This agreement governs the construction of GIES, including manufacturing, assembly, and construction of the balance of the plant (electrical and civil works). There are many contractual approaches that can be chosen to construct the GIES such as an EPC contract. Alternatively, the EPC contract may be divided into an equipment supply contract (e.g., solar panels supply contract) and a balance of plant contract, where the warranty operating and maintenance agreement states the guaranteed performance. The choice of contracting approach will depend on a number of factors including the identity of the contractors, lenders' requirements, and the time available. The main advantage of the EPC contract compared to other alternative approaches is that it paves for a single point of responsibility. Most large renewable energy projects use an EPC contract as claimed by DLA Piper [13]. The construction agreement typically concerns with three parties.

④ **Connection agreement:** This agreement between the PC and the network owner is for the connection of the GIES into the relevant electricity transmission or distribution network. The network owner can be a small grid owner/operator, distribution network operator (DNO), a transmission system operator (TSO), or an electric utility. In this agreement, the network operator states the construction and installation requirements of GIES and the terms and conditions by which electricity is to be delivered to the GIES from the network (i.e., import electricity) and delivered into the network once generated by GIES (i.e., export electricity).

⑤ **Offtaker agreement:** For renewable energy, a PPA may be established between the government authority and PC in project financed projects. The government authority will pay for a fixed amount of electricity each year produced by the power plant during the concession period (i.e., "take or pay" obligation). The PC is obliged to produce a minimum quantity of electricity and/or green products (e.g., renewable energy or carbon credits). For EES, there are two important types of offtaker agreement, known as the power purchase agreement (PPA), and the energy savings performance contract (ESPC) described as follows [22]:

PPA is a contract between a power generator, e.g., IPP and the electricity supplier (e.g., British Gas and npower) or capacity of grid services (i.e., National Grid) or government authority. The PPA is especially important for independently financed power generator, as it states the terms and conditions for the agreement and is used to secure financing for the project. PPA is commonly used for front-of-the-meter projects (i.e., electricity trading occurs in the transmission and distribution systems).

ESPC is for behind-the-meter (BTM) projects (i.e., electricity consumed locally and onsite used). ESPC is common in energy efficiency market to assist customers to pay for energy efficiency upgrades to their facility (from cost reduction). Customers can avoid to pay upfront for the desired upgrade.

Seamus et al. [6] commented that GIES is potentially more economic than non-GIES (i.e., with batteries) when storing large scale (MWh) of renewable energy. In this

case, this paper focuses on front-of-the meter (i.e., PPA) from the grid perspective.

In U.K., the Office of Gas and Electricity Markets (Ofgem) is the government regulator for the electricity markets in Great Britain. The available PPAs are continuously evolving implemented by Ofgem, such as the renewable obligation scheme is closed to all new generating capacity on 31 March 2017 [23]. As of 2019, the PC can sell the electricity to offtakers based on a PPA with the entities, such as the National Grid (i.e., fast reserve [24] and short-term operating reserve [25]), wholesale market [26], and Low Carbon Contracts Company (i.e., contract for difference) [27]. The wholesale market is regulated by the British Electricity Trading and Transmission Arrangements (BETTA) since 2002 [21, 28]. It is not clear how multiple PPAs between PC and multiple offtakers work.

⑥ **Financing and security agreements:** This concerns with the lenders to finance the development of GIES.

In summary, this section has presented the private sector participation and public private partnership for the energy sector. The contractual model for GIES is presented in the U.K. context. The challenges in interactions between stakeholders are described in the contractual model.

## 4. CONCLUSIONS

Financing methods play an important role in the successful deployment of GIES systems. Several stakeholders (e.g., lenders and government) participate in the project financing and contractual agreements govern the duties and rights of the contracting parties. There is a limited amount of discussion on contractual agreement for electrical energy storage (EES) and GIES systems. This paper presents a generic contractual model for the GIES system in the U.K. context. The structure of the contractual model and the challenges in contractual agreements are described. Due to the inherent differences between EES and electric generators, there are several contractual agreement challenges that need to be addressed for the future work; such as how charging the EES will affect the offtakers, operating right allocation, manufacture's requirement, and system decommissioning. In addition, alternative forms of contractual model with greater detail will be proposed and compared.


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