Renewable and Sustainable Energy Reviews 104 (2019) 429–438

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

De-risking solar auctions in sub-Saharan Africa – A comparison of site selection strategies in South Africa and Zambia

Wikus Kruger[a,*], Susann Stritzke[b], Philipp A. Trotter[b]

[a] Graduate School of Business, University of Cape Town, Cape Town 8002, South Africa
[b] Smith School of Enterprise and the Environment, University of Oxford, OX1 3QY, UK

ARTICLE INFO

Keywords:
Renewable energy procurement
Competitive tendering
Energy governance
Investment risks
Sustainable development

ABSTRACT

While auctions are becoming increasingly popular for tendering renewable energy projects to private developers in Africa, their specific project risk implications are not yet fully understood. This paper identifies project risks arising from two types of auction schemes. It compares an approach where the government pre-selects the sites for future renewable energy plants in Zambia's Scaling Solar initiative to one where project developers choose, secure and conduct due diligence on their sites before bidding in South Africa's Africa's Renewable Energy Independent Power Producers Procurement Programme (REI4P). Semi-structured interviews with developers who have participated in both schemes reveal notably different risk profiles. Despite contrary intentions, site-specific risks have been perceived as the highest overall project risk in the government-led site selection process in Zambia. Specifically, site-specific risks were driven by several severe technical issues such as geotechnical, grid connection and solar irradiation uncertainties. In contrast, in South Africa's developer-led site selection process, site-specific risks have been reported to be important, but less pronounced, and more evenly distributed among technical, economic, legal, permitting and social risk factors. This paper recommends an auction design which minimises project risks for all stakeholders. Where governments pre-select sites, closely consulting the private sector is advisable prior to bidding to identify and mitigate technical and other site-specific risks.

1. Introduction

Recent years have seen the beginnings of a global transition towards renewable energy-based power systems, with the majority of investments in the power sector since 2015 being directed at renewables [1]. Developing countries particularly are becoming a key focus for renewable energy investments [2]. To tender utility-scale renewable energy projects, competitive procurement schemes (or auctions) have spread rapidly [3], currently being applied in at least 65 countries worldwide [1]. This trend is salient in sub-Saharan Africa (SSA) in the last five years. Following South Africa's Renewable Energy Independent Power Producers Procurement Programme (REI4P), with its first auction in 2011, there are now at least 11 countries in SSA that have either started or completed competitive renewable energy project procurement, including Zambia, Uganda, Ghana, Namibia, Malawi, and Ethiopia. Competitive procurement of renewable energy projects is being rolled out in several further countries in the near future. The majority of these tenders focus on utility-scale solar photovoltaic (PV) plants, between 5 MW and 100 MW in size [4–11].

While the growing use of auctions for solar PV projects is mainly driven by their ability to attract low-cost bids from a variety of international project developers, different auction designs imply different specific risks – and, as a result, different prices. This paper analyses the risks associated with auction processes which differ in how the project site is selected, widely seen as a crucial element for the successful operation of a solar PV plant [3,12–14]. For the implementation of large-scale solar PV projects, two different strategies for site selection can be distinguished. The first is government-led, i.e. where a governmental agency or state-owned utility selects a potential site prior to inviting private companies to bid on the project. The second is a developer-led strategy for site selection, where private companies select their own sites on which they want to develop their energy project before submitting a bid in an auction.

Both strategies have recently been applied in SSA. In South Africa's

* Corresponding author.
E-mail address: wikus.kruger@gsb.uct.ac.za (W. Kruger).

https://doi.org/10.1016/j.rser.2019.01.041
Received 29 May 2018; Received in revised form 26 November 2018; Accepted 23 January 2019

REI4P and Uganda's GET FiT Solar Facility, developers have selected and prepared[1] their project sites [15,16]. Government-led site selection, however, is the dominant strategy in Africa, applied in countries such as Namibia, Ethiopia, Malawi, Ghana and Zambia's Scaling Solar initiative [8,17–19]. Arguments by the IFC, as well as authors such as Del Rio and Lucas et al. for government-led site selection have included the potential of speeding up project development and reducing project risks through governmental procuring authorities securing land access, providing geotechnical data, securing integration with the national grid, and obtaining general permits before the auctions take place [14,20,21]. Quicker project development through lower risks imply a lower cost of capital, which enables lower bid prices [14,20,21]. However, contrasting recent auctions experiences of two prominent African cases, namely Scaling Solar in Zambia and REI4P in South Africa, raise questions about these arguments. Both of the Scaling Solar PV projects with government-led site selection have been significantly delayed, with one of the winning bidders explicitly stating that the private sector would have been better placed to select the sites [22]. In contrast, more than 90% of the renewable energy projects from the first three rounds of South Africa's developer-led REI4P were delivered on time [15,23].

To the best of our knowledge, this paper is the first to empirically analyse and compare government-led versus developer-led site selection approaches in renewable energy project auctions. Drawing from semi-structured interviews with solar PV development companies that have participated in both the Scaling Solar and REI4P auctions, this paper makes two novel contributions to the literature. Firstly, we find different perceived general risk patterns for the two site-selection approaches. Site-specific risks were named as the most important and dominant risk where the government had chosen the site in Scaling Solar. In REI4P, where site selection has been developer-led, site-specific risks, while still salient, are perceived to be less important. These results further question the common assumption that a pre-selection of sites by the government reduces site risks for developers. Secondly, studying the different types of perceived site selection risks by the developers reveals that several crucial technical risks, as well as legal risks surrounding land ownership, have been especially severe in Scaling Solar, despite the Zambian government's initial motivation to reduce these risks by pre-selecting sites. In REI4P, site-specific risks were less pronounced and more evenly spread between different technical, economic, legal, permitting and social issues. Especially given the Zambian government's failure to provide sufficient detail to fully assess the sites' geotechnical risks, seen as a significant challenge for successful project implementation, we recommend that developers should be involved in the site selection process before the auction takes place to utilise their expertise and jointly reduce project risks. The prominence of government-led site selection processes in sub-Saharan renewable energy auction programmes, as well as the fact that most of these programmes are still in their infancy, warrant an improved understanding of the way that these site selection processes influence project risks and costs.

The paper is structured as follows. Section 2 explains solar PV project site selection processes in general and discusses the central features of the paper's two case studies, namely REI4P in South Africa in comparison to Scaling Solar in Zambia. Research method details regarding the semi-structured interviews and the analytical framework used to analyse the responses are presented in Section 3. Sections 4 and 5 discuss the results – placing them within a broader discussion context - while a conclusion and policy implications are offered in Section 6.

[1] In this context, site preparation refers to the administrative, analytical and acquisition processes involved in getting a site ready for a project before construction can begin. Most of these processes occur prior to financial close being reached on a project. Depending on the programme, bidders may need to have completed parts of site preparation prior to bidding.

2. Background

2.1. Renewable energy site selection

Site selection issues have gained considerable attention in the literature on renewable energy development in industrialized countries and, to a lesser extent, in developing countries [12,24]. Thematically, the site selection literature can be grouped into three strains. Firstly, the majority of studies is concerned with the technological optimisation of renewable energy resource utilisation [25–31], oftentimes through the use of multi-criteria decision support models [32–40].

Secondly, a related body of literature is concerned with understanding and estimating the site-specific environmental and social impacts of renewable energy plants [41–47]. There is a recently growing interest in renewable energy-related land politics, land grabbing and social conflict as these technologies penetrate developing country markets [16,48,49].

A third and yet smaller cluster of literature, most closely related to this paper, discusses site selection issues as risks for renewable energy projects, most often through the lens of potential investors and project developers [12,50–55]. Kahn ([12]: 22) claims that "[s]ite location has more to do with a renewable energy project's ultimate success or failure than any other single factor". Site-specific risks identified in the literature include renewable energy resources, permitting (environment, social, planning), land acquisition or leasing, grid access and administrative capacity. In terms of Africa-focused studies, Barry et al. [51] find that site selection is a key success factor for renewable energy pilot projects in the region, specifically emphasising community acceptance as a core issue [51]. A systematic review of electricity planning and implementation literature focused on SSA by Trotter et al. [56] finds that land access is listed by 30 articles as an electrification delivery success factor, including for renewable energy investments [56]. While the academic literature has not focused on different site-selection process designs, the World Bank's International Finance Corporation (IFC) has suggested that an optimal site selection process is crucial for the success or failure of a renewable energy project [13]. The following subsections discuss the two cases this paper focuses on - Scaling Solar in Zambia and REI4P in South Africa - in terms of their different setup and site selection approaches, respectively.

2.2. Government-led site selection: the scaling solar case in Zambia

Scaling Solar was developed by the International Finance Corporation (IFC), a member of the World Bank Group, as a "one stop shop" package to support the implementation of grid-connected solar PV projects across Africa. It comprises advisory services, standardised (bankable) contracts and documentation, and offers stapled financing, guarantees and insurance [20]. Scaling Solar was launched in Zambia in 2015 following a directive by Zambia's president Edgar Lungu to the Industrial Development Corporation (IDC), a Zambian state-owned enterprise (SOE), to install 600 MW of solar PV capacity. This directive was part of the government's response to a severe electricity supply crisis, caused primarily by prolonged periods of drought affecting the largely hydro-based power system.[2] The IDC entered into an agreement with the IFC to implement the Scaling Solar programme for the procurement of this capacity [57,58]. A prequalification round was launched in October 2015 for two 34–55 MW plants. Forty-eight bidders submitted expressions of interest and 11 were prequalified. Bids were ranked based solely on price, and the two winning bidders were announced in June 2016: Neoen/First Solar with 52 MW (US$c 6.02/kWh) and ENEL Green Power with 34 MW (US$c 7.84/kWh) [59–61].

[2] In 2016, the installed capacity from Zesco and Independent Power Producers (IPPs) in Zambia amounted to 2827 MW. The largest share of the installed capacity was hydro power (2388 MW or 84.5%) [77].

At the time of their announcement, these non-indexed tariffs were some of the lowest for utility-scale solar PV in the world, made all the more significant by Zambia's sub-investment grade credit rating and the considerable solvency problems of the state-owned utility company ZESCO (Zambia Electricity Supply Corporation) which functioned as the offtaker for the Power Purchase Agreements (PPAs) [59,62,63]. The IDC, which formally owns ZESCO, and the developers who were awarded the project, act as shareholders of special purpose vehicles (SPVs) that own and operate the PV plants.

In terms of site selection, Scaling Solar's approach was entirely driven by the Zambian government through its SOEs, with the support of IFC advisors. The Zambian institutions lacked experience with large-scale solar PV projects, which directly impacted the site selection process. The land for the two sites in the Lusaka South Multi-Facility Economic Zone was allocated by the Zambian Development Agency (ZDA) and leased by the IDC. The IDC led the permitting and site inspection process. It provided site climatic studies, environmental and social impact reports through independent contractors, grid interconnection information, as well as site and legal due diligence reports to bidders. The IDC (through ZESCO) was also responsible for providing the sub-station and transmission infrastructure to the site for evacuation of the power. Environmental and social impact reports of the site showed that there are several potential problem areas, including geotechnical risks and illegal land occupation, but the government's description lacked the necessary detail to enable developers to carefully assess and price these risks [64].

The main reasons to use a government-led site selection approach in Zambia included the limited number of projects, the political urgency due to the energy crisis and largely unregulated land-ownership conditions in the country. Stated goals of the site selection and preparation process were to enhance general interest and competition amongst potential bidders in a nascent market; to mitigate the risk of programme failure; to minimize or avoid the cost of land acquisition and securing long-term land-title agreements; to facilitate comparability of the bids, and to shorten the overall timeline of project implementation. Despite achieving low tariffs during the first bidding round and a comparatively short timeline from project announcement to project award, the projects of round one faced significant delays. The official timeline issued by IDC for awarded projects to reach financial close was six months after the award date in May 2016. Only in December 2017, financial close of the 52 MW project awarded to Neoen was confirmed, while financial close of the second project awarded to Enel Green Power was reached in June 2018 [57,60]. Stritzke [65] has illustrated that the institutional inexperience, lack of capacity building and the absence of a neutral coordination body were in large part to blame for these project delays.

2.3. Developer-led site selection: The REI4P case in South Africa

The South African REI4P programme was initiated in 2011, after the country switched from feed-in tariffs to a competitive tendering scheme for renewable energy. There have since been five rounds of competitive procurement of renewable energy projects. As of 2017, 102 projects worth more than 6328 MW of renewable capacity have been awarded. The majority of the energy generation projects were either solar PV or onshore wind, although there were also auction allocations for biogas, biomass, small hydro and concentrated solar power (CSP). The program attracted significant international attention, with more than 390 bids submitted over 5 rounds (2011 – 2015), and competition dramatically driving prices down to levels below the national electricity utility, Eskom's, average cost of supply [15]. The solar PV projects were constrained to a maximum project size of 75 MW, and most projects are at or very close to this limit. During the first auction round, less than half of the total auctioned volume (3626 MW) was awarded. 1450 MW of this volume was reserved for solar PV, but only 627 MW was awarded. The second round awarded 1040 MW in total and 417 MW for solar PV, with similar capacity levels awarded in subsequent rounds. By March 2017, 56 of the contracted projects had completed construction and moved into operation; a further nine projects were under construction.[3] Over 95% of the projects awarded in REI4P's first three rounds managed to achieve financial close and commercial operation within the planned timeframe [66].

With regards to its developer-led site selection approach, compliance criteria and bidding requirements in REI4P have been stringent. In contrast to Scaling Solar, developers were solely responsible for the selection, preparation and securing of the project site [15,67]. These included choosing potential sites, measuring renewable energy resources where such data were not available, assessing technical and non-technical risks, securing land ownership, and ensuring the connection to the national grid by agreeing with national utility Eskom to which transmission substation the new plant could connect. The developers needed to prove the fulfilment of site-related duties by presenting finalised contracts (explicitly including land rights), permits, as well as financial and non-financial site-related agreements prior to bidding. They were initially required to have either a lease agreement for the entire life of the project (20 + years), or a land title submitted as part of the bid. Later rounds saw bidders having the option of submitting a land option agreement as part of their bid in an attempt at lowering some of the bidding costs associated with the program.

It is also important to note the role that financing entities played in the pre-qualification of sites in the South African programme: the bidding process required projects to present bank letters at the point of bidding indicating that financing was locked in – effectively outsourcing project due diligence to the banks (including for the project site) [67]. The banks therefore required comprehensive screening of project risks (incl. site risks) – especially with regards to solar resource assessments – before making a financing commitment. The implication is that projects would not have been able to secure finance, nor submit a bid, without all parties being comfortable with the risks presented by the project – including risks particular to the proposed site. This ensured that only projects that had been able to effectively deal with their site-related risks – whether through site selection, preparation or other risk mitigation tools – would qualify for the bid evaluation stage of the programme. Site-related risks were therefore fully transferred to the private sector developers and their investors.

3. Methodology

Although the size of both initiatives differs, comparing Scaling Solar's government-led site selection approach with REI4P's developer-led strategy constitutes an intriguing vehicle to study associated risk patterns. Of the at least 11 renewable energy auction programmes in SSA, only four have seen projects reach financial close: REI4P in South Africa; GET FiT's solar facility in Uganda; the Nampower Mariental PV project in Namibia; and Scaling Solar in Zambia. REI4P is the biggest and most advanced developer-led renewable energy auction program in SSA. Scaling Solar in Zambia is a prominent renewable energy procurement program in SSA, and the only one in which a project with a government-selected site managed to reach financial close in 2017. Several project developers have participated in the auction schemes of both programmes, possessing key insights of the different risk implications of both processes.

Semi-structured interviews were conducted over a three-month period between Nov 2017 – Jan 2018 with six solar PV project

[3] The remaining awarded projects were held up by Eskom's refusal to sign their power purchase agreements, despite the being the official offtaker of power for the procurement programme. 27 Round 4 projects' contracts were eventually signed in 2018, with most of these projects having reached financial close within the required timeframes.

developers and investors[4] that have significant experience in auctions with both government-led and developer-led site selection strategies. All six developers interviewed for this paper participated in Scaling Solar Round 1 in Zambia, all belonging to the group of 11 bidders that passed the pre-qualification stage for this round. Four of these developers had also taken part in South Africa's REI4P. The remaining two have had experience with other developer-led processes in developing countries. Interviews were structured to elicit responses on general as well as site-specific risk assessments in both types of programmes. Respondents were asked to identify, explain and rank the top (maximum five) general project development risks for both types of processes – with the intention of identifying the relative importance of site-related risks within a broader set of project risks. Respondents were similarly asked to identify, explain and rank the top (maximum five) site-related risks for both a government-led and developer-led solar PV bidding process. Questions were framed in an open-ended fashion, and responses categorised according to thematic clusters after the interviews. This introduced a quantitative aspect to the primarily qualitative research, and enabled the authors to rank the different risks and risk categories according to their ranking and frequency mentioned. While this is not an explicitly mixed-methods research design, the introduction of a quantitative element assists in the analysis of the qualitative results. Respondents were further asked to explicitly state whether site-related risks were of more concern in the government-led or developer-led processes. They were also asked to provide reasons for the differences (if any) in the site-related risks between both types of processes, and to provide recommendations for possibly addressing some of these concerns.

Based on an empirical analysis in cooperation with a Spanish project developer, Aragonés-Beltrán et al. [50] presented 50 different project delay and stoppage risks for the processes of solar PV site-selection and project implementation [50]. These single risks have been subsumed by Aragonés-Beltrán et.al. under the following six categories: political risks, technical risks, economic risks, permitting[5] risks, legal risks and social risks (Aragonés-Beltrán et al. [50]). This paper uses these categories to categorise and analyse the responses by developers. The results are also compared across both site selection processes, as well as with the expected results based on renewable energy auction design literature.

4. Results and discussion

Results are presented by first interrogating general project development risks for both types of solar PV site selection processes, government-led vs. developer led (Section 4.1). We then analyse the site-selection specific risks mentioned for both programmes (Section 4.2) through using the six risk categories presented by Aragones Beltran et al. [50], and explore some of the potential impacts. Finally, we provide and discuss the respondents' recommendations for improving the site selection process (Section 4.3).

4.1. General project risks

In terms of overall project risk perceptions for the two programmes, the interviewed developers identified salient differences in risk patterns and priorities (Fig. 1).

In the government-led Zambian case, site-related risks are the most pressing concern for most developers. Issues such as geotechnical problems with the site, as well as uncertainty regarding the ownership of the site were not only mentioned frequently, but were also mentioned first by most respondents. This was further borne out when developers were asked whether they are more concerned with site risks in Scaling Solar, or in the REI4P: the majority of respondents indicated that while the provision of the site in Scaling Solar "levels the playing field", it also introduced significant and potentially severe risks to the project development process. As a result, developers were considerably more concerned with site-related risks in the Zambian programme than in the South African one.

The Zambian electricity regulatory framework introduced a number of further uncertainties to the process – specifically the fact that the grid code requirements were not aligned with solar PV technologies, requiring "black-start" capabilities at all times of the day. Respondents mentioned that project financial closure was therefore further delayed to allow for a revision of the applicable regulations. There was also seemingly limited transparency with regards to the process of and timelines for the granting of generation licenses to projects. Further project development risks mentioned for Scaling Solar included: the mismatch between the currency of the PPAs (US dollars) and the currency of the electricity tariffs (Zambian Kwacha); the actual availability of foreign currency in the country; and the creditworthiness of the off-taker (ZESCO).

By contrast, most interviewed developers were less concerned with site-specific risks where site selection was performed by themselves in South Africa's REI4P. Rather, they identified political and process-related risks as most pressing. The off-taker – national utility Eskom – had refused to sign PPA's of projects awarded in the 2015 REI4P round (Round 4), creating a policy and political impasse that seemed likely to derail the entire procurement programme. This power imbalance between bidders and the off-taker – a very large monopoly incumbent - created further uncertainty about grid access, and the related costs.

Permitting and other licensing requirements were also mentioned as project development risks for REI4P, and while these are traditionally considered to be site-related risks, in this particular context the concern was more due to the fact that the delays in the signing of the PPA's would mean that many of these approvals would lapse, opening up project bids to potential additional unforeseen costs. This same concern was raised regarding some of the land agreements: landowners might be unwilling to extend existing agreements based on the delays and uncertainty in the programme. Further project development risks mentioned for REI4P included currency depreciation (the PPAs of REI4P are denominated in South African Rand); a shortage of relevant technical Operations and Maintenance skills (O&M); and the potential of poor technical performance of the PV plant itself.

4.2. Site selection specific risks

Fig. 2 provides a visual summary of the site-specific risk categories identified by developers for the two different types of project site selection processes. While *technical* risks are important for both processes, risks in this category make up a larger part of the site-specific risk profile in a government-led process than for a developer-led process. *Permitting* risks also receive significant attention in a developer-led process. While a developer-led process also seems to introduce *economic* and *social* risks to the process (perhaps unique to the South African programme due to the specific socio-economic development requirements in the procurement documentation), it is probably not surprising to note that *political* risk related to the site is a concern in a government-led process.

The apparent differences in risk categories for the two types of site selection processes need to be further unpacked to provide useful insight into the reasons for the different risk patterns. Below we therefore discuss the elements that make up these categories in more detail. Table 1 provides a list of the specific risks identified by the interviewees for each category. Each risk will be discussed and defined in the context

[4] The respondents requested to remain anonymous due to their current active engagement.

[5] The original title for this category in Aragones-Beltran et al.'s [50] classification is "time delay risks". Given that the majority of the risks in this category deals with permitting and approval processes, we have changed the name to "permitting" for greater clarity.

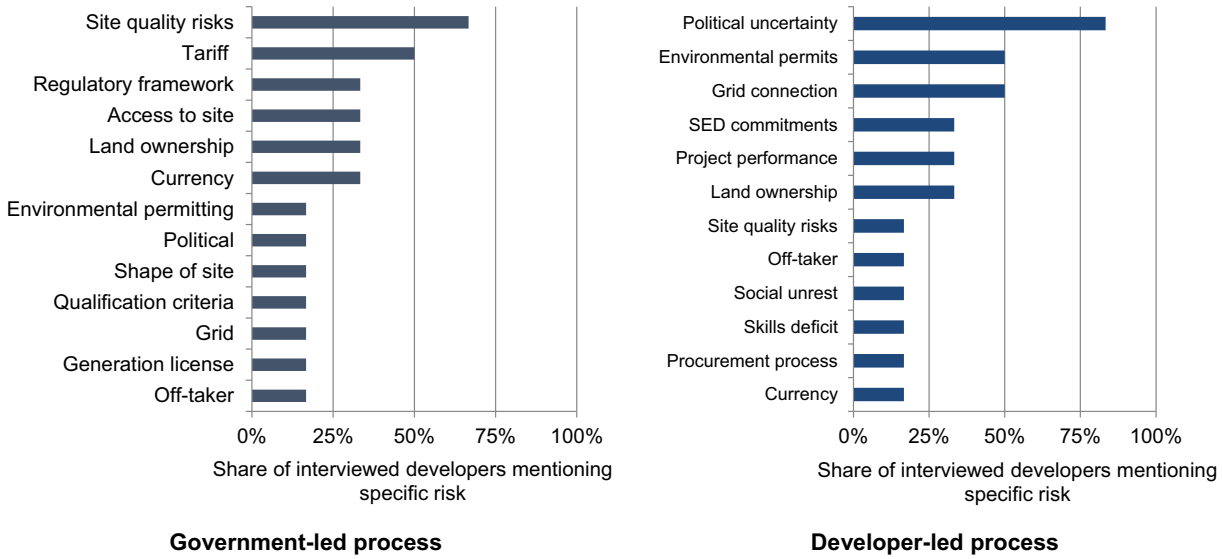

Fig. 1. General project risks for solar PV auction processes, as mentioned by interviewed developers.

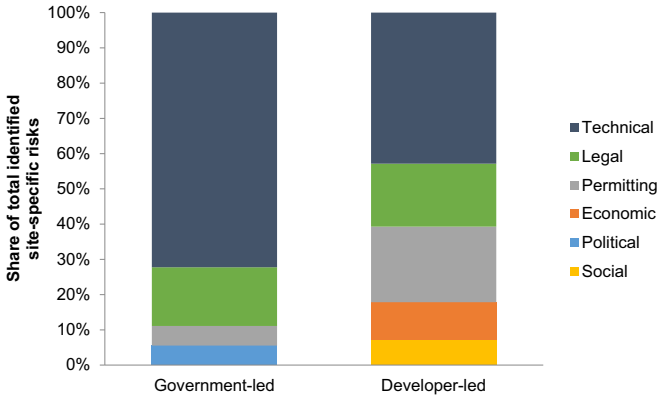

Fig. 2. Site-specific risk categories identified by interviewed developers.

Table 1
Categorized, specific risks identified by developers.

Category	Code	Specific risk
Technical	Tech.1	Geotechnical issues
	Tech.2	Grid connection
	Tech.3	Estimation of effective solar irradiation
	Tech.4	Evacuation capacity of the local grid
	Tech.5	Access to and control of site
	Tech.6	Flood risks
	Tech.7	Water availability
	Tech.8	Shape of site
Legal	Leg.1	Land ownership agreement
	Leg.2	Land agreements for transmission lines
Permitting	Perm.1	Environmental permitting
	Perm.2	Zoning and land use approvals
	Perm.3	Water use license
Economic	Econ.1	Cost of grid connection
	Econ.2	Cost of permitting and site preparation
Political	Pol.1	Expropriation
Social	Soc.1	Social consequences from land acquisition

of the interview responses in the following sub-section.

Fig. 3 breaks down Fig. 2 into specific risks as indicated in Table 1, showing how often a specific risk was mentioned for the two types of site-selection processes (government-led on the left-hand side vs. developer-led on the right-hand side). It suggests that the quantum of perceived risks for a developer-led process is greater than for a government-led process; conversely, a government-led process shows a higher concentration in a handful of prominent risks.

Geotechnical risks (Tech.1) – while being a prominent risk for both processes – dominates the perceived risks for the government-led process. Grid connection (Tech.2) is an important risk for both processes (more prominent in a government-led process),[6] as well as land ownership agreements (Leg.1). Environmental and other permitting (Perm.1) is the most frequently mentioned risk in a developer-led process.

In the following section, each risk is discussed in the context of its corresponding risk category according to the responses from the interviewed project developers.

4.2.1. *Technical risks*

The technical risk category appears to be the most important in terms of site-related risks. More than eight distinct “technical” risks were identified, most of which were highly ranked – more so for government-led processes than for developer-led ones.

The most frequently identified and highest ranked technical risk for the Scaling Solar program was the geotechnical (Tech.1), or sub-soil problems with the selected sites: sinkholes are apparently pocketed throughout the sites provided by the ZDA, requiring significant (and costly) additional site preparation work. Respondents reported that the full extent of these problems were not known at the time of bidding, and that bidders had therefore failed to adequately price in the costs for remedying the situation. One of the respondents concluded that, given the intense competition in the program that resulted in very low prices with thin margins, this omission has the potential to become a fatal flaw for a project. Geotechnical risks were also mentioned by three developers for a developer-led site selection processes, yet it is not highly ranked and is an issue that would have been fully scoped and costed prior to bidding in this type of process.

The second most prominent technical risk is grid connection (Tech.2), identified by three developers for the government-led process in Zambia, and two developers for the developer-led process in South Africa. This risk refers to the physical infrastructure required to connect the project to the grid, and the possible barriers (technical, physical) involved in ensuring that this connection is in place on time. In South Africa, developers were responsible for connecting their PV power

[6] Grid connection risks are particularly pronounced when dealing with a grid that is owned and managed by a state utility company.

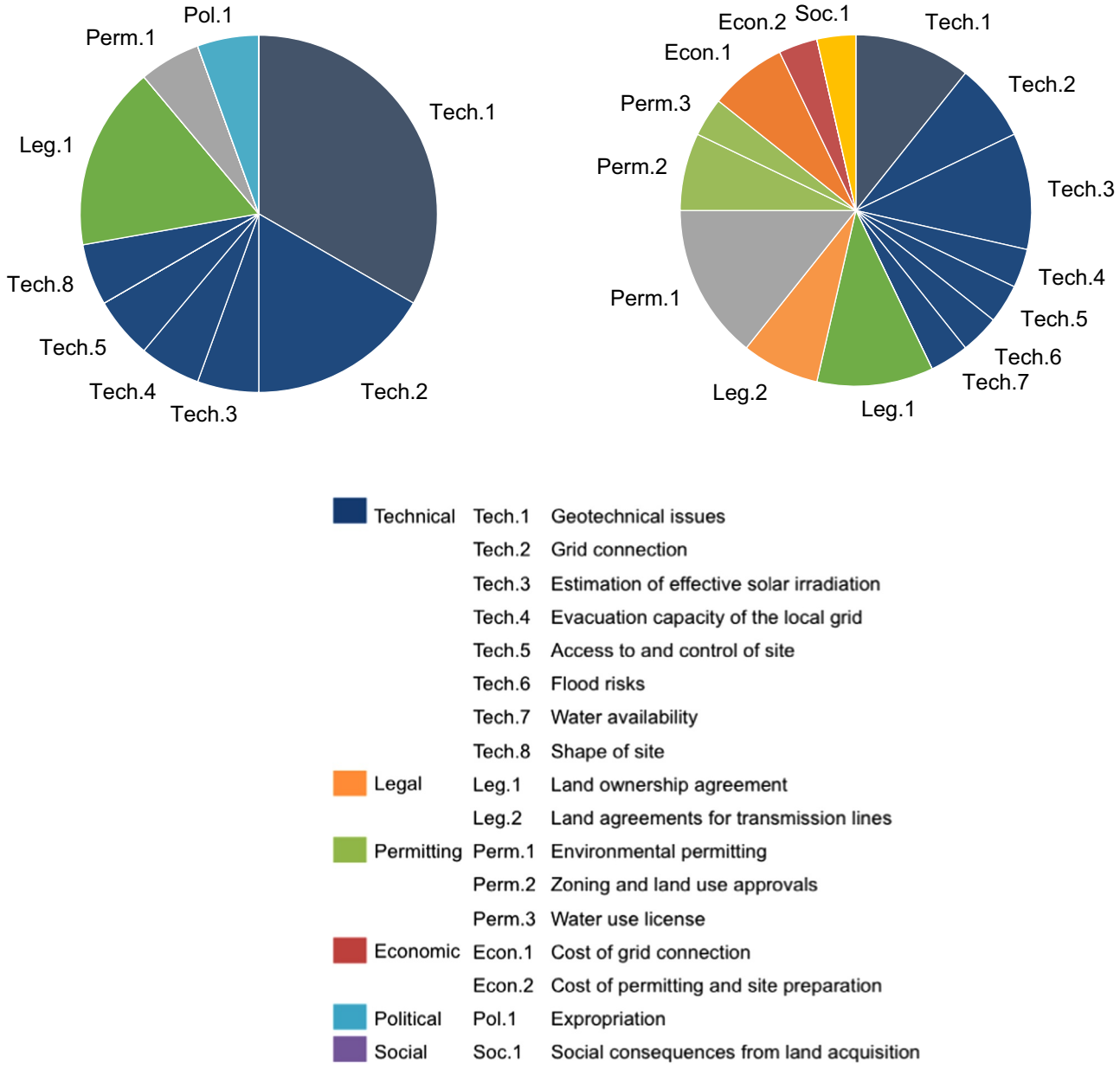

Fig. 3. Frequency of identified risks for site selection processes, grouped by risk categories.

plants to the closest sub-station – often meaning that power lines had to be built over many kilometres. It also meant that, where grid strengthening was needed, the project would be dependent on the grid provider (Eskom) to complete this work on time. In general, projects are responsible for the costs of "shallow" connection works, while Eskom is responsible for carrying out and paying for "deep" connection works. Bidders are responsible for submitting a "Cost Estimate Letter" from Eskom as part of their bid, indicating the potential cost of connecting the proposed renewable energy plant (for the bidder's account). This letter has to be replaced by an accurate and up-to-date "Budget Quote" once the bidder has advanced to "preferred bidder" status. The discrepancies between the "letters" and "quotes" can be considerable, with many bidders complaining of cost escalations many times the original quoted price. This is a risk borne entirely by the bidder, and therefore exposes bidders to considerable financial risk. In the government-led process in Zambia, the projects were completely dependent on ZESCO for building the power line and sub-station on time. This point of interconnection between the project and the off-taker/grid-provider is therefore an important area of uncertainty and risk for developers.

Effective estimation of solar irradiation (Tech.3) was mentioned for both programmes, but it is a more prominent risk for a developer-led program. This risk refers specifically to the fact that there is always an error index in the estimates of solar radiation, which adds uncertainty to the project.

Evacuation capacity (Tech.4) was identified as a site-specific risk by one respondent for each of the two programmes. In the Zambian case, it refers specifically to the fact that a grid capacity study had apparently not been completed prior to the bidding process. One respondent was therefore concerned that the local grid at the project site would not be able to evacuate the additional generation capacity. In South Africa, developers needed to ensure that the closest sub-station had sufficient capacity to be able to evacuate their power – as previously discussed.

Access to and control of the site (Tech.5) refers mainly to the difficulty in reaching and servicing a remote project site, and was considered as a risk for both types of processes.

Flood risks (Tech.6) was mentioned by a single developer for developer-led site-selection processes, and refers to the possibility of damage to the plant due to flooding in the area.

Water availability (Tech.7) is another risk only mentioned by a single respondent in the context of a developer-led process, and again reflects the fact that many of the solar PV plants in the South African programme are situated in remote, arid regions of the country.

The shape of the site (Tech.8) was a risk identified specifically by one developer in the context of the Scaling Solar government-led process. It refers to the fact that the provided project sites are unfortunately not optimally shaped for a solar PV plant; the result is that the PV plant is smaller than one would have expected on a similarly sized plot of land.

4.2.2. Legal risks

The land ownership agreement (Leg.1) appears to be the one risk that features equally for both programmes – but for slightly different reasons. In the government-led process in Zambia, the two project sites were leased to the IDC by the Zambian Development Agency (ZDA), who in turn will on-lease these to the project companies.[7] It became apparent in the process (post-award) that parts of the provided sites actually extended onto the adjoining nature reserve. This has required significant additional remedying action, which was perceived as a cause for delays in project realisation by one respondent. In the South African developer-led process, respondents indicated that the uncertainty regarding the land ownership agreement is due to two factors: the possibility of incorrect information in the land registry, and the unwillingness of land owners to extend agreements for projects that have been awarded preferred bidder status, but whose PPA's have not been signed (and have therefore not been able to progress to financial close) due to Eskom's obstructive behaviour.

The potential of failure to achieve land agreements for transmission lines (Leg.2) is another risk mentioned by two developers in the context of a developer-led process, and refers to the fact that power lines to connect the project to the grid often cross multiple properties. It can be quite challenging to secure and maintain the needed agreements from the different property owners for this critical infrastructure.

4.2.3. Permitting

Environmental and other site permitting requirements (Perm.1) have been mentioned for both processes, but features most prominently for developer-led processes. While permitting for the site would normally need to have been resolved by the time a bid is submitted for the REI4P, the significant delays in the signing of the PPAs of the latest rounds of bids has meant that several of these approvals have lapsed, introducing further uncertainty. This therefore poses not only a project realisation risk, but can also impose significant additional costs.

Zoning and land use approvals (Perm.2) is another risk mentioned by two respondents for a developer-led process as applied in the REI4P, since there is no guarantee that these will be granted once a project development process is underway. These approvals also require interaction with a number of government spheres (local, provincial, national) and departments (environment, minerals, agriculture), introducing further complexity to the development process.

Obtaining a water use license (Perm.3) is a further risk identified by a respondent in the developer-led South African process, due to the aforementioned location of many of the solar PV plants in arid regions of the country.

4.2.4. Economic risks

The cost of grid connection (Econ.1) was identified by two respondents in the context of a developer-led process, and is a top-ranked risk for one of them. It refers specifically to the aforementioned Cost Estimate Letter and Budget Quotes from Eskom for grid connection costing. The two respondents complained that there is little visibility in terms of what these costs will end up being, and that they vary widely based on the project site location.

The cost of permitting and site preparation (Econ.2) was mentioned by a developer in the context of the South African developer-led process as a major cost driver, especially due to the fact that there is such limited capacity in the country's professional services industry to provide the services required.

4.2.5. Political risks

Political risks were only mentioned by one of the interviewed developers as a site-specific risk for the Zambian government-led site selection process. The specific risk mentioned related to the possibility of the expropriation of the PV plant or the land by the host government (Pol.1) – potentially after a change of government or in response to local political or social unrest. Of the five risks mentioned by this particular developer, this was the lowest ranked.

4.2.6. Social risks

Social consequences of land acquisition (Soc.1) refer to potential social unrest around a power plant location [50]; this risk was mentioned in the context of the South African developer-led process, and refers not only the classic NIMBY (Not In My Backyard) phenomenon that has plagued so many wind power projects in developed countries [45,47,68], but also to a host of other location-specific social risks particular to developing regions. These include the commitments made by projects towards local community ownership of the project, and benefits flowing from the project to the community – in response to specific qualification and evaluation criteria in the South African RFP. Projects are evaluated on 16 different “economic development” indicators, grouped under job creation, local content, ownership, management control, preferential procurement, enterprise development and socio-economic development. A key area of potential concern that was pointed out in the interviews are the local ownership and revenue provisions, which require a minimum 2,5% local community ownership level in the project company, as well as revenue flows equivalent to 1% of total revenue to local communities. These requirements introduce additional complexity to a project, and could lead to unrealistic community expectations not being met, resulting in social unrest. Failure to meet socio-economic development commitments can also result in financial penalties and the cancellation of the PPA. Projects therefore have to continually manage expectations and ensure effective implementation of their socio-economic development plans. It is a long-term risk for projects, and can result in not only project realisation delays, but also project failure (e.g. Kinangop in Kenya) and significant additional costs.

4.2.7. Summary of site-selection risks: a comparison

The analysis of the responses shows that the site itself posed a major risk to the developers in Scaling Solar Zambia Round 1 – seemingly thwarting the original intention for the government in providing and preparing the site. Reasons put forward for this assessment centred mainly on the ability of developers to control the risks they are to bear. While the site risks were considerable in the South African programme for developers, they were able to make informed decisions about their willingness to take on these risks. This was not the case in Zambia, where developers were “forced” to take on site risks that they had no control over and had very poor visibility on. As one developer stated: “we would never have chosen those sites” (Personal communication, December 2017).

Not only were site-related risks much more prominent in the government-led Scaling Solar Zambia Round 1, but the nature of the site-related risks in both programmes differ substantially. In the developer-led South African case, most site-related risks are concerned with issues “around” the site, such as permitting, connection agreements and community engagement. In the Zambian case, the reported risks are much “closer” to the actual sites, including the aforementioned geotechnical and land rights problems. These are issues that would

[7] The project companies formally own and operate the solar PV power plants. In the Zambian case, each of the two project companies is owned by two shareholders - the developer (80%) and the IDC (20%).

normally have been dealt with at a pre-feasibility assessment level by developers in a developer-led programme, before proceeding to the concerns around permitting and connections. From a developer's perspective, the site-selection risks in Zambia therefore appear to be much more fundamental, raising concerns about the quality of pre-feasibility assessments performed for the programme. Respondents indicated that this might be due to the limited experience of the procurer, the short project preparation timelines, or limited financial provision being made for the necessary assessments.

4.3. Developers' proposals for addressing site-related risks

In the final step of the semi-structured interviews, developers were asked for suggestions in terms of how the site-related risks for both the REI4P and Scaling Solar can be mitigated in the future. In response to this question, developers put forward a number of proposals for better dealing with these risks in subsequent procurement rounds. This would mainly include increasing the level of private sector involvement in the project preparation process. Such involvement could take several forms. One developer mentioned an interesting example from Egypt, where developers grouped together to finance a range of feasibility studies required to enable them to submit bankable proposals. By grouping their financial resources and jointly selecting service providers, these developers were able to significantly reduce the risks of a poorly conducted site selection and preparation process. Their findings and recommendations were used by the procurer to select an appropriate site.

With regard to the Scaling Solar programme, respondents proposed expanding the timeline and increasing the resources allocated to the site selection and preparation process by the public sector, whether this is the host government or other development partners, to ensure high quality, bankable project data. A further suggestion was to allow developers to propose two sites and associated tariffs when bidding; the first for a government-selected site, the second for a site selected by the developer. This will allow developers to potentially lower their own risk exposure, provide a transparent evaluation of the risks and returns related to each site, and offer potential additional benefits to the procurer in the form of a better site with lower costs. This has been applied in Malawi's first solar PV auction in 2017, and while the projects are yet to reach financial close, it has shown that it is possible to structure a bidding program in a way that tries to have "the best of both worlds".

5. Discussion

The analyses in Section 4 has shown that the government-led site selection process in Zambia produced comparably high levels of perceived risks by developers due to several substantial technical and legal risks. Yet, rather than calling for abolishing government-led site selection processes, this paper argues that with an adequately designed process which matches all site selection tasks with the required skill sets (either within the public sector institution or via leveraging outside expertise where needed), government-site selection and preparation can work. The successful use of solar parks in India and the Middle East underline this assertion [69–71]. In the sub-Saharan region, Namibia's 37 MW solar PV auction used a site that was selected, leased and prepared by Nampower, the government-owned national utility.[8] While problems to secure land access delayed the project, the Namibian project reached financial close in early 2018, and the price achieved was comparable to the lowest winning bid in Zambia.[9] It is also important to note that despite the challenges and delays experienced in Zambia's Scaling Solar auction process, both awarded projects managed to reach financial close, within reasonable timeframes.

Our analysis is mainly concerned with the impact of the site-selection process on perceived risks – especially given the crucial role that risk-adjusted cost of capital plays in the pricing of solar power [72,73]. It is worth noting that such risk perceptions tend to be influenced by the varying quality of institutions in the two case study countries in general. Indeed, the World Bank ranks South Africa notably higher on its Government Effectiveness and Regulatory Quality scales than Zambia [74]. However, the levels of institutional quality and capacity can be expected to directly impact the quality of the site-selection and preparation process: adequate site selection processes require institutional alignment and capacity building, especially where a new technology is being introduced. Our earlier research has shown neither the necessary institutional alignment, coordination nor capacity building took place in Zambia [65]. Furthermore, one would expect concerns around institutional capacity and quality in Zambia to have been somewhat mitigated by the prominent presence of the World Bank group in the auction process. The auction price results seem to bear this out, with the price levels achieved below what many would have expected if bidders were taking Zambian risk instead of World Bank risk. Our analysis therefore supports the assertion that differences in terms of institutional quality impacted risk perceptions – but maintain that a key area where this played out in practice was in the selection and preparation of the sites.

To address these institutional issues, this paper suggests a capacity building process comprising three steps. As a first step, the current level of experience and know-how in implementing a certain type of project is to be reviewed and potential knowledge gaps or uncertainties vis-à-vis the processual requirements systematically identified. In a second step, a coordination and communication process with other institutions and potential outside stakeholders involved in the project's development and implementation must be implemented. The incorporation of a neutral PPP unit to take on this role has been suggested [65]. In a third step, identified knowledge gaps should be filled by involving experienced stakeholders (such as developers, other government departments, or development partners) in providing advice that can be neutrally reviewed by a PPP unit.

6. Conclusion and policy implications

This paper analysed and compared the perceived project risks for competitive renewable energy project tendering schemes with different site selection strategies in sub-Saharan Africa. The evidence gathered from project developers in government-led site selection in Zambia's Scaling Solar Round 1, as well as from developer-led site selection in South Africa's REI4P, suggests that different general and site-specific risks are present. In Zambia's government-led approach, site-specific risks dominated all other project risks, and centred around several technical issues. In REI4P, such risks were noticeable, yet less pronounced and more evenly spread between different risk categories. These findings challenge the widely held assumption within [14] and outside academia [20] that pre-selecting a site for a solar PV plant procurement process in SSA directly translates into a reduced risk profile, lower prices and result in quick project realisation. The type of risks that ended up slowing down the government-led Scaling Solar process have been not only elemental - both in terms of being early

[8] Nampower received a 19% equity stake in the project as "payment" for the land and grid connection.

[9] The Namibian PPA price is however indexed to inflation (which is not the case in Zambia), but the tariff is denominated in local currency and there is no sovereign support provided. Nevertheless, Namibia's case is not a clear-cut example of this process working: the auction was initially designed to procure

(*footnote continued*)

3 × 10 MW from three different sites. However, due to problems with securing the leases for all three sites, the auction was changed at quite a late stage to a single 37 MW project. One of the bidders took Nampower to court due to this change, with the result that the utility had to cancel and then rebid the project (37 MW) – resulting in significant delays in the overall buildout timelines.

stage project development risks, and potential fatal project flaws; more importantly, the nature of the site selection process meant that bidders had limited or no control over these risks. In more general terms, these results can be seen as a manifestation of a lack of instiutional capacities in Zambia. Implementing a new and complex process like power plant site selection constitutes a case where limited technical experience has become salient.

This has important implications for utility-scale solar PV tender design in SSA. Many of the factors that plagued the Zambian Scaling Solar site selection and preparation process are not unique to the country. Only a handful of countries in the region have managed to realise private-sector led utility-scale renewable energy investments [75], pointing to a regional deficit in the requisite experience, capacity and resources required to effectively scale up these kinds of investments. In this context, the Scaling Solar programme is a welcome development with great potential. Nevertheless, to be effective it is recommended that programmes that entail government-led site selection processes such as Scaling Solar take certain lessons into account, especially on the issue of site selection and preparation. South Africa's experience has shown that the private sector is able to effectively deal with site selection and preparation issues, without compromising on costs or project realisation. Whether solar PV auctions with government-selected sites in the sub-Saharan region are able to achieve a similar outcome still needs to be proven.[10] We propose that where a procurer opts for a pre-selected site – whether to deal with land rights issues or to reduce costs, or both – it is done in close consultation with the private sector. Specifically, the public sector institutions should map out their current know-how against the specific technical, legal and permitting requirements for successful site selection, and then involve developers and other parties where knowledge gaps and uncertainties exist. A vehicle like a PPP unit can be a feasible and efficient way to realise and organise this interaction. In addition, it is important that sufficient time and resources are dedicated to this process, and that, where possible, the pre-selected site is an option for bidders, instead of a hard restriction.

Early indications are that reforms of Scaling Solar are underway, although how exactly these risks are being addressed is not clear at present [76]. This also has implications beyond Scaling Solar, as the success of the rapid rise of utility-scale solar PV auctions in SSA more broadly depends on making appropriate choices on this important topic.

Funding Sources

This work was supported by the British Academy [Grant number GF 160016 Making Light Work]; and the UK Department for International Development [Grant number PO00022908].

References

[1] McCrone A, Moslener U, D'Estais F, Grünig C. Global trends in renewable energy investment. Frankfurt; 2017.
[2] Trotter PA, Abdullah S. Re-focusing foreign involvement in sub-Saharan Africa's power sector on sustainable development. Energy Sustain Dev 2018;44:139–46. https://doi.org/10.1016/j.esd.2018.03.003.
[3] IRENA. Renewable energy auctions: analysing 2016. Renew Energy Auction Anal 2017;2016:1. [28].
[4] Kruger W, Eberhard A. Renewable auctions in sub-Saharan Africa. Proj Financ Int EMEA Rep 2016:7–10.
[5] ESCOM. ESCOM to add 70 MW of power through solar 2016. 〈http://www.escom.mw/escom_solar.php〉 [Accessed 24 August 2017].
[6] Kenning T. Senegal plans 200 MW solar via IFC Scaling Solar programme. PVTECH; 2016. 〈http://www.pv-tech.org/news/senegal-plans-200mw-solar-via-ifc-scaling-solar-programme〉 [Accessed 2 August 2016].
[7] Kilian A. BioTherm energy secures 20 MW solar project in Ghana. Eng News 2016:13–5.
[8] NAMPOWER. Tender for the development of a solar photovoltaic power plant on a build-own-operate (BOO) basis near Mariental, in Namibia. Tender No NPWR/2016/22; 2016.
[9] Sibanda Z, MacInnis L. World bank group's scaling solar to give Madagascar a clean power boost. IFC Press Release 2016:711964.
[10] Tebele BM. Botswana to build new 100 MW solar plant; 2017, p. 1–5.
[11] Tsagas I. Scaling solar update: Senegal, Madagascar, Ethiopia and Zambia. PV Mag Int 2017:1–6.
[12] Kahn RD. Siting struggles: the unique challenge of permitting renewable energy power plants. Electr J 2000;13:21–33. https://doi.org/10.1016/S1040-6190(00)00085-3.
[13] IFC. Utility-scale solar photovoltaic power plants: a project developer's guide. International finance corporation. World Bank Group; 2015.
[14] del Río P. Designing auctions for renewable electricity support. Best practices from around the world. Energy Sustain Dev 2017;41:1–13. https://doi.org/10.1016/j.esd.2017.05.006.
[15] Eberhard A, Naude R. The South African renewable energy independent power producers procurement programme (REIPPPP) – lessons learned. J Energy South Afr 2016;27:1–14. https://doi.org/10.17159/2413-3051/2016/v27i4a1483.
[16] McEwan C. Spatial processes and politics of renewable energy transition: land, zones and frictions in South Africa. Polit Geogr 2017;56:1–12. https://doi.org/10.1016/j.polgeo.2016.10.001.
[17] ESCOM. Bidding document for supply of solar photovoltaic power through international competitve bidding tender number: Esc801/Icb/S/Fy2016-17; 2016.
[18] Ethiopian Electric Power. Request for proposal for the procurement of 100 mw solar photovoltaic electricity generation facility; procurement reference no: EEP/ICB/Gen/Metehara-01; 2016.
[19] Industrial Development Corporation (IDC). World Bank Group. Request for prequalification for utility-scale solar photovoltaic IPP projects in Zambia. Lusaka.
[20] Fergusson J, Croft D, Charafi Y. Scaling solar: making the sun work for Africa. Afr Energy Yearb 2015:113–7.
[21] Lucas H, Del Rio P, Sokona MY. Design and assessment of renewable electricity auctions in Sub-Saharan Africa. IDS Bull 2017;48:79–100.
[22] del Río P. Auctions for renewable energy support in Zambia: instruments and lessons learnt. Report D4.4-ZM, July 2017; 2017.
[23] Department of Energy, National treasury, development bank of Southern Africa. Independent power producers procurement programme (IPPPP): an overview. As at 31 March 2016. Tshwane: 2016. 〈http://dx.doi.org/10.1002/ejoc.201200111〉.
[24] Beck F, Martinot E. Renewable energy policies and barriers. In: Cleveland C, editor. Encycl. energy. 1st ed.Amsterdam, Boston: Elsevier Academic Press; 2004. p. 365–83.
[25] Azizi A, Malekmohammadi B, Jafari HR, Nasiri H, Amini Parsa V. Land suitability assessment for wind power plant site selection using ANP-DEMATEL in a GIS environment: case study of Ardabil province, Iran. Environ Monit Assess 2014;186:6695–709. https://doi.org/10.1007/s10661-014-3883-6.
[26] Baban SM, Parry T. Developing and applying a GIS-assisted approach to locating wind farms in the UK. Renew Energy 2001;24:59–71. https://doi.org/10.1016/S0960-1481(00)00169-5.
[27] Fernandez-Jimenez LA, Mendoza-Villena M, Zorzano-Santamaria P, Garcia-Garrido E, Lara-Santillan P, Zorzano-Alba E, et al. Site selection for new PV power plants based on their observability. Renew Energy 2015;78:7–15. https://doi.org/10.1016/j.renene.2014.12.063.
[28] Khan G, Rathi S. Optimal site selection for solar PV power plant in an Indian state using geographical information system (GIS). Int J Emerg Eng Res Technol 2014;2:260–6.
[29] Kim T, Park J-I, Maeng J. Offshore wind farm site selection study around Jeju Island, South Korea. Renew Energy 2016;94:619–28. https://doi.org/10.1016/j.renene.2016.03.083.
[30] Latinopoulos D, Kechagia K. A GIS-based multi-criteria evaluation for wind farm site selection. A regional scale application in Greece. Renew Energy 2015;78:550–60. https://doi.org/10.1016/j.renene.2015.01.041.
[31] Van Haaren R, Fthenakis V. GIS-based wind farm site selection using spatial multi-criteria analysis (SMCA): evaluating the case for New York State. Renew Sustain Energy Rev 2011;15:3332–40. https://doi.org/10.1016/j.rser.2011.04.010.
[32] Atici KB, Simsek AB, Ulucan A, Tosun MU. A GIS-based multiple criteria decision analysis approach for wind power plant site selection. Util Policy 2015;37:86–96. https://doi.org/10.1016/j.jup.2015.06.001.
[33] Charabi Y, Gastli A. PV site suitability analysis using GIS-based spatial fuzzy multi-criteria evaluation. Renew Energy 2011;36:2554–61. https://doi.org/10.1016/j.renene.2010.10.037.
[34] Ghasempour R, Nazari MA, Ebrahimi M, Ahmadi MH, Hadiyanto H. MCDM approach for selecting solar plants site and technology: a review. Int J Renew Energy Dev 2017:0. https://doi.org/10.14710/ijred.0.x.%p.
[35] Ioannou A, Angus A, Brennan F. Risk-based methods for sustainable energy system planning: a review. Renew Sustain Energy Rev 2017;74:602–15. https://doi.org/10.1016/j.rser.2017.02.082.
[36] Noorollahi Y, Yousefi H, Mohammadi M. Multi-criteria decision support system for wind farm site selection using GIS. Sustain Energy Technol Assess 2016;13:38–50. https://doi.org/10.1016/j.seta.2015.11.007.
[37] San Cristóbal JR. Multi-criteria decision-making in the selection of a renewable energy project in spain: the Vikor method. Renew Energy 2011;36:498–502. https://doi.org/10.1016/j.renene.2010.07.031.
[38] Uyan M. Optimal site selection for solar power plants using multi-criteria evaluation: a case study from the Ayranci region in Karaman, Turkey. Clean Technol Environ Policy 2017:1–14. https://doi.org/10.1007/s10098-017-1405-2.
[39] Yunna W, Yi-sheng Y, Tian-tian F, Li-na K, Wei L, Luo-jie F. Macro-site selection of

[10] Namibia's 37 MW solar PV auction result seems to suggest that they can – albeit in a stable country with an investment-grade offtaker.

wind/solar hybrid power station based on Ideal Matter-Element Model. Int J Electr Power Energy Syst 2013;50:76–84. https://doi.org/10.1016/j.ijepes.2013.02.024.
[40] Yunna W, Geng S. Multi-criteria decision making on selection of solar–wind hybrid power station location: a case of China. Energy Convers Manag 2014;81:527–33. https://doi.org/10.1016/j.enconman.2014.02.056.
[41] Akella AK, Saini RP, Sharma MP. Social, economical and environmental impacts of renewable energy systems. Renew Energy 2009;34:390–6. https://doi.org/10.1016/j.renene.2008.05.002.
[42] Devine-Wright P, Howes Y. Disruption to place attachment and the protection of restorative environments: a wind energy case study. J Environ Psychol 2010;30:271–80. https://doi.org/10.1016/j.jenvp.2010.01.008.
[43] Hernandez RR, Easter SB, Murphy-Mariscal ML, Maestre FT, Tavassoli M, Allen EB, et al. Environmental impacts of utility-scale solar energy. Renew Sustain Energy Rev 2014;29:766–79. https://doi.org/10.1016/j.rser.2013.08.041.
[44] Saidur R, Rahim NA, Islam MR, Solangi KH. Environmental impact of wind energy. Renew Sustain Energy Rev 2011;15:2423–30. https://doi.org/10.1016/j.rser.2011.02.024.
[45] van der Horst D. NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. Energy Policy 2007;35:2705–14. https://doi.org/10.1016/j.enpol.2006.12.012.
[46] Varun Prakash R, Bhat IK. Energy, economics and environmental impacts of renewable energy systems. Renew Sustain Energy Rev 2009;13:2716–21. https://doi.org/10.1016/j.rser.2009.05.007.
[47] Wolsink M. Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support. Renew Energy 2000;21:49–64. https://doi.org/10.1016/S0960-1481(99)00130-5.
[48] McEwan C, Mawdsley E, Banks G, Scheyvens R. Enrolling the private sector in community development: magic bullet or sleight of hand? Dev Change 2017;48:28–53. https://doi.org/10.1111/dech.12283.
[49] Scheidel A, Sorman AH. Energy transitions and the global land rush: ultimate drivers and persistent consequences. Glob Environ Chang 2012;22:588–95. https://doi.org/10.1016/j.gloenvcha.2011.12.005.
[50] Aragonés-Beltrán P, Chaparro-González F, Pastor-Ferrando JP, Rodríguez-Pozo F. An ANP-based approach for the selection of photovoltaic solar power plant investment projects. Renew Sustain Energy Rev 2010;14:249–64. https://doi.org/10.1016/j.rser.2009.07.012.
[51] Barry M-L, Steyn H, Brent A. Selection of renewable energy technologies for Africa: eight case studies in Rwanda, Tanzania and Malawi. Renew Energy 2011;36:2845–52. https://doi.org/10.1016/j.renene.2011.04.016.
[52] Butler L, Neuhoff K. Comparison of feed-in tariff, quota and auction mechanisms to support wind power development. Renew Energy 2008;33:1854–67. https://doi.org/10.1016/j.renene.2007.10.008.
[53] Byrnes L, Brown C, Foster J, Wagner LD. Australian renewable energy policy: barriers and challenges. Renew Energy 2013;60:711–21. https://doi.org/10.1016/j.renene.2013.06.024.
[54] Nasirov S, Silva C, Agostini CA. Investors' perspectives on barriers to the deployment of renewable energy sources in Chile. Energies 2015;8:3794–814. https://doi.org/10.3390/en8053794.
[55] Outka U. Siting renewable energy: land use and regulatory context. Ecol Law Q 2010;37:1041–106.
[56] Trotter PA, McManus MC, Maconachie R. Electricity planning and implementation in sub-Saharan Africa: a systematic review. Renew Sustain Energy Rev 2017;74:1189–209. https://doi.org/10.1016/j.rser.2017.03.001.
[57] Ahlfeldt C, Attia B. A world bank group solar program may unlock 1.2 GW of utility-scale projects in emerging markets. Greentechmedia 2017:1–5.
[58] Industrial Development Corporation (IDC). Forty-eight bidders submit pre- qualification applications to develop 2 × 50 MW solar PV IPP projects. News release; 2016, p. 1–7. ⟨http://www.idc.co.zm/article/forty-eight-bidders-submit-pre-qualification-applications-develop-2-x-50mw-solar-pv-ipp⟩ [Accessed 3 September 2016].
[59] Bloomberg New Energy Finance. Scaling solar for Africa: Zambia's 6-cent PV 2016. ⟨https://www.scalingsolar.org/wp-content/uploads/2016/07/press-060116-bloomberg-ss-africa-zambia.pdf⟩ [Accessed 7 May 2017].
[60] IFC. IFC financing advances record-setting scaling solar project in Zambia; 2017.
[61] International Finance Corporation. Scaling solar delivers low-cost clean energy for zambia; 2016, p. 1–2. ⟨http://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/scaling+solar+delivers+low+cost+clean+energy+for+zambia⟩ [Accessed 7 August 2016].
[62] Sargsyan G Why Zambia's 6 cents is more significant than Dubai's 3 cents. World Bank Energy All; 2016, p. 1–6. ⟨http://blogs.worldbank.org/energy/why-zambia-s-6-cents-more-significant-dubai-s-3-cent⟩ [Accessed 9 December 2016].
[63] Trimble C, Kojima M, Perez-Arroyo I, Mohammadzadeh F. Financial viability of electricity sectors in sub-Saharan Africa. Quasi-fiscal deficits and hidden costs. Policy Res Work Pap 7788. World Bank; 2016.
[64] Knight Piésold Zambia. Environmental and social impact statement for the proposed bangweulu solar PV plant under round 1 scaling solar zambia project volume 3 – figures and appendices; 2016.
[65] Stritzke S. 'Clean energy for all': the implementation of Scaling Solar in Zambia. World J Sci Technol Sustain Dev 2018;15:214–25. https://doi.org/10.1108/WJSTSD-11-2017-0042.
[66] Leigland J, Eberhard A. Localisation barriers to trade: the case of South Africa's renewable energy independent power program. Dev South Afr 2017. [Forthcomin].
[67] Eberhard A, Kolker J, Leigland J. South Africa's renewable energy IPP procurement program: success factors and lessons. Washingt DC, USA: PPIAF; 2014. p. 1–56.
[68] Burningham K, Barnett J, Walker G. An array of deficits: unpacking NIMBY discourses in wind energy developers' conceptualizations of their local opponents. Soc Nat Resour 2014;28:246–60. https://doi.org/10.1080/08941920.2014.933923.
[69] Goyal S, Mhorotra B, Purohit I. Concept of solar parks and lessons from India.
[70] Tsanova T. Bid for 800-MW solar project in Dubai falls below USD 30/MWh. SeeNews Renewables; 2016.
[71] Kruger W, Eberhard A, Swartz K. Renewable energy auctions: a global overview renewable energy auctions: a global overview; 2018.
[72] Ondraczek J, Komendantova N, Patt A. WACC the dog: the effect of fi nancing costs on the levelized cost of solar PV power; 2015; 75, p. 888–98.
[73] Angelopoulos D, Doukas H, Psarras J, Stamtsis G. Risk-based analysis and policy implications for renewable energy investments in Greece. Energy Policy 2017;105:512–23. https://doi.org/10.1016/j.enpol.2017.02.048.
[74] Kaufmann D, Kraay A. World Governance Indicators. World Bank Gr; 2018.
[75] Eberhard A, Gratwick K, Morella E, Antmann P. Independent Power Projects in Sub-Saharan Africa: investment trends and policy lessons. Energy Policy 2017;108:390–424. https://doi.org/10.1016/j.enpol.2017.05.023.
[76] World Bank. International development association project paper on a proposed additional guarantee in the amount of up to US$2,8 million equivalent to the republic of zambia and on a proposed international finance corporation (IFC) financing consisting of an a loan i; 2017.
[77] Energy Regulation Board Zambia. Public notice invitation to submit written comments on zesco's application to revise electricty tariffs for the year 2017; 2017.