Developing countries may be catalysed by certain policy measures

1. Introduction

Improving the uptake of renewable energy technologies in
developing countries may be catalysed by certain policy measures
[1–3] and market incentives [4–7], but also by entrepreneurship

A B S T R A C T

This paper cumulates the findings from a review of the challenges faced by renewable energy entrepreneurs in developing countries. To date, research that could facilitate the success of renewable energy entrepreneurs in the world’s developing regions has been fragmented across two main bodies of literature – management (specifically, entrepreneurship) and renewable energy. By conducting a qualitative review of the extant literature, I propose that the findings from both bodies of research may be distilled to six (6) key challenges: inadequate access to institutional finance; the price of renewable energy technologies (RETs); the lack of skilled labour; underdeveloped physical infrastructure and logistics; power/dominance of incumbents; inadequate government or policy support. Through this research, I not only advance a unified conceptualisation of the challenges faced by renewable energy entrepreneurs in developing countries, but also highlight a number of the revealed opportunities for future research.

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1. Introduction

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[1–3] and market incentives [4–7], but also by entrepreneurship

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review was approached with the following questions in mind: (1) How best can the challenges presented in the literature be summarised and distilled? (2) What is suggested about how entrepreneurs may overcome these challenges? (3) What are the revealed opportunities for further research?

Although entrepreneurship has been identified as an important solution for developing countries, the literature's coverage of the challenges that may be faced by entrepreneurs working in the renewable energy space has been fragmented. An understanding of the challenges faced by entrepreneurs in general can be gleaned by studying the business management and entrepreneurship literature [17–21], while the challenges to the uptake of renewable energies are covered substantially in a range of technical [22,23], policy [1,2,24] and business [17,25] literatures. Indeed, the prominence, effectiveness and unique business models offered by enterprises such as Grameen Shakti, Illumination Solar, and those under the Lighting Africa programme suggest the need for a body of research that focuses on the business models, success factors and challenges associated with renewable energy entrepreneurship, specifically in developing countries. Microfinance and microfranchising schemes, for example, have been investigated, and factors such as policy [1,3], overall ease of doing business [26,27] and government support [24,28] have been identified as contributing to the success of renewable energy start-ups in developing countries. However, I surmise that understanding the challenges faced by renewable energy entrepreneurs in such environments requires, first, a coalescence of the management and renewable energy literatures on the subject and, second, an assessment of the gaps in our coverage of the means of overcoming these challenges to date.

This paper combines the management literature that focuses on challenges that may affect entrepreneurs in developing countries, and the renewable energy literatures that focus on the challenges and obstacles to increasing the uptake of renewable energy technologies in such countries. In so doing, a unified conceptualisation of the challenges faced by renewable energy entrepreneurs in developing countries is advanced, and opportunities for future research and for helping entrepreneurs overcome these challenges are highlighted.

2. Review method

The literature was reviewed by using qualitative meta-analytic methods, which allow the synthesis of the findings and implications of previous studies. The aim of using this approach is to derive an understanding of the body of knowledge built up around renewable energy entrepreneurship challenges in developing countries. Individual studies have focused on specific challenges faced by entrepreneurs and renewable energy stakeholders in various developing country contexts. This method facilitates the accrual of the findings from these individual studies.

Topical similarity and inclusion were determined by searching the ProQuest Central, Academic OneFile, Business Source Complete, Academic Search Complete, Scopus, Science Direct and Web of Science databases for documents whose abstracts met one or more of three topical search criteria. These search topic criteria were renewable energy entrepreneurship (search terms “renewable energy” AND “entrepreneur”), renewable energy challenges (search terms “renewable energy” AND “challenge” OR “constraint”), and entrepreneurship challenges (search terms “entrepreneur” AND “challenge” OR “constraint”). The results of these searches were further refined to include only scholarly peer-reviewed articles published since 1990, and these results were even further assessed to determine relevance to renewable energy entrepreneurship in developing countries. International development literature was also consulted in parallel.

A total of 499 unique and relevant journal articles were found. These articles were analysed in NVivo using a Template Analysis method. This involved developing a broad template list of challenges from the start then, by coding each of the 499 articles into relevant existing challenge nodes and creating new nodes as new themes emerged, a final list of the main challenges identified by the papers was derived. The original template list consisted of only 2 nodes – entrepreneurship challenges and renewable energy challenges – which was further developed during analysis into a final list of 31 hierarchical nodes. Distillation of the main issues addressed by the articles resulted in a final list of six key challenges. First, however, the main identified challenges to entrepreneurship (Section 3.1) and renewable energy uptake (Section 3.2) in developing countries are presented separately.

3. Review of challenges identified by previous research

The entrepreneurship and renewable energy literatures have developed steadily and independently over the years. The key findings from each of these literatures are therefore explained independently first (Sections 3.1 and 3.2), and then jointly (in Section 4), so as to highlight the commonalities that are pertinent to renewable energy entrepreneurs in developing countries.

3.1. Entrepreneurship challenges

Challenges that have been identified as being influential on entrepreneurial action in developing countries include poor provision and access to formal finance and credit [26,29], lack of investor protection [26], the provision and effectiveness of government regulations and incentive programs [27,30], political stability [31], access to information or education on how to start a new business [29,30,32], supply and demand [33], technical and infrastructural limitations [31] and factors influencing institutional integrity, such as corruption [29,34]. Indeed, the entrepreneur’s ability to identify and exploit opportunities is strongly influenced by the challenges faced [35–38]. Researchers such as Busenitz et al., Van Burg et al. and Katila and Shane argue that institutional constraints are of particular concern [30,33,39,40], as entrepreneurs in developing countries face far more constraints than others [17,18]. Indeed, Child and Tsai [17] and Zhou and van Witteloostuijn [181] confirm that businesses in developing economies tend to experience significant government and political involvement in their affairs [17,18].

The Global Entrepreneurship Monitor (GEM) has also identified nine Entrepreneurial Framework Conditions (EFCs) that affect the quantity and quality of entrepreneurship activity at the national level: education and training, entrepreneurial culture and respect for entrepreneurs, government regulations, government programmes and commercial, legal infrastructure, market dynamics, R&D transfer, government policy, physical infrastructure and finance [41,42]. There is some consistency between the GEM EFCs and the literature. Table 1 provides an overview.

Financial challenges consistently featured in the entrepreneurship literature. The main issues are, as shown in Table 1, the non-existence or ineffectiveness of institutions that provide formal financing options to entrepreneurs [43–46], and the difficulty faced when trying to access credit [43,44,47,48]. In particular, the lack of access to credit has been viewed as a major challenge to entrepreneurs in developing countries. The World Bank has highlighted the availability and knowledge of credit facilities and overall investor attractiveness as crucial determinants of entrepreneurial activity in sub-Saharan Africa in particular [26].
Physical or technical challenges refer to the infrastructure, technology and support provided and managed by external entities, such as government and utilities [41,49]. Physical infrastructure such as utilities, information and communication technologies, and transportation and logistics infrastructure have been found wanting in sub-Saharan Africa [27]. Yet, despite their importance for the successful running of businesses [20,50], Levine and Autio surmise such challenges have “received less attention from entrepreneurship researchers” [41]. In the same paper, they also argue that the entrepreneur may also be affected by knowledge-related challenges such as lack of access to information on how to start a business [27,41], as well as, for technology entrepreneurs, the knowledge deficits that may be caused by a lack of R&D transfer [41]. Nepal conducted research in Nepal [51], Boris Urban’s research focused on South Africa [52], and the work of Beeka and Rimmington spanned across the African region [53] – these researchers all found the lack of knowledge about starting a business to be an important issue.

Demand for the product or service offered by entrepreneurs is another challenge. Christensen and Bower (1996) argued that factors such as high production costs may increase the market price of the product or service, reducing its attractiveness on the market [54,55]. On the other hand, it has more recently been argued by Parthan et al., and illustrated in the IEA/IRENA Joint Policies and Measures Database, that government subsidies may help alleviate this [93,94]. However, as shown in Table 1, governance challenges are yet another issue faced by entrepreneurs. Here, the main constraints faced are a lack of government policies and incentives for entrepreneurship, as well as failure to enforce such policies [19,21]. Busenitz et al. [39] investigated the relationship between certain country characteristics and types or amounts of entrepreneurial activity, in particular the effects and extent of local norms on entrepreneurship. In so doing, they developed a Country Institutional Profile (CIP) framework that may be of interest to renewable energy researchers interested in the relationship between specific institutional or country-level entrepreneurship parameters and various renewable energy factors. Normative challenges addressed in the literature include the extent to which general society has a positive view of entrepreneurship [27,42,52,56,57], and whether entrepreneurial activity matches both the formal [58] and informal [58,59] norms and rules of the society. At the country level, the annual GEM surveys investigate general societal perspectives of entrepreneurship. The focus is on the extent to which social and cultural norms encourage or allow entrepreneurship [27].

### Table 1

<table>
<thead>
<tr>
<th>Entrepreneurship challenges</th>
<th>Examples of author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial challenges</strong></td>
<td></td>
</tr>
<tr>
<td>Poor provision and access to formal finance</td>
<td>(Bianchi [43]; deMel et al. [44]; Kerr and Nanda [45]; Van Auken, [46])</td>
</tr>
<tr>
<td>Accessing credit</td>
<td>(Bianchi, [43]; deMel et al. [44]; Kim [47]; Parker [48])</td>
</tr>
<tr>
<td><strong>Physical/Technical challenges</strong></td>
<td></td>
</tr>
<tr>
<td>Technical/infrastructure constraints</td>
<td>(Amoros and Bosma [27]; Levine and Autio [41]; Mambula [49]; Stel [19])</td>
</tr>
<tr>
<td>Challenges affecting demand</td>
<td>(Sirdeshmukh et al. [110]; Van Burg et al. [33]; Vos et al. [132])</td>
</tr>
<tr>
<td>Unfavourable market dynamics (incl. lack of opportunities) and industry structure</td>
<td>(Levie and Autio [41]; Reynolds et al. [42]; Khoury and Prasad [123])</td>
</tr>
<tr>
<td><strong>Knowledge-based challenges</strong></td>
<td></td>
</tr>
<tr>
<td>Lack of R&amp;D Transfer</td>
<td>(Levie and Autio [41]; Reynolds et al. [42])</td>
</tr>
<tr>
<td>Lack of access to information/education on starting a business</td>
<td>(Beeka and Rimmington [53]; Nepal [51]; Urban [52])</td>
</tr>
<tr>
<td><strong>Governance challenges/Institutional voids</strong></td>
<td></td>
</tr>
<tr>
<td>Lack of policy, legislative and tax incentives</td>
<td>(Ardagna and Lusardi [115]; Baumol [56,114]; De Castro et al. [122]; Mullainathan and Schnabi [116]; Urban [52])</td>
</tr>
<tr>
<td>Lack of enforcement: property rights, contracts, etc.</td>
<td>(Mair and Marti [21]; Smallbone and Welter [131]; Stel [19])</td>
</tr>
<tr>
<td><strong>Normative challenges</strong></td>
<td></td>
</tr>
<tr>
<td>Field-specific standards (formal)</td>
<td>(Desa [58])</td>
</tr>
<tr>
<td>Norms and rules (informal)</td>
<td>(Desa [58]; Giné et al. [59]; Powell and Di Maggio [129])</td>
</tr>
<tr>
<td>Lack of institutional integrity &amp; formality</td>
<td>(De Castro et al. [122]; Mullainathan and Schnabi [116]; Urban [52])</td>
</tr>
<tr>
<td>Lack of cultural value and respect for entrepreneurship</td>
<td>(Amoros and Bosma [27]; Baumol [52]; Davidson and Wiklund [57]; Reynolds et al. [42]; Urban [52])</td>
</tr>
</tbody>
</table>

### 3.2. Renewable energy challenges

Table 2 summarises the challenges identified as being specific to renewable energy uptake in developing countries.

The lack of provision or access to finance, including the ease with which both renewable energy proponents and end-users can access credit, has been highlighted by researchers as the main challenge to the uptake of renewable energy technologies. Also, the prevailing institutional conditions in developing countries do not consider the needs of investors. Research has shown that private investment in renewable energy is affected by many factors that are not specifically addressed by policy [60–62]; for example, perceived risks [63,64] and unattractiveness of the business strategies employed by new market entrants [65–67]. It has been argued that renewable energy policies in developing countries need to target, specifically, a reduction of the risks involved in using renewable energy instead of institutionally established fossil fuels. It is indeed challenging to develop mutually agreed upon policies that make fossil energies less attractive and financially feasible.

The dominance of fossil fuel incumbents and their supporting institutional/governance structures is therefore another important constraint. Obstacles to improving the uptake of renewable energy technologies, such as infrastructural, logistical and cost-efficacy problems related to upscaling/expanding demonstration projects [68] and the lack of attention paid to increasing demand by setting up and developing end-user markets [22,69], are related to the overarching institutional challenge of the legitimacy and lock-in of incumbent fossil fuel technologies [23,70,71]. The work of Berg, Pietzner, Volkmann, and Fischdeich [60], Jackson [72], Kliemann, Held, Rathmann, and Ragwitz [73], Walsh [67] and Balachandra et al. [74], for example, all emphasize the importance of improving the policy environment in order to provide a more enabling environment for the uptake of renewable energy technologies.

Developing countries represent a context with a particularly unsupportive institutional environment. This means that proponents and agents of renewable energy are not only faced with challenges related to the uptake of renewable energy technologies,
but also the same institutional challenges faced by entrepreneurs in general. The challenges related to increasing the uptake of renewable energy technologies (Table 2) have therefore been combined with the institutional challenges faced by entrepreneurs in general (Table 1). The following section (Section 4) presents a synopsis of the main findings from the literature on the main challenges faced by renewable energy entrepreneurs in developing countries.

### 4. Renewable energy entrepreneurship challenges in developing countries

The individual challenges found in the separated literatures on renewable energy and entrepreneurship were combined. That is, the challenges faced by entrepreneurs (highlighted in Table 1) were compared to and consolidated with the challenges to the uptake of renewable energy technologies (highlighted in Table 2). This section presents some of the suggested solutions for overcoming these challenges. Challenges related to lack of maturity and the slow diffusion of renewable energy technologies were not included in the following synopsis because, as explained in Section 1, such challenges are considered the reason that entrepreneurial intervention is needed to accelerate the uptake of renewable energy technologies in developing countries.

In summary, the literature shows that some of the most common challenges constraining renewable energy entrepreneurship in developing countries include inadequate access to institutional finance, relatively high prices, lack of skilled labour, underdeveloped physical infrastructure, inadequate government or policy support and the presence and power of incumbents. These are the main groupings that have been found in the literature, as shown in Table 3.

The findings are in line with expectations. However, they provide a useful framework for systematising and understanding the challenges faced. They also reveal substantial opportunities for future research.

#### 4.1. Inadequate access to institutional finance

The inaccessibility of institutional or regulated finance is a major issue in developing countries. In terms of solutions for overcoming this challenge, two broad research themes recur: the nature of renewable energy investment in various countries [65,66,75] and the advancement and utility of venture capital (VC) and private sector investments compared to tapping into public funds [28,60,67,74,76,77]. Particularly in the European Union (EU) between 1990 and 2005, the major role of the government has been as a facilitator of international private sector involvement in renewable energies [74], not as a major investor itself. This approach is compared to the situation in developing countries where governments’ intervention (or lack thereof) may directly intervene in renewable energy business affairs [17,18]. International development pressures have pushed such governments to directly invest in renewable energy, rather than simply facilitating and encouraging the interest and investment of the private sector, as is the case in the EU.

Recognising the tension between public and private financiers of renewables, Atabi and Gboney suggest that the EU’s approach is a model that could be successfully adopted by developing countries [78,79]. Balachandra et al. and Atabi both argue that in developing countries, public-private funding and incentive partnerships are likely to be more effective than relying solely on private VC initiatives [67,74,78]. Indeed, the downstream renewable energy sector is more decentralised and service-oriented, and is heavily reliant on private sector investment [25,80]. In the unique case of developing countries however, where public institutions are better suited to facilitating rather than providing funding, and where stock and bond markets and VC are still not adequately established to provide large-scale funding [81], tapping into private investment may not be as effective and sustainable as it has been in Europe.

Joint public-private or bi- or multi-laterally funded renewable energy initiatives such as Grameen Bank (India), Illumination Solar (Tanzania), Lighting Vanuatu (Vanuatu) and various World Bank-funded rural electrification and solar home projects [82,83] have had some success. Therefore, as Brunschwiler and Reddy et al. suggest, public-private partnership-type funding, particularly those that rely on international bi- or multi-lateral funding, may better facilitate the uptake of renewable energies in developing countries [81,84]. Indeed, Koch and Caradonna (2006) suggest that in general any kind of partnership (whether strategic, franchising or otherwise) may be preferable to venturing alone [85]. As suggested by Sklarew, the policy models adopted by China and India, which have had some success in strategically opening their local markets to external investment [86], may support this suggestion.

In particular, international development organisations have become important providers of grant assistance for the development
<table>
<thead>
<tr>
<th>Challenges</th>
<th>Entrepreneurship challenges</th>
<th>Examples of author(s)</th>
<th>Renewable energy challenges</th>
<th>Examples of author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate access to institutional finance</td>
<td>Securing investor/financier interest</td>
<td>X</td>
<td>(Brunnschweiler [81]; Dinica [88]; Foster-Pedley and Hertzog [75]; Loock [65]; Randjelovic et al. [77])</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor provision &amp; access to formal finance</td>
<td>X</td>
<td>(Bianchi [43]; deMel et al. [44]; Kerr and Nanda [45]; Van Auers [46])</td>
<td>(Lüdeke-Freund and Loock [66]; Nepal [51])</td>
</tr>
<tr>
<td></td>
<td>Accessing credit</td>
<td>X</td>
<td>(Brunchi [43]; deMel et al. [44]; Kim [47]; Parker [48])</td>
<td></td>
</tr>
<tr>
<td>Price of technologies</td>
<td>Inability to compete with fossil energy (service) providers on price, so no market</td>
<td>X</td>
<td>(Sirdeshmukh et al. [130]; Van Burg et al. [33]; Voss et al. [132])</td>
<td>(Arinaitwe [91]; Aslani and Mohaghar [90]; Foster-Pedley and Hertzog [75]; Kirchgeorg and Winn [92]; Martinot [83]; Balachandra et al. [74]; Linnanen [126]; Negro et al. [128]; Rady [107]; Yunus and Jolis [133])</td>
</tr>
<tr>
<td></td>
<td>Lack of R&amp;D transfer</td>
<td>X</td>
<td>(Levie and Autio [41]; Reynolds et al. [42])</td>
<td></td>
</tr>
<tr>
<td>Lack of skilled labour</td>
<td>Lack of capability/human resources (education, know-how &amp; training)</td>
<td>X</td>
<td>(Beeka and Rimmington [53]; Levy and Autio [41]; Nepal [51]; Reynolds et al. [42]; Urban [52])</td>
<td>(Aslani and Mohaghar [90]; Martinot et al. [82]; Nepal [51]; Painuly [100]; Reddy and Painuly [98])</td>
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<td></td>
<td>Lack of cultural value and respect for entrepreneurship</td>
<td>X</td>
<td>(Amoros and Bosma [27]; Baumol [56]; Davidsson and Wildlund [57]; Reynolds et al. [42]; Urban [52])</td>
<td></td>
</tr>
<tr>
<td>Underdeveloped physical infrastructure &amp; logistics</td>
<td>Grid distribution, preparedness &amp; stability</td>
<td>X</td>
<td></td>
<td>(Mahama [103]; Mohammed et al. [127]; Rady [107]; Reddy and Painuly [98]; Schmidt et al. [25])</td>
</tr>
<tr>
<td></td>
<td>Technical/infrastructure constraints</td>
<td>X</td>
<td>(Amoros and Bosma [27]; Levy and Autio [41]; Mambula [49]; Stel [19])</td>
<td></td>
</tr>
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<td></td>
<td>Installation sites</td>
<td>X</td>
<td></td>
<td>(Glemarec [106]; Mahama [103]; Mohammed et al. [127]; Rady [107])</td>
</tr>
<tr>
<td>Power of incumbents</td>
<td>Tension with fossil energy (service) providers</td>
<td>X</td>
<td></td>
<td>(Brunnschweiler [81]; Christensen et al. [14]; Kim [120]; Mohammed et al. [127]; Richter [110]; Schoettl and Lehmann-Ortega [11]; Smink et al. [109]; Wüstenhagen and Boehinke [16])</td>
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<td></td>
<td>Field-specific standards (formal)</td>
<td>X</td>
<td>(Desa [58]; Desa [58]; DiMaggio and Powell, 1983; Giné et al. [59]; Powell and DiMaggio [129])</td>
<td>(Aslani and Mohaghar [90])</td>
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<td></td>
<td>Norms &amp; rules (informal)</td>
<td>X</td>
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<td>Inadequate government or policy support</td>
<td>Lack of policy, legislative and tax incentives</td>
<td>X</td>
<td>(Ardagna and Lusardi [115]; Baumel [56]; De Castro et al. [122]; Mullainathan and Schnabl [116]; Urban [52])</td>
<td>(Foster-Pedley and Hertzog [75]; Zydin et al. [24])</td>
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<td></td>
<td>Lack of enforcement: property rights, contracts, etc.</td>
<td>X</td>
<td>(Mair and Marti [21]; Smallbone and Welter [131]; Stel [19])</td>
<td>(Kim [120]; Lalic et al. [125]; Mohammed et al. [127]; Nepal [51]; Pinkse and Groots [121]; Smink et al. [109])</td>
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<td></td>
<td>Lack of institutional integrity &amp; formality</td>
<td>X</td>
<td>(De Castro et al. [122]; Mullainathan and Schnabl [116]; Urban [52])</td>
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<tr>
<td></td>
<td>Lack of government buy-in</td>
<td>X</td>
<td></td>
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<tr>
<td></td>
<td>Lack of access to information/education on starting a business</td>
<td>X</td>
<td>(Amoros and Bosma [27]; Beeka and Rimmington [53]; Levy and Autio [41]; Nepal [51]; Urban [52])</td>
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</table>
of renewable energy projects in developing countries [82,83,87]. The suggestion is that such partnerships and international development-related funding schemes are a solution to the rampant inability to access institutions-based funding locally, foster greater communication between all parties involved and encourage better discussion of all aspects of the venture, thus potentially producing the best result in terms of both business longevity and local sustainability [78,80,88,89].

4.2 Price of renewable energy technologies

Some of the most often-articulated barriers to the diffusion and uptake of renewable energies are related to the technologies’ inability to achieve economies of scale. Although this problem largely affects upstream activities along the renewable energy value chain [90], there are also considerable effects on downstream activities as the inability to achieve economies of scale greatly affects the cost and, by extension, grid parity of renewable energy technologies. Brunnswieker argues that challenges associated with the price of renewable energy technologies directly hinder downstream entrepreneurial players who provide end-user oriented services [81]. This is especially the case in developing countries where end-users’ inability to afford renewable energy products and services may have a crippling effect if alternative approaches are not found [90–92]. However, parts of the development literature (the World Bank and Martinot et al.) have argued that while this challenge may be addressed by incentives such as government subsidies, tax breaks and feed-in-tariffs (FIT) [93,94], these have mainly been effective in increasing interest from developed countries, rather than improving affordability in developing countries [80,82].

The first challenge to the renewable energy entrepreneur in a developing country without adequate cost-defraying policy incentives is therefore to develop business models that utilise innovative pricing and/or cost-offsetting strategies that benefit the end-user. Innovative strategies such as micro-financing and microlending, as well as alternatives to the conventional purchase model (such as technology leasing and fee-for-service (ESCO) models) are potential solutions [16,80,82,95]. Microfinancing and microlending, in particular, have been championed as examples of business model innovations that improve end-users’ ability to afford renewable energy technologies [82,96].

However, while the documentation of such strategies appears to be increasing, much of the research carried out in this regard consists of either review-type studies and general guidelines [16,80] or studies that focus simply on a single strategy [10,97]. What is therefore lacking are comprehensive empirically-motivated studies of how such strategies fit into the overall business models used by entrepreneurs, and national- or regional-level surveys of the effect of these strategies on entrepreneurial activity in developing countries.

4.3 Lack of skilled labour

Improving the affordability of renewable energy technologies may eventually increase the need for suitably skilled labour to support increasing service demands. The problem of the shortage of skilled persons in the renewable energy sector in developing countries has been specified by Reddy and Painuly and Martinot et al. as a shortage of skilled technical know-how [80,82,98], referring to those skills and knowledge levels that are specific and often unique to renewable energy technologies. Painuly and Alazraque-Cherni have noted a considerable lack of technical know-how in the areas of renewable energy installation, maintenance and repair in developing countries [82,90,99,100]. The end-user is not reasonably expected to possess the know-how necessary to maintain their own technologies, so the onus of servicing, maintenance, repair and part replacement is usually on the entrepreneur him/herself and his/her business [82,99]. Also, for a new business to grow, input from other individuals with similar skills is required. Yet this is a major challenge for entrepreneurs in developing countries [90,101].

A solution offered by the downstream market in many developed countries is either the re-training and subcontracting of already existing service providers such as electricians, roofers and plumbers to act as installers, or the outsourcing of such jobs [16,102]. However this solution is documented mostly in European markets, and whether similar solutions have been applied successfully in developing country contexts has yet to be answered empirically by the literature. In fact, the literature seems to focus mainly on strategies related to overall know-how transfer from developed countries [79,82] and China and India [86] as part of an indirect, short-term solution to the skill shortage problem. Research may therefore be needed to investigate this particular context. For renewable energy businesses in developing countries that do not use either existing artisans or outsourced labour, it may be useful to investigate whether entrepreneurs and their employees are being trained locally (and by whom). This would improve our understanding of the strategies used by entrepreneurs to overcome the skill shortage problem in developing countries.

4.4 Underdeveloped physical infrastructure and logistics

Kirchgeorg and Winn, and Samli identified inadequate infrastructure and issues associated with the distribution of goods as another challenge faced in developing countries [92,101]. Although the state of physical infrastructure in developing countries was generally rated positively by entrepreneurs in GEM’s 2013 report, there is still concern about the situation in sub-Saharan Africa [27]. Also, when viewed from the perspective of entrepreneurship, the issue of physical infrastructure becomes much more challenging as infrastructural issues surpass those associated with distribution and also include issues of installation [103].

In the particular case of developing countries, one of the major themes is the supply of renewable energies to rural areas, which are a target market for decentralised energy supply [80,103,104]. Decentralised supply has therefore been touted as perhaps the best means of advancing the uptake of renewable energies in developing countries, especially in remote rural areas [105–107]. Decentralised supply does not exclude the construction of one’s own infrastructure, but this is a strategy that seems to have been used exclusively by larger companies and development initiatives in developed countries [82,103].

An issue that has yet to be addressed, however, is the effect of geographical, political and trade barriers on renewable energy entrepreneurs’ ability to meet their logistical and import needs. For example, do landlocked African countries feature less renewable energy than coastal ones? Do government import taxes and duties (or lack thereof) impact the import routes taken, the exchange rates and currencies traded, and therefore the cost effectiveness with which entrepreneurs may import and distribute renewable energy technologies? Further research may be directed to addressing these issues in the near future.

4.5 Power of incumbents

To date, some of the main actors within the renewable energy system are incumbent utility providers and other existing large firms [108]. However, incumbent entities do not provide effective alternatives to the fossil-fired status quo and, as Smink et al. have
Compared to renewable energy start-ups however, utilities have more renewable energy technologies by investing in start-ups, as they are more flexible and adaptable [11]. This issue, however, has only been researched and discussed in the context of developed countries, and no studies have been found to date that highlight renewable energy businesses that have developed complementary partnerships with incumbent utilities. Such arrangements are theorised as being potentially advantageous to renewable energy entrepreneurs, as they may be able to take advantage of the utilities’ access to finance and their knowledge and control of existing infrastructure [11,16,78,84,85]. Additionally, the entrepreneur can then focus his/her business model on only the service aspects of the value chain, thereby improving the end-user strength of the business. Our understanding of renewable energy entrepreneurship activities in developing countries might therefore benefit from focusing on the dynamics of such partnerships [102], particularly from the perspective of the entrepreneur, rather than his/her utility partner.

Another newly addressed issue with potential for future research is the cultural acceptability of certain renewable energy technologies [111], as certain culture or community may disagree with, for example, the use of certain kinds of wastes as a source of energy, or the construction of wind turbines in their community. A 2007 special issue covers the many dimensions of this challenge, including community participation in decision-making, and the extent to which communities trust the investors bringing renewable energy to their locales. Also, the lack of cultural value and respect for entrepreneurs in certain cultures has potentially significant implications for renewable energy entrepreneurship in developing countries [27,42,52]. Particularly in societies where the good of the community is prioritised over individual benefit, starting a business of one’s own and venturing against the status quo may be discouraged. Under such circumstances, increasing the uptake of renewable energy technologies might rely more heavily on government or institutional support, or on individual entrepreneurs who must break from cultural norms in order to champion the increased uptake of renewables.

4.6. Inadequate government or policy support

A survey of 122 clean energy researchers and academics was conducted recently in order to gauge their perceptions of the biggest challenges to the uptake of renewable energy technologies. Lack of government policies emerged as the most important challenge faced; this challenge seemed to be especially important to respondents from developing countries in Asia and Africa [24]. In developing countries, some argue that the lack of institutional rigour and support poses a challenge to entrepreneurs [101,112,113] as it is suggested that government policy plays a key role in facilitating entrepreneurship and growth [114]. Conversely, it has also been argued that strict regulation curbs entrepreneurship, and that this is especially the case in developing countries [115,116]. It has been suggested that an entrepreneurship-enabling policy regime is the key ingredient for the accelerated uptake of renewable energy technologies [117]. Technology-oriented innovation policies that use a systemic approach are thought to be the most effective in facilitating the successful diffusion of renewable energy technologies [71,117–119]. However, it has been found that government support still tends to favour incumbents [24,120]. Renewable energy entrepreneurs therefore need to become politically active, as incumbent utilities and larger energy businesses do, in order to ensure they can influence the increased uptake of renewable energy technologies [109,121].

Lack of government support or policies is viewed as an overarching challenge in the literature as it can affect all other aspects of the renewable energy landscape, including education levels, state of physical infrastructure, and accessibility of institutional finance [30,32,52]. Together with price of renewable energy technologies and access to finance, government support and the need for enabling policies in developing countries were found to be the three most often cited challenges in the literature.

5. Conclusions and opportunities for future research

In this paper, renewable energy entrepreneurship has been used as a form of entrepreneurship concerned with the advancement and uptake of renewable energy technologies. Indeed, developing countries represent a context with particularly unsupportive conditions, which means that proponents of renewable energy are not only faced with challenges related to the uptake of renewable energy technologies, but also the same challenges faced by entrepreneurs in general. This research has therefore combined the challenges related to increasing the uptake of renewable energy technologies with the challenges faced by entrepreneurs in general. The result is a unified conceptualisation of the challenges that renewable energy entrepreneurs in developing countries may be facing. Organisations and programmes that try to encourage renewable energy innovation and development are often operating with limited budgets, particularly in developing countries. Therefore, an understanding of the challenges faced by renewable energy entrepreneurs, as well as the suggested means of overcoming them, may be useful in helping such organisations to better arrange and prioritise their efforts.

The preceding summation of the challenges that may be faced by renewable energy entrepreneurs in developing countries has relied on a considerable collection of research and development literature. Indeed, the extant renewable energy and entrepreneurship literatures have effectively identified and contextualised some of the lessons learned from existing start-ups and technology deployments in developing countries, as well as from conceptual analysis of the relevant issues in such countries.

However, conducting a review of the issues concerning renewable energy entrepreneurship in developing countries has also highlighted a number of opportunities for further work. These opportunities are illustrated in Table 3 by the lack of papers (denoted by no ‘x’) on five specific challenges to renewable energy entrepreneurship in developing countries. First, in terms of options for financing a renewable energy business, while existing research (see Kozloff [124], Brunnschweiler [81] and Larsen et al. (2012), for example) paints a vivid ‘big picture’ of the state of renewable energy investment, the effect of such trends on the individual renewable energy entrepreneur in developing countries has still largely been neglected by extant research. Indeed, focusing on the individual level is an area that would certainly add to our understanding of renewable energy entrepreneurship in developing countries. Who is the renewable energy entrepreneur? What are his/her motivations? Are renewable energy entrepreneurs mostly locals, or internationals with international knowledge or experience? How does this background affect his/her ability to access finance? Some research is needed to better understand the renewable energy entrepreneur him/herself in the context of the unique challenges faced in their different country and cultural contexts.

Second, much of the literature to date has focused on indirect strategies (e.g. policy incentives and unique business models) for
addressing the challenge of the price of renewable energy technologies and the purchasing power of end-users in developing countries. However, what may be lacking is a comprehensive assessment of more direct strategies, such as the marketing strategies used by renewable energy entrepreneurs in developing countries. That is, what are the unique selling points that renewable energy entrepreneurs should focus on? A marketing perspective of the business models used by renewable energy entrepreneurs in developing countries may prove useful for understanding the factors that may lead to successful renewable energy enterprise, and the unique needs, market position and market segmentation of end-users in developing countries.

A third avenue for future research is around the question of whether renewable energy entrepreneurs in developing countries have successfully adapted to, or avoided, competition from incumbent utilities and other larger energy providers. (How) have renewable energy entrepreneurs in developing countries partnered with incumbent utilities? A typology and characterisation of the relationships between renewable energy entrepreneurs (and small businesses) and incumbent utilities would improve our understanding of whether such partnerships have had any success in developing countries. Even further, a study comparing the understanding of whether such partnerships have had any success in renewable energy entrepreneurs in developing countries may prove useful for understanding the factors that may lead to successful renewable energy enterprise, and the unique needs, market position and market segmentation of end-users in developing countries.

The informal norms and rules in particular developing country contexts can indeed influence whether and how renewable energy stakeholders choose to embark on entrepreneurship. It may therefore also be useful to gain a better understanding of the effect of a lack of value and respect for entrepreneurs on renewable energy entrepreneurship. Are renewable energy stakeholders in such contexts interested in entrepreneurship, and do they have access to information on how to start a business? What skills do they possess, and how can they be leveraged to start and manage a successful renewable energy business?

Finally, it was found that policy and government support is treated as an overarching challenge for renewable energy uptake and entrepreneurship in developing countries. However, such issues have not been addressed exhaustively, as there may be room for future research that focuses on how suggested policies might be effectively enforced, and the role of integrity and corruption in renewable energy governance in developing countries.

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