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How do developing country constraints affect renewable energy entrepreneurs?

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ABSTRACT

Renewable energy entrepreneurs in developing countries are selling and facilitating the uptake of a new technology and new ideas in an already difficult environment. We explore entrepreneurs' perceptions of the constraints they face while operating their businesses. We used two stages of analysis — primary data from individual entrepreneurs and country level secondary data. The primary data included in-depth interviews with entrepreneurs, as well as their self-ranking of constraints via a questionnaire. Findings emphasised the importance of government/regulatory and local market constraints. To contextualise these findings, we compared the individual-level findings to country-level conditions to assess whether they have any bearing on the entrepreneurs' perceptions of constraints. Country conditions may influence the entrepreneurs' perceptions of the demand for their products and/or services, and their opportunity and ability to supply these to customers. These may be influencing whether and how the entrepreneurs perceive and respond to opportunities to carry on with their renewable energy businesses.

Introduction

Facilitating entrepreneurship has been touted as an important vehicle for promoting energy for sustainable development in developing countries (Reddy and Balachandra, 2006; Kooijman-van Dijk and Clancy, 2010; Vidican et al., 2012). But, being an entrepreneur is hard. Being an entrepreneur in a developing country is, arguably, even harder. Indeed, entrepreneurs in developing countries are no strangers to constraint. They face many obstacles to starting and running their businesses (see Amine and Staub, 2009; Antonites and Mungoni, 2011; Acheampong and Esposito, 2014; WorldBank and IFC, 2012). Yet, such countries have among the world's highest entrepreneurship rates (Xavier et al., 2012), and infrastructure and other support for start-up firms is improving (Radelet, 2010; Roxburgh et al., 2010; WorldBank and IFC, 2013). Many developing countries are considered factor-driven economies, characterised in the 2015/2016 Global Entrepreneurship Monitor as comprising mostly of subsistence enterprises, and a heavy reliance on unskilled labour (Kelley et al., 2016). In particular, the countries of sub-Saharan Africa are reported to have the highest proportion of early-stage entrepreneurial activity motivated by necessity, rather than opportunity (Kelley et al., 2012, 2016). Given these prevailing conditions, how, then, do entrepreneurs whose livelihoods are built around a new, advanced technology and service industry, requiring highly skilled labour and technical knowledge, such as renewable energy, cope?

For the purpose of this research, we have derived a working definition of renewable energy entrepreneurship as the starting up, running and (potentially) growth of a new business venture (Walley et al., 2010) that focuses on the development, design, production and distribution of renewable energy, as well as renewable energy systems and technologies, including all aspects of the renewable energy value chain, comprising planning, consulting, financing, installation, maintenance and end of life management or disposal. Therefore, our definition of renewable energy entrepreneur (REE) represents a person who has started and owns a renewable energy business.

This paper explores the constraints and challenges faced by REEs in developing countries, focusing on the individual viewpoints of 42 such entrepreneurs in 28 developing countries. Building on previous work identifying entrepreneurship as a key driving force behind the development of the renewable energy industry in developing countries (Balachandra, 2011; Balachandra et al., 2010; Gabriel and Kirkwood, 2016), we ask the following questions:

(1) How do REEs in developing countries perceive the importance of the constraints they face?
(2) How are the REEs dealing with these constraints?

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This enabled us to get a better understanding of the effect of regional constraints on entrepreneurial actions. The focus of our interviews was a discussion of one key aspect of the renewable energy institutional environment: challenges, specifically the constraints that the entrepreneurs view as restricting them. Thus, the paper starts with a brief outline of the literature in the area of seven key constraints. The material and methods used are presented next. Our findings and discussion then contribute to existing discussion and research in two ways. Firstly, we discuss implications for developing countries; our findings reveal logistical and strategic insights for nascent entrepreneurs in developing countries and for stakeholders interested in the role of entrepreneurship in improving the uptake of renewable energy technologies in these countries. Secondly, we contribute to ongoing discussions of the challenges and implications of doing business in countries characterised by necessity-motivated entrepreneurship.

Literature review

Basic dictionary definitions of the word 'constraint' describe it as something that limits or restricts and, conventionally, the use of the notion of constraint has had negative connotations. Scholarly research on constraint in management and organisation, as well as the literature on renewable energy constraints, is no exception and scholars have contemporarily focused their efforts on addressing and minimising the negative effects of constraints (see Gibbert et al., 2014; Pinkse and Kolk, 2007; Rao and Drazin, 2002). However, focusing on the ability of constraints to ruin a business or venture does not account for the mounting evidence to suggest that many firms (particularly new ones) find promising opportunities and survive (Baker and Nelson, 2005; Gibbert and Scranton, 2009; Katila and Shane, 2005; Van Burg et al., 2012), or even prosper (Xheneti and Bartlett, 2012), under highly constraining conditions. It is with this failing in the logic of the argument that constraint is bad that the entrepreneurship literature has taken issue. Indeed, from an entrepreneurship perspective, it has been suggested that constraints play a dual role, as they both hinder and help the process of venture formation and growth (Baker and Nelson, 2005; Gibbert et al., 2007; Katila and Shane, 2005; Sarasvathy, 2001, 2004; Senyard et al., 2014).

Developing regions are consistently reported to be regions of factor-driven economies where entrepreneurs are characterised as being motivated by necessity, rather than opportunity, due to the constraining institutional environment (Kelley et al., 2012, 2016). We therefore focus on the idea that entrepreneurial action is influenced by institutional constraints (Busenitz et al., 2000; Casero et al., 2013; Katila and Shane, 2005; Van Burg et al., 2012).

The setting in developing countries

Research focusing on developing regions has found institutional conditions to be unfavourable or constraining for entrepreneurship and business in general (Bruton et al., 2013; Manolova et al., 2008; West et al., 2008; Ault and Spicer, 2013). Such constraining conditions include corruption and poor legal structures (Adomako and Danso, 2014; Gupta et al., 2014), weak property rights (Herrera-Echeverri et al., 2014), and lack of access to information or education about how to start a new business (Baumol et al., 2009; Casero et al., 2013). In many developing countries, the current fossil fuel-dominated system acts as a hindering force with respect to the uptake of renewable energy technologies (RETs) (Chendo, 1994; UNEP, 2012). Unlike many other parts of the world, though, such countries have unsupportive legal, institutional and market frameworks, which means that proponents and agents of renewable energy are faced with additional challenges with respect to stimulating and developing new institutional structures that are more supportive of RETs. In developing countries, some of the most common challenges constraining the uptake of RETs include inadequate access to institutional finance (Ernst and Young, 2011; Foster-Pedley and Hertzog, 2006), low demand (Martinot et al., 2002), relatively high prices (WorldBank, 2008; Wüstenhagen and Boehnke, 2008), lack of skilled labour (Alazraque-Cherni, 2008; Reddy and Painuly, 2004), underdeveloped physical infrastructure (Glemarec, 2012; Monroy and Hernández, 2008), inadequate government or policy support (Gboney, 2009; UNEP and Bloomberg, 2016), and the presence and power of incumbents (UNEP, 2012).

Of the 189 countries included in the International Finance Corporation's (IFC) 2013 ranking of the ease of doing business, sub-Saharan African countries fared extremely poorly, with an average ranking of 140 and characterisation as having weak legal institutions and complex regulatory processes (WorldBank and IFC, 2013). Indeed, the developing countries[1] that represent the home bases of the entrepreneurs in this study generally received low rankings in the World Bank's latest ease of doing business index: Barbados (119), Belize (120), Cambodia (127), Cameroon (172), Chile (48), Costa Rica (58), Ecuador (117), Ethiopia (146), Fiji (88), Ghana (114), Guatemala (81), India (130), Indonesia (109), Kenya (108), Lao PDR (134), Nigeria (169), Panama (69), Papua New Guinea (145), Philippines (103), Senegal (153), South Africa (73), Tanzania (139), Thailand (49), Tonga (78), Trinidad and Tobago (88), Uganda (122) and Zambia (97) (WorldBank, 2016a). The only exceptions were Somalia (which was not included in the ranking) and some newly emerging Latin American countries, where business infrastructure and other conditions are improving noticeably (WorldBank, 2016a). Based on the literature, seven key constraints were identified as potentially affecting REEs in developing countries. Each of these is discussed in turn in the following section.

Key constraints

Seven constraints were identified as key to REEs' success (or, conversely, failure) in developing countries: *Inadequate or inappropriate government or policy support*, *Inadequate local demand*, *Price of RETs*, *Inadequate access to institutional finance*, *Lack of skilled labour*, *Underdeveloped physical infrastructure and logistics* and *Power of incumbents* (*existing players on the energy market*). Our categorisation of findings from the literature into seven challenges was strongly influenced by Gabriel's (2016) review, which presented the findings from a qualitative meta-analysis of the renewable energy and management/entrepreneurship literatures on constraint in developing countries. At the start of our study, we approached participants with these seven challenges with a view to confirming whether they were also important to these entrepreneurs, and uncovering any other challenges we might have missed.

Researchers in developing countries have found that government and public entities have direct involvement in the affairs of local business people (Child and Tsai, 2005; Ince et al., 2016; Zhou and van Witteloostuijn, 2010). This is especially the case for renewable energy businesses, as this new and emerging technology has been the focus of a considerable amount of international aid and assistance (Dornan and Shah, 2016; Martinot, 2001; Martinot et al., 2002). While indeed this has helped, some (such as Dornan and Shah, 2016 for example) consider this kind of government intervention as stifling to the natural growth and uptake of RETs in developing countries. It has been argued that, in order to ensure that the uptake of RETs in such countries is lasting and sustainable, efforts must be made to ensure that the right market incentives (Rickerson et al., 2013) and business models (Aslani and Mohaghar, 2013; Gabriel and Kirkwood, 2016; Wüstenhagen and Boehnke, 2008) are encouraged. Badly planned or unmeasured public

[1] It should be noted that the sample of entrepreneurs for this study was based on their doing business in countries we characterised as 'developing countries'. We referred to the countries listed in 'Table E' (list of "emerging and developing economies") in the International Monetary Fund's (IMF) 2012 World Economic Outlook (WEO) Report (IMF, 2012) pp. 182–183 when making this distinction.

sector intervention is therefore perceived as one of the barriers in the drive towards RET uptake in developing countries. Another criticism of the government/public sector's role in RET uptake is the lack or fragmentation of supporting policies (Aslani and Mohaghar, 2013; Gboney, 2009; Sovacool, 2013). When coupled with a lack of enforcement and corruption monitoring (Engelken et al., 2016) and attention paid to measuring the outcomes of such policies (Chang et al., 2016; Urmee and Md, 2016), the literature presents a strong case for the inclusion of *Inadequate or inappropriate government or policy support* as one of the seven key constraints faced by renewable energy entrepreneurs in developing countries.

Public institutions have also been found to play a key role in the availability and access to entrepreneurial resources, including finance (Ardagna and Lusardi, 2010; Doblinger et al., 2016). Indeed, many researchers report the need for innovative financing and credit schemes and attracting dedicated local and international capital (see Newman et al., 2014; Nepal, 2012; Kimura et al., 2016 for example) for businesses in developing countries. For renewable energy entrepreneurs, the issue may be threefold: (1) finance for a business based on a technology that is less understood and accepted locally (Kardooni et al., 2016; Wüstenhagen et al., 2007), (2) finance for entrepreneurs who themselves may not meet local criteria for accessing credit (Naudé et al., 2008; Sovacool, 2013), and (3) finance and local investor interest and risk averseness to business start-ups and ventures in developing countries (Chirambo, 2016; Giovannetti and Ticci, 2012; González-Pernía et al., 2015; Vidican et al., 2012). The immense amount of attention paid to this issue in various disciplines (for example in the business and management (González-Pernía et al., 2015; Naudé et al., 2008), renewable energy technology (Chirambo, 2016; Kimura et al., 2016), and development and economic (Brunnschweiler, 2010; Dumas et al., 2016) literatures) reflects the inadequacy of the institutionalised support available in developing country contexts. *Inadequate access to institutional finance* has therefore been included as the second nominated constraint presented to the entrepreneurs in this study.

The third and fourth constraints we included in our interviews with developing country renewable energy entrepreneurs are *Inadequate local demand* and the *Price of RETs*. The literature on constraints faced by renewable energy businesses in developing countries largely refers to these constraints interchangeably. This is because the issue of a lack of demand for RETs in developing countries has been tied to the inability of end-users in such countries to afford them (see Sovacool, 2013; Kardooni et al., 2016; Reddy, 2015; Nepal, 2012 for example). In developing countries where the renewable energy market is already strained by inadequate or inappropriate cost-defraying policies, renewable energy entrepreneurs are likely to face the challenge of offering products and services that end-users, generally, cannot afford (Sovacool, 2013; Urpelainen and Yoon, 2015). Indeed, Brunnschweiler (2010) has argued that the constraint of price of RETs has a direct effect on entrepreneurs, particularly technology distributors, whose businesses rely on the ability and willingness of end-users to purchase renewable energy products (Brunnschweiler, 2010; Gabriel and Kirkwood, 2016). Yet, Gabriel's (2016) distillation of the literature paints these two constraints as being separate and independent of each other. We tend to agree with the separation of these two issues, as there are distinctly different theorised causes of these constraints.

Theorised reasons for RETs being unaffordable for end-users in developing countries could include generally low income and capability levels (refer to Ansari et al., 2012; Martinot et al., 2002; Sovacool, 2013) and the resistance or inability of RET innovators and distributors to adopt Base of Pyramid (BoP) appropriate business and credit models (see Balachandra, 2011; Nepal, 2012; Kimura et al., 2016 for example). On the other hand, the suggested causes of insufficient demand include lack of knowledge and understanding of RETs (see Balachandra et al., 2010; Vidican et al., 2012; Kardooni et al., 2016 for example) and the ubiquity (and perceived greater affordability) of incumbent fossil fuel generated energy (Beck and Martinot, 2004; Vidican et al., 2012). Both issues place renewable energy entrepreneurs in developing countries in a catch-22 situation: though indeed price may be seen as one of the reasons for lack of demand and slow uptake in the region, insufficient demand may also be seen as a reason that RET businesses are unable to offer RETs at lower prices without affecting their profit margins. Indeed, there have been suggestions that microfinancing, rental or fee-for-service (ESCO) models, for example, are potential solutions to both issues (Martinot et al., 2001; Sovacool, 2013; WorldBank, 2008; Wüstenhagen and Boehnke, 2008; Yaqoot et al., 2014). In order to better understand these issues, we have included *Inadequate local demand* and the *Price of RETs* as two of the seven key constraints faced by renewable energy entrepreneurs in developing countries.

There appears to be a shortage of skilled technical know-how (Martinot et al., 2001; Reddy and Painuly, 2004; WorldBank, 2008) in the renewable energy sector in developing countries (Martinot et al., 2001; Reddy and Painuly, 2004). Such skills are those that are specific to RETs. In particular, RET installation, maintenance and repair activities appear to be the most affected by these skill shortages (Alazraque-Cherni, 2008; Aslani and Mohaghar, 2013; Martinot et al., 2001; Painuly, 2001). This affects the renewable energy entrepreneurs in these countries, as they are expected to provide full-service offerings to their customers, ensuring that all of their after-sales needs are met (Alazraque-Cherni, 2008; Martinot et al., 2001). The result is that the entrepreneurs themselves become the only or main authority on the subject in their respective locales. Indeed, renewable energy knowledge seems to be less widespread in these contexts (see Kardooni et al., 2016; Sovacool, 2013 for example). Also, it appears that end-users in developing countries have generally not been given adequate or appropriate education to be able to make informed decisions about whether and how they should use and maintain RETs (Sovacool, 2013). Finally, findings from the International Renewable Energy Agency (IRENA) suggest a need for strategies to increase the proportion of developing country labour force employed in the RET sector (IRENA, 2016). Therefore, it has been concluded that *Lack of skilled labour* is potentially one of the seven key constraints faced by REEs in developing countries.

Yet another constraint faced in developing countries is the inadequacy or inappropriateness of the existing infrastructure to accommodate RETs (Kirchgeorg and Winn, 2006; Samli, 2009; Urmee et al., 2009; Urmee and Md, 2016). 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 transport and also include issues of installation and grid access (Mahama, 2012; Szakonyi and Urpelainen, 2015). The latest World Bank data suggest that considerable investment has been made in the development of local renewable energy and electricity infrastructure in developing countries (UNEP and Bloomberg, 2016; WorldBank, 2016b), and the Global Entrepreneurship Monitor's (GEM) latest reports (Amoros and Bosma, 2013; Kelley et al., 2016) claim that physical infrastructure has generally been rated positively by business entities in developing countries. However, there is still concern about the situation in some regions, especially sub-Saharan Africa (Chirambo, 2016). Furthermore, there is concern that current designs and distribution modes for RETs now accepted in developed countries are incompatible with the distribution and use needs of end-users in developing countries (Urmee and Md, 2016; WorldBank, 2008), particularly in remote regions (Hillig, 2016; Sovacool, 2012). Indeed, the remoteness of many regions in need of RETs is a logistical concern, but is also an identified and well-established area of opportunity (Engelken et al., 2016; Gabriel and Kirkwood, 2016). *Underdeveloped physical infrastructure and logistics* is therefore identified as one of the seven key constraints faced by REEs in developing countries.

Despite recorded efforts to increase the diversity and number of businesses and other entities involved in renewable energy locally, besides local policymakers, some of the main actors within the renewable energy system in developing countries are still incumbent utilities

and other existing large infrastructure and international energy firms (Ince et al., 2016; Richter, 2012). The combined experiences and networks of market incumbents build up over time and contribute to their attainment of legitimacy within local markets (Hall et al., 2010; Hockerts and Wüstenhagen, 2010). That these businesses and organisations are already established in the market poses a challenge for new entrants – that is, entrepreneurs entering the market – particularly if the product or service being offered has not yet been fully accepted by the market (as claimed by Balachandra et al., 2010; Vidican et al., 2012; Kardooni et al., 2016 for example). For REEs, the power of existing players in the energy market (e.g. other renewable energy businesses, existing utilities and fossil fuel businesses) can be a barrier to the start-up and survival of a new venture, even in developed countries (Ince et al., 2016; Rommel et al., 2016). However, these incumbent actors are still not providing an adequate or effective alternative to the current fossil fuel system, and due to their size, longevity and establishment on local markets, they tend to be slow, resistant or unable to change (Christensen et al., 2012; Smink et al., 2013). On the other hand however, these same characteristics give these incumbents better access to finance and better ability to lobby for (or create) institutional support (Brunnschweiler, 2010; Painuly, 2001; Richter, 2012; Smink et al., 2013; Wüstenhagen and Boehnke, 2008). How, then, can entrepreneurs starting a new business and championing a relatively new technology in a market dominated by incumbent fossil fuel businesses compete, grow and survive? Consistent with the discussion of these issues in the extant literature, we have therefore included *Power of incumbents* (*existing players on the energy market*) as one of the seven nominated constraints presented to the entrepreneurs in this study.

Methods

A purposeful recruitment of profit-seeking[2] renewable energy entrepreneurs in developing countries formed the basis of our study. Participants were identified via systematic web-based searching for developing country entrepreneurs and/or their businesses,[3] relevant international organisations, as well as regional renewable energy-related associations. Collecting data via interviews did limit the level of participation somewhat, as it meant that we focused only on entrepreneurs who spoke English (the working language of the study's investigators), and that we were unable to secure the participation of very busy, high profile entrepreneurs who were unwilling or unable to commit to the time for the interview. Nonetheless, we considered interviews to be the best way to conduct this exploratory research, and to gain a fuller picture of the entrepreneurs' perceptions of constraint.

We also recognise the limitations of using a snowball approach to identify potential participants. That said, we did find that, after some time of asking businesspeople and participants for referrals, the same entrepreneurs and business names began to be repeated on a consistent basis. As renewable energy is an emerging and niche market in these countries, we believe that the 122 entrepreneurs from across the region that were invited to participate in the study comprised strong representation from across the industry. Of the 122 entrepreneurs contacted via email and invited to participate in the study, 42 agreed to participate in our survey and be interviewed. These participants and their businesses represent 28 developing countries. The mean number of people employed by each of the 42 entrepreneurial ventures was 17, including the entrepreneurs themselves. The main characteristics of the entrepreneurs and their businesses are summarised in Table 1.

Table 1
Main characteristics of the entrepreneurs and their businesses.

Participants	Territory	Years in business	No. of employees	Sex (m/f)	(Main) type of renewables
BBS01	Barbados	14	36	M	Solar
BZ01	Belize	2	3	M	Solar
CAM01	Cambodia	5	12	M	Solar
CHL01	Chile	3	6	M	Solar
CHL02	Chile	6	10	M	Biomass
CMN01	Cameroon	1.5	14	M	Solar
CMN02	Cameroon	1	3	F	Solar
CR01	Costa Rica	8	7	M	Solar
EC02	Ecuador	4	6	M	Solar
ETH01	Ethiopia	8	6	M	Biomass
ETH02	Ethiopia	1.5	2	M	Solar
FJ01	Fiji	15	17	M	Solar
FJ02	Fiji	7	18	M	Solar
GH01	Ghana	15	6	M	Solar
GH02	Ghana	7	3	M	Solar
GUA01	Guatemala	3	20	M	Solar
INA01	Indonesia	3	5	M	Wind
INA02	Indonesia	20	42	M	Hydro
IND01	India	18	224[a]	M	Solar
IND02	India	3	4	M	Solar
IND03	India	12	5	M	Solar
KE01	Kenya	3	6	M	Solar
KE02	Kenya	3	3	M	Solar
KE03	Kenya	13	9	M	Solar
LA01	Lao PDR	12	41	M	Solar
NIG01	Nigeria	16	10	M	Solar
NIG02	Nigeria	7	13	M	Solar
PAN01	Panama	2	6	M	Solar
PH01	Philippines	6	15	M	Solar
PNG01	Papua New Guinea	4	1	M	Solar
SA01	South Africa	2	2	M	Solar
SEN01	Senegal	8	12	M	Solar
SOM01	Somaliland	1	6	M	Solar
TLD01	Thailand	5	90	M	Solar
TLD02	Thailand	9	11	M	Solar
TON01	Tonga	0	1	M	Solar
TT01	Trinidad and Tobago	5	1	M	Solar
TZ01	Tanzania	4	4	M	Solar
TZ02	Tanzania	7	14	M	Solar
UG01	Uganda	5	25	M	Solar
UG02	Uganda	1	3	M	Solar
ZA01	Zambia	2	6	M	Solar

[a] IND01's employee count is high because, as the informant clarified, the business has an extensive microfranchising network of individuals in many of India's rural communities.

Firstly, the seven key challenges emerging from our literature review, as well as an additional category, 'Other', were presented to the entrepreneurs, and each of these was discussed with the entrepreneurs in turn. Including an additional 'Other' option helped limit the starting point bias caused by basing our interviews on literature-derived constraints, as participants could raise and bring to the fore any other constraints they deemed important. Participants were asked to rank these challenges from 1 to 8 in order of importance to, and influence on, their entrepreneurial endeavours. They were also given the opportunity to identify any other challenges they thought were important, or that affected their ventures. Secondly, data was also collected via semi-structured interviews between one and two hours' duration. All of the interviews were conducted and initially coded by the same researcher. However, the completed codes were reviewed by a second researcher, who reported 100% intercoder agreement on 374 of the 417 specifically-coded nodes. The remaining 43 specifically-coded nodes had an average intercoder agreement of 90%. During the interviews, discussion focused on the constraints faced by the entrepreneurs.[4] Thirdly, when the interviews were completed and participants had ranked the challenges faced, the entrepreneurs were asked to provide

[2] Our selection of for-profit enterprises is likely to have limited the type of responses observed with respect to the constraints faced by the entrepreneurs (along with the 'other' constraints identified).

[3] The intentionally success-biased selection of participants is another potential limitation of this study, as the inclusion of unsuccessful entrepreneurs would have not only provided an alternative view of the challenges faced, but their experiences could also have provided insight into how not to respond to the challenges faced.

[4] In our interviews, we used the words constraints and challenges interchangeably, to ensure mutual understanding between interviewer and the interviewees.

additional secondary data on their ventures. These were utilised in an effort to triangulate and verify information about the business strategy or structure of each venture. This data included, for example, any documents of significance to the history, reputation, or web and market presence of the venture as well as any information that could provide further insight into their entrepreneurial experiences and opinions, such as written articles or opinion papers. These secondary data were then obtained from each participant, in the form of Word and Portable Document Format (pdf) files, via email. These secondary sources were valuable for triangulating the entrepreneurs' claims. For example, the entrepreneurs' product and/or service lists provided visual confirmation of the value proposition offered by their businesses. The entrepreneurs' websites confirmed whether they had been awarded grants from international development organisations, and blog posts and articles written in magazines such as *Renewable Energy Magazine* confirmed their indifference towards the lack of government and policy support available in their countries. For consultants, reference on the company website to another business as a contractor or business partner confirmed they subcontracted their installation expertise. Overall, we did find that the secondary data confirmed the claims made in the interviews.

Data analysis via descriptive statistics (mean, mode, and standard deviation) and inference (95% confidence intervals for the mean)[5] of the ranking of each of the seven challenges was undertaken. Comparing each pair of confidence intervals reveals two relatively distinct groups of constraints. The first group – Government/regulatory Constraints – includes *Inadequate access to institutional finance* and *Inadequate government or policy support*, which have been identified by participants as the most important constraints to their entrepreneurial endeavours; both have modal rankings of 1. The second group – Market Constraints – includes the other five nominated challenges: *Inadequate local demand*, *Price of RETs*, *Lack of skilled labour*, *Underdeveloped physical infrastructure and logistics*, and *Power of incumbents* (*existing players on the energy market*).

The seven challenges and their groupings, together with the other challenges raised by participants, were used as the basis of a template analysis, conducted in NVivo, with an initial configuration of nine hierarchically-arranged nodes and two levels of specificity (King, 1998). As a structured qualitative approach, template analysis facilitates the organisation of data under broad headings or themes at the start of analysis (Crabtree and Miller, 1999; King, 1998, 2004, 2012; Waring and Wainwright, 2008). We organised our data by constraint group, then by constraint, then, upon analysis, by responses to each constraint, which enabled us to lay a template over our data, in order to identify patterns. Lower-order nodes of increasing specificity were added to the template as new themes emerged. Each node represents a unique topic that was raised and discussed by participants. Therefore, the number of nodes emerging under each of the constraints faced may be taken as indicative of the breadth of participants' discussion of the constraint. This allowed for systematic (re)organisation and the development of a deeper understanding of the entrepreneurs' perspectives on the importance of each of the constraints, as well as their way of dealing with these constraints.

In a final stage of analysis, and in an effort to assess whether our qualitative findings could be explained by country-level conditions, we collected national level data related to each of the seven constraints studied. This served to triangulate the results of our quantitative rankings and qualitative interview findings with quantified features of the entrepreneurs' country environments that could have a bearing on not only their perceptions of the constraints faced, but also their responses to these constraints. Indicators chosen included the time and cost to import goods (which could have a bearing on the entrepreneurs' perceptions of the *inadequate physical infrastructure and logistics* constraint) and the ease of getting credit and access to entrepreneurial finance (which could have a bearing on the entrepreneurs' perceptions of the *inadequate institutional finance* constraint), for example. We present our findings, and a discussion of these findings, in the following section.

Findings and discussion

The entrepreneurs' rankings of the constraints faced

Table 2 shows the results of the entrepreneurs' rankings of the challenges faced.

The high average and modal ranks for *Access to finance* (2.9 and 1, respectively), and the average rank for *Government support* (3.4) and *Price of renewable energy technologies* (4.4), suggest that these challenges are among the key perceived challenges faced by the renewable energy entrepreneurs in the study. The average ranks for *Power of existing players on the energy market* (incumbents) (5.8), *Physical infrastructure & logistics* (5.2) and *Local demand* (5.0) place them among the lowest ranked challenges. It was also found that the 95% confidence interval for the mean of *Access to finance* [2.2, 3.5] overlaps with that of *Government support* [2.8, 4.0], which suggests that it is difficult to distinguish between them, in terms of importance. These two challenges may therefore be grouped together. However, although *Access to finance* overlaps with none of the other challenges, there is some overlap between *Government support* and *Price of renewable energy technologies* [3.8, 5.0]. Indeed, based on the confidence intervals, it is difficult to separate price from any of the other challenges, except *Access to finance* and *Power of existing players on the energy market* [5.3, 6.3].

Looking to the individual rankings for answers, we found that despite finance, government support and price being the top 3 challenges faced by the entrepreneurs in the study, only one participant (KE02) included all three among his highest ranked 3 challenges. KE02 runs a young consulting business (only 3 years in business) with only 3 employees. Twenty-one out of the remaining 41 participants had two of the top 3 challenges (i.e. finance, government and price) ranked among their own top 3. Of these 21 participants, only 2 ranked price as their first biggest challenge (i.e. GH02 and TLD02), while 3 ranked it as their second biggest challenge (i.e. FJ01, KE02 and UG01). Thus, broadly, the findings derived from our quantitative data suggest that the entrepreneurs face two categories of constraints – Government/Regulatory constraints and Market constraints – with the former arguably viewed as the more severe group of constraints. *Access to finance* and *Government support* have been grouped together as Government/regulatory Challenges; in addition to their shared government/regulatory

Table 2
Mean and modal ranks[a] of constraints faced by entrepreneurs in the study[b].

	Average rank	Modal rank	Standard deviation	95% confidence intervals for mean
Government/regulatory constraints				
Access to institutional finance	2.9	1	2.0	[2.2, 3.5]
Government/policy support	3.4	4	2.0	[2.8, 4.0]
Market constraints				
Price of renewable energy technologies	4.4	3	1.9	[3.8, 5.0]
Inadequate local demand	5.0	6	2.4	[4.3, 5.8]
Power of existing players on energy market	5.8	7	1.7	[5.3, 6.3]
Physical infrastructure & logistics	5.2	4	1.9	[4.6, 5.8]
Lack of skilled labour	4.8	5	1.9	[4.2, 5.4]
Other	4.4	8	2.9	

[a] Ranks were assigned on a scale from 1 to 8, where 1 = most challenging and 8 = least challenging.
[b] The identified constraint groups (i.e. Government/Regulatory and Market) were used as initial coding template for the Template Analysis of the qualitative data.

[5] If the confidence intervals for two challenges overlap, then we interpret the mean ranks as not being significantly different. Conversely, if two confidence intervals do not overlap, then we interpret the mean ranks as being significantly different, and therefore as belonging to different constraint groupings.

Table 3
Table of findings, including explanations.

Issues	Illustrative quotes	Responses	Explanation
Access to finance: • *Start-up funding* • *Ongoing funding*	The worst you can do is launch a new kind of product in a new type of market as a start-up – not even as an existing business – so, yeah, that mix is not very attractive to capital providers. [UG01] The biggest challenge is cash flow. There are 11 of us in the company. When it's small that means that we have to take care of the regular monthly salaries of 11 people, which is not much for big companies but for small companies it's no joke to be paying salaries of 11 people [because] your revenues do not come regularly and work does not come regularly. [TLD02]	Self-finance (own money) and/or rely on family, friends or partners (40 participants) Develop business around project-by-project funding (the kind of funding usually available through NGOs & IDOs) wherever possible (35 participants)	Having tried unsuccessfully to access institutional finance, rather than trying to access other forms of funding trying to lobby for more supportive financial institutions, participants **ACCEPT** the financing limitations of their environment and simply leverage whatever limited funding is available to them. This has been categorised as a **PASSIVE RESPONSE**. The presence of IDOs in developing provides an alternative, potentially more viable option to REEs, as IDOs fund renewable energy projects and improve affordability for poor end-users. So, participants do not feel the need to lobby for support or influence regulatory change — they simply decide to **AVOID** working with government entities. This has been categorised as a **PASSIVE RESPONSE**.
Government support/ facilitation: • *Government as hindrance*	Well I think the government can be a facilitator. In our case, it isn't. I don't see them as facilitator. I see them as a hindrance more than anything else. I don't see, as I sit here, much that the government does for me. [GH01] The government has very poor support for renewable energy technologies […] I would say government, when it comes to policy standards, is PP … piss poor. Local demand is dampened and hampered by the lack of government support. [BBS01]	Avoid working with government (39 participants)	Given their experience with corruption and their perceived powerlessness to influence policy, rather than trying to influence regulatory change, participants concede there is nothing they can do and simply decide to **AVOID** working with government entities. This has been categorised as a **PASSIVE RESPONSE**.
Local demand: • *Quantity of demand, caused by poor quality RET work* • *Location of demand, which relates more to the need for renewables than to the demand*	So what we did is we reviewed that [microfinance] process for a long time, and we realised the best thing to do is to remove that barrier of having to take out a loan. So the idea is that we are going to change our model to a pay-as-you-go model instead, which means that we reduce the reliance on loans and people can pay for their solar energy in daily, weekly or monthly instalments, whatever is best for them. [GUA01] Some come to us, but some people you just have to always show them the economics. [CR01] In Uganda we call it micro-franchising. The market is still there in many places where the most effective way to sell is just to recruit an amount of people that go and have individual conversations. Because if you don't have that conversation it's an expensive product. [UG01]	Develop strategies for convincing (would-be) customers, i.e. marketing and better, after-sales service (28 participants) Focus on urban middle class or commercial customers, rather than rural poor (15 participants) Partner on NGO and IDO projects (35 participants) Develop strategies to help customers afford the technologies (22 participants)	Responses involve adapting aspects of participants' businesses (marketing, customers, etc), especially to suit the requirements of IDOs, as IDOs facilitate poor end-users' (who *need* energy access) access to RETs. Participants are actively engaged in improving the demand for their products and services by leveraging NGO and IDO identification of the need for them in developing countries. These responses have been categorised as **ACTIVE RESPONSES**.
Price of renewable energy technologies: • *Upfront costs of technology too expensive for most (would-be) customers*	[Aid is] a problem for the entrepreneurial … for local business as well because you can't compete against aid. If they're gonna be getting free solar panels, then you're not gonna be able to sell it to them because their idea of how much that is worth goes out the door. [TON01] If their cell phones are not powered then the [telecommunications] company is losing much because they can't make calls and can't receive calls. So we are trying to bring them [the telecommunications companies] in, trying to bring the solar lanterns or solar gadgets that help them keep their cell phones charged. [CMN01] I look at the client to see [their] strength and try and tailor the system to meet the client's needs. So what happens is that if his energy needs is maybe 20 or 30 kW I will try and say maybe let's start with a system of maybe 5 kW	Partner with NGOs and IDOs (35 participants) Focus on urban middle class or commercial customers, rather than rural poor (15 participants) Develop strategies to help customers afford the technologies (22 participants) Referrals to and/or relationships with external customer funding organisations or schemes (5 participants)	Due to the high price of RETs, participants are forced to adapt and improve pricing strategies and customer relationships in response to disparate customer needs — they developed tiered pricing schemes and offered 'migration paths'. However, while some participants responded to the challenge by selecting and serving end-users who could afford it, the presence of IDOs on the market means that, for poorer end-users, though unaffordable, RETs are at least fundable. Therefore, IDOs make renewable energy products and services a more attractive and exploitable business opportunity in developing countries. These responses have been categorised as **ACTIVE RESPONSES**.

(continued on next page)

Table 3 (*continued*)

Issues	Illustrative quotes	Responses	Explanation
	and see how it goes. If you are happy with it, we can upgrade it to meet your full demand. [GH02]		
Power of existing players on energy market (incumbents): • *Number of incumbent* • *Power of incumbents*	'So, where the niche is[…] we don't actively market to residential customers where other small 1-and 2-man companies are sort of running around and fighting in that space. We are marketing ourselves to medium companies right up to large private and industrial[…]' [SA01] We provide quite a very good after sales service I mean, compared to other businesses. [FJ01] 'We meet at workshops and we collaborate with some of them on jobs. Also because we are authorised service centre for some of the major inverters a large number of other installers come to our workshop anyway for warranty issues' [NIG01]	Find and exploit niche (34 participants) Develop relationships and/or alliances with other market entities, including competitors (21 participants)	The two responses to this challenge involve (1) using one's knowledge of the market to identify and target neglected segments (niches), and (2) actively using one's own acquaintances and knowledge networks to ensure that one is aware of and able to deal with incumbents. Being able to leverage one's own experiences and networks therefore makes this challenge seem easier to overcome. These responses have been categorised as **ACTIVE RESPONSES**.
Physical infrastructure and logistics: • *Transport and logistics costs, incl. taxes, importation,* etc. • *Remoteness and lack of infrastructure for installation*	Roads to access rural communities now, especially in this season, the wet season, it's very very difficult. A lot of road problems. So we can't access the communities that we target. [CAM01] So why is it that all of the policy support for renewables is for people in the farthest villages? And to get the equipment to them is very expensive. And then to ensure that that equipment is going to last a long time requires education, and requires logistics and infrastructure. [Our] tourism clients are private sector. The agriculture clients are private sector. The telecom clients are private sector. […] So our view is that we would like to move the sector away from helping the base of the pyramid and the rural people get access… to helping companies and the productive sector get access to green energy. [KE01] The small kits, they don't need installing, they are just plug-and-play kits. So the sales team can take them on the back of a motorbike and they can take them to the house. [GUA01]	Focus on consulting, rather than distribution (19 participants) Utilise networks to help with logistical issues related to procurement and importation (and also installation) (9 participants) Focus on urban (middle class) areas or commercial customers (15 participants) Offer systems that are easy to manage & maintain, & are suitable for end-users (20 participants)	Participants who are inexperienced with dealing with complex logistical considerations (such as procurement and import duties and taxes) choose to exploit opportunities that better match their own capabilities, i.e. choosing to focus on consulting rather than distribution activities, and choosing to focus on urban areas only. These responses have been categorised as **ACTIVE RESPONSES**. The remote location of considerable portions of the market means that many would-be end-users of renewable energy *need* renewable energies as electricity grids cannot reach them. Therefore, participants can use this as an opportunity to tailor their value propositions to suit the needs of end-users in remote locations (e.g. plug-and-play systems, etc). This response has been categorised as an **ACTIVE RESPONSE**.
Renewable energy skill shortages: • *Lack of skilled labour* • *Finding the right people*	It's a challenge that can be overcome. It's easy to grab a couple people who have some background in electrical and get them up to speed on renewables. That's a lot easier than increasing demand. You can do something about it — you can send them overseas for a course or something, but how do you change the price of renewables or the demand or the access to finance? [FJ01] At the moment we have a pilot with 32 families and they're using the pay-as-you-go strategy and we're learning what works and what doesn't. [GUA01] [We] sometimes invite villagers to come to our central office to train and [our] personnel live in the community until the project is over. [INA02]	Hone and leverage own skills & knowledge for competitive advantage (32 participants) Hire employees with 'basic' skills and provide renewable energy training in-house (32 participants) Use inclusive business models (include end-users in business) or train end-users in remote villages (5 participants)	Participants' deep knowledge of the renewable energy field means that they seek and hire workers with only 'basic' skills and rely on their own experience and expertise to be able to exploit the opportunity and grow their business. This means that responding to this challenge may be perceived as more within their control — that is, these responses have been categorised as **ACTIVE RESPONSES**.

nature, the calculated confidence intervals for the means suggest commonalities between the mean rankings for *Government support* and *Access to finance*. The remaining nominated challenges (*Local demand*, *skill shortages*, *Physical infrastructure & logistics* and *Power of existing players on energy market*) have been grouped as Market Challenges due to their shared nature as influencers of market dynamics, as well as their lower average rankings and the overlaps in their confidence intervals.

Participants were also asked to clarify the type of business they operate. Consistent with findings published by Gabriel and Kirkwood (2016), the entrepreneurs were generally involved in three kinds of business activity: consulting, distribution and integration. The consultants were the smallest in terms of the number of employees, and the integrators were the largest. In general, we found more variation in the constraint rankings by business type than by geographical region. For instance, the entrepreneurs involved in distribution (retail) of renewable energy equipment ranked the constraints of infrastructure and logistics and skill shortages higher than the other types of businesses. This is consistent with their need for employees with technical skill, and the logistics of transporting and installing renewable energy technologies and systems. The large integrators in our study only ranked the constraint of inadequate local demand higher than the other business types. They were, it seemed, less averse to constraint than the other business types, possibly because of their longer experience and more employees. Finally, the consultants in our study had the highest rank for all other constraints, which is consistent with them being the youngest and in the earliest stages of growth and, as Gabriel and Kirkwood (2016) argue, potentially located in the most penurious business and renewable energy support environments.

Although 31 participants (14 in sub-Saharan Africa, 10 in Asia-Pacific and 7 in Latin America and the Caribbean) introduced and discussed challenges they perceived as 'other' challenges, we found that all but two of these could be incorporated into one of the seven nominated categories.[6] The two 'other' constraints that did not correspond to one of the nominated categories were the suitability of existing RETs to local physical and cultural conditions, and the presence of international aid and development organisations (IDOs) in developing markets. In particular, challenges related to the IDO presence seemed to weigh heavily on the entrepreneurs' way of dealing with the constraints faced. Participants have identified IDOs as some of the most powerful incumbents on local renewable energy markets in developing and emerging countries. Indeed, their presence and operations in the participants' markets is considered ubiquitous. Participant TON01 described aid and the presence of aid donors and organisations in the Pacific renewable energy market as an 'Other' challenge faced, noting that the presence of these organisations distorts the market and creates conditions whereby renewable energy access projects are given priority over commercial projects. Participants' discussion of their interactions with such organisations suggests that they are conflicted in their perspective of the role IDOs are playing on their respective markets. On one hand, IDOs provide funding and project opportunities that are unavailable locally. However, on the other hand, their presence is thought to warp the market: they show preference for dealing with poor end-users (who are unable to afford the technologies) and non-profit enterprises and projects, and spoon-feed opportunities to entrepreneurs who might otherwise work towards creating new opportunities and institutions that improve the uptake of renewable energy technologies.

Table 3 provides an overview of the qualitative findings from our interviews, including illustrative quotes and explanations of the potential implications of our findings.

Government/regulatory constraints

Though ranked among the most important challenges, lack of government or policy support was by far the least talked-about issue in our interviews. Of the 423 nodes[7] created using the interview data, 71 pertained to Government/regulatory Constraints.

Inadequate or inappropriate government or policy support

Of this 71, only 18 nodes concerned the entrepreneurs' perceived lack of government support. Only 2 nodes pertained to ways of dealing with this particular constraint, and another 2 showed some optimism regarding governmental support, by acknowledging that 'government support is improving' [KE01] and that government is 'willing to help a lot, but willing is not enough' [ZA01].

However, the prevailing sentiment among participants was pessimism, and that they face a notable lack of government acknowledgement and support. Discussion of the issue generally focused on the lack of appropriate legislation and frustrations with bureaucratic processes. When asked how they deal with these issues, respondents consistently responded that, wherever possible, they simply avoided working with government. Thirty-nine participants reported trying to avoid working with the government. The general sentiment was that this was simply the way things worked and 'there's no way around it' [SEN01]. Participants seem to perceive, quite uniformly, that this is an issue over which they have no control, so that they just had to develop approaches to succeed in spite of it. Indeed, of the 18 nodes pertaining to government support, 14 simply described the variety of complaints raised against governance and public institutions.

Inadequate access to institutional finance

The remaining 53 nodes in the Government/regulatory Constraints group pertained to *Inadequate access to institutional finance*, which was another of the most important constraints faced (modal rank = 1). The problem here is twofold: entrepreneurs are finding it difficult to access start-up funding or investment and, due to the low or inconsistent supply of work, they are also finding the day-to-day financial upkeep of their businesses difficult. As a result of such challenges, 40 of the renewable energy entrepreneurs in the study were self-funded at the start, relying on their own financial resources and the help of friends and family to start their businesses. The other 3 received funding from either private investors or local and international government or development institutions. This situation with respect to start-up funding contrasts somewhat to the entrepreneurs' approaches to finding financiers for the ongoing, day-to-day operation of their businesses. Interviewees complained that the only funding available was through 'do-goody' [GH01] donor and aid investors, who usually provide funding only on a project-by-project basis, rather than investing in entire businesses. Thirty-five of the participants reported turning to such sources as a means of ensuring that they are able to keep their businesses going. Respondent TZ01 explained, 'it probably would be much easier for us to get money if we were asking for grants and if we were not-for-profit — there's a lot of money around for that'.

We found the entrepreneurs to be accepting of this situation, often conceding that, as that was where the money was, the best way to run a successful renewable energy business in a developing country was to develop one's business strategy around applying for grants, particularly those administered by international aid and development organisations (IDOs) and NGOs.

[6] For instance, the challenge of undeveloped 'distribution channels' is related to physical infrastructure and logistics, skill shortages in government may relate to government support, and 'incompetent' competitors and inferior competing products are related to the power of incumbents on the market.

[7] As a reminder, each node represents a unique topic that was raised and discussed by the study's participants. Therefore, the number of nodes emerging under each of the constraints faced may be taken as indicative of the breadth of participants' discussion of the constraint.

Market constraints

The ways in which the entrepreneurs deal with Market Constraints revealed that their responses involved adapting their businesses' customer relationships, value proposition and products offered, marketing and promotion strategies, as well as the partners and resources they engaged with. Market Constraints accounted for 268 of the 423 nodes in the template analysis, which means that the entrepreneurs' discussion of this group of constraints was more thematically complex than their discussion of the Government/Regulatory Constraints that they faced.

Inadequate local demand

According to participants, the problem of *Inadequate local demand* relates to the quantity and the location of demand. In terms of quantity, 'the challenge has more to do with the fact that demand is affected by the poor perception of solar and that's caused by the poor quality of work that's done' [KE01]. In terms of the location of demand, participants claimed that IDO intervention has augmented only the rural market, which means that potential customers who can afford to pay for the technology, in urban areas, are not sensitised about renewable energy. Participant TON01 explains the entrepreneurial dilemma caused by IDO intervention in Tonga: '[Aid is] a problem for local business as well because you can't compete against aid. If they're gonna be getting free solar panels, then you're not gonna be able to sell it to them because their idea of how much that is worth goes out the door'.

Yet, demand was ranked as one of the least important constraints. For 28 participants, the solution seems to be a matter of having a convincing sales strategy, providing better service than had been offered previously, enhancing after-sales interaction with end-users, and aiming to have more face-to-face interaction with potential customers. They explained, for example, that: 'Some people you just have to always show them the economics' [CR01]. While some interviewees claimed they focused their efforts strictly on the urban middle class or '100% commercial' [TLD01] customers, others tried to find a compromise by 'taking the bottom of the pyramid from the top, and not from the bottom [that is, not the poorest of the poor]' [SEN01]. For the entrepreneurs who chose not to avoid the rural poor as customers, the solution involved finding ways to help poor customers afford the technologies — by adapting their business models to include pay-as-you-go or microfinance schemes for instance (22 participants), and by partnering with NGOs and international aid and development organisations in their respective market environments (35 participants).

Lack of skilled labour

Lack of skilled labour represents another issue faced by the REEs in the study. We found that participants viewed this challenge, in particular, as a way to differentiate themselves from others in the market. Able to leverage their own technical skill, the entrepreneurs claimed that they seek and hire workers with only 'basic' skills, offering their own renewable energy-specific training in-house. Indeed, 32 participants reported that hiring employees possessing only basic skills was how they handled the challenge of skill shortages. They explained that 'it's a challenge that can be overcome. It's easy to grab a couple people who have some background in electrical and get them up to speed on renewables. That's a lot easier than increasing demand. You can do something about it — you can send them overseas for a course or something, but how do you change the price of renewables or the demand or the access to finance?' [FJ01]. Another way the entrepreneurs have responded to the lack of technical skill is to develop programs for either testing technologies and strategies before large-scale distribution or involving end-users in some aspects of the business (e.g. by using inclusive business models) (5 participants). This ensures that end-users, particularly in remote villages, are adequately trained to maintain the installed technologies themselves.

This approach to dealing with skill shortage constraints merits further consideration, as it brings to mind the question of how literacy, skillsets and level of education affect end-users' ability to maintain installed systems. What role does this play in hindering the uptake of RETs in developing countries? Considering these issues may enrich our understanding of the true nature of the skill shortage problem in developing countries. In the literature, the response to this issue is often to focus on providing formal training in order to improve and enhance the technical skills of existing artisans and local electricians and builders in such countries (see Wüstenhagen and Boehnke, 2008 for example). Another strategy could be to focus on businesses (rather than education and training institutions or NGOs) as key partners in the sustainable energy education drive in developing countries. These entrepreneurs might provide leadership for much needed practice-oriented, hands-on apprenticeship programs for future renewable energy installers, system designers, repairers and instructors in the region. However, the approach of offering one's own training in-house has certain implications on the day-to-day running of the entrepreneurs' businesses. For instance, after investing resources in training new employees, as the employees' skills and market value improve further resources may need to be invested in employee satisfaction and retention. Also, although this approach might improve general knowledge and interest in RETs in these countries, it is likely to also proliferate renewable energy entrepreneurship in the region, as many of these newly-trained technicians may one day become competitors against the existing entrepreneurs in the market.

Underdeveloped physical infrastructure and logistics

One might argue, however, that given the relative newness of RETs, it is unlikely that market saturation will be reached in the very near future. Indeed the remote locations of considerable portions of the market in these countries means that many would-be end-users of renewable energy *need* these technologies, particularly decentralised renewable energy mini- and micro-grids, as electricity infrastructure do not presently extend to these regions. Indeed, participants' discussion of the constraint of *underdeveloped physical infrastructure and logistics* generally focused on both the remoteness of some installation sites and issues with the transportation and logistics involved in getting the technology to the necessary locations. As CAM01 explained, 'roads to access rural communities now, especially in this season, the wet season, it's very very difficult. A lot of road problems. So we can't access the communities that we target'.

Generally, the REEs in the study acknowledged that, though issues with infrastructure, in particular, can be challenging, these were viewed instead as opportunities. This is noteworthy as, although literature on the barriers to renewable energy business and uptake in developing countries suggests that infrastructure is a major challenge (see Urmee et al. (2009) and Glemarec (2012) for example), it was the second least important constraint in our rankings. This could be because the literature on the barriers to renewable energy business and uptake do not investigate the issue from the perspective of entrepreneurship. Indeed, the entrepreneurship literature portrays opportunity recognition as a key aspect of entrepreneurial endeavour (Cohen and Winn, 2007; Garud and Karnøe, 2003; Linna, 2013; Vanevenhoven et al., 2011). From an entrepreneurship perspective, the participants in the study saw the infrastructure constraint as an opportunity to 'be innovative, resourceful and patient' [LA01]. A great deal of the literature on renewable energy and decentralisation, particularly in developing countries, focuses on developing and adapting technologies to remoteness and off-grid users (see Hillig, 2016; Urmee and Md, 2016; Sovacool, 2012 for example). Although decentralised business models have been addressed (see WorldBank, 2008; Glemarec, 2012 for example), some work on developing and adapting *entrepreneurial* business models (as well as the various kinds of institutional support they require) to this segment of the market would enable us to better

understand the unique value propositions that appeal best to community leaders and households in remote locations.

The participants explained that the cost of ordering and importing stock was one of the major deterrents to running a distribution business. In fact, of the 9 participants for whom infrastructure and logistics was ranked among their top 3 constraints, 6 had distribution businesses and 1 was running a business based on his own technology. Both types of businesses lend themselves to the need for greater infrastructural and logistical support than consulting businesses. Indeed, focusing on consulting rather than distribution enabled them to avoid the issues related to manoeuvring logistical bottlenecks in their respective regions.

Price of renewable energy technologies

Under the *Price of renewable energy technologies* constraint, there were two main ways that the entrepreneurs viewed the price challenge: as a problem related to the fluctuating price of the technologies on the international market (a general price reduction trend), and as a problem related to the ability of end-users in developing countries to afford the technologies. With respect to the former, the entrepreneurs related the price challenge to the steadily declining international price of solar panels. This makes it difficult for distributors, in particular, to keep large amounts of inventory. As BZ01 explains, 'the price is changing too much you know. If you still have a container full of solar panels that is 2 years old and that costs nothing anymore but you bought it for $10 a Watt'. In cases where the price challenge was viewed from the perspective of the variability of the price of the technology, the entrepreneurs' solutions to the challenge generally overlapped with those related to the demand challenge — that is, differentiation, based on the quality of the products and services they offer.

However, the inability of end-users to afford the upfront cost of acquiring RETs seems to be the key price-related issue. Here, the entrepreneurs either suggested that they prefer to work with clients who could afford the RET, or they worked to offer various financing and credit options to help customers afford it, including collaboration with other organisations, such as IDOs. Much of the work on renewable energy supply to remote regions (often, economically, the poorest) of developing countries has been led by IDOs and NGOs. The presence and ubiquity of these organisations on the market means that, for poorer end-users in the region, though unaffordable, RETs are at least fundable. These organisations are therefore helping to make renewable energy products and services more attractive and accessible to the regions' poor. This has potentially important implications for REEs in developing countries. In particular, rather than segmenting his/her market according to end-users' ability to afford RETs (as the entrepreneurs in our study have done — offering 'tiered pricing' and 'migration paths'), perhaps they might focus instead on the end-user's *fundability*. This slight shift in perspective would lead nascent REEs to perhaps consider which NGOs or IDOs might be interested in funding his/her customers or project. Partnering with IDOs has important implications for these entrepreneurs (in terms of their business models, accountability and ability to compete) (Gabriel and Kirkwood, 2016) but could, arguably, more importantly, facilitate a much faster uptake of RETs in their respective regions. Instead of funding individual customers and households, partnering with international organisations and local NGOs seems to have given some of the entrepreneurs' access to entire communities and regions in need of RETs.

Power of incumbents (existing players on the energy market)

For the renewable energy entrepreneurs in this study, market incumbents were identified as utilities and other fossil fuel-reinforcing entities (usually government-run entities), other renewable energy businesses and international organisations. Yet, the challenge of *Power of existing players on the energy market* was identified as one of the least important challenges. Similar to the challenge of infrastructure and logistics, although there is acknowledgement that, in general, the power and legitimacy of incumbents is a challenge, participants saw it as an opportunity. The participants reported coping by not having any relationship or interaction with others in the market and developing and remaining within their own niches (34 participants), and by networking extensively with NGOs, IDOs and incumbent businesses who can help supply projects or services (21 participants). Indeed, though adamant about maintaining their niche in the market by honing their own skills, some entrepreneurs explained that 'instead of you know, sort of competing against each other … we joined together to elevate our skills and our experience' [SA01]. Another way by which the REEs in the study combined both strategies for coping with this constraint is by leveraging their own international networks, in order to generate interest locally. For instance, participant CAM01 claims that his relationship with an international development partner 'means more power to negotiate with'.

The ways that the entrepreneurs have segmented their respective markets is also insightful. The entrepreneurs have focused on either private household clients, or industrial/business clients; on urban clients who need RETs for backup systems, or rural clients without access to an electricity grid; or entrepreneurs who admit that their clients are the international organisations they work with, rather than the local households who are the end-users of the technology. The entrepreneurs' preferences depend on their perceptions of the constraints they are facing in their respective locales. For instance, where the challenge of establishing energy infrastructure for rural supply seems insurmountable, entrepreneurs focus instead on supplying urban customers, who are themselves faced with the challenge of an unreliable power supply. Also, in situations where end-users are unable to afford the product or service offered, the solution might be to partner with local NGOs or IDOs.

These insights could be valuable to nascent entrepreneurs in developing countries. They not only offer suggestions for dealing with the constraints that such entrepreneurs are going to face, but also uncover opportunities for tailoring the marketing and positioning of their businesses to some of the unique features of the renewable energy market in these regions.

Comparing entrepreneurs' responses to the two types of constraint

The emergence of access to finance and lack of government support as the most important constraints faced by the REEs is consistent with previous research identifying issues related to knowledge and mobilisation of financiers, as well as legal and policy incentives (or lack thereof), as hindrances to private renewable energy endeavours in developing countries (e.g. Giovannetti and Ticci, 2012; UNEP and Bloomberg, 2016). Yet, as Table 3 indicates, the entrepreneurs in this study have described their means of dealing with the Government/regulatory Constraints faced as either avoidance or acceptance while, in response to the Market Constraints faced, it seems that they have taken decisions to actively amend and adapt aspects of their businesses and strategies. The responses to the Government/regulatory Constraints, overall, seem more passive, with acceptance of the situation, relative to the responses to Market Constraints, whereby more action is taken to create favourable situations. Although acceptance and avoidance may themselves be considered a form of thoughtful (in)action, we describe them as 'passive' actions, at least in comparison to the more 'active' actions taken in response to the Market Constraints faced by the entrepreneurs in our study.

Based on our interviews, it appears the entrepreneurs discern which constraints they can overcome. Constraints such as those pertaining to the government/regulatory environment are likely to be accepted by disillusioned entrepreneurs, which might suggest the entrepreneurs might have the perception that they are unable to shake free of the confines imposed by their current regulatory environment. However, this

may also reflect the necessity motivation previously assumed to be characteristic of entrepreneurship in this region. If, indeed, out of necessity the entrepreneurs are more concerned with survival than creating new business and innovation opportunities for RETs, then their reported disregard for (and perseverance in spite of) inadequate government support may be, arguably, appropriate. Conversely, the entrepreneurs responding more actively to market constraints suggests that they offer more of an opportunity for action than government/regulatory constraints. These implications also allow speculation about the conditions under which such actions were triggered. It is theorised that the absence of well-established, supportive, and enabling institutions, particularly in developing countries, presents an opportunity for entrepreneurs to innovate and lead change (Ardagna and Lusardi, 2010; Mullainathan and Schnabl, 2010; Voss et al., 2008). But how does this translate to entrepreneurs motivated by necessity, rather than innovation? We find that, even in a region where entrepreneurs are characterised as being motivated by necessity, these entrepreneurs are able to identify and discern opportunities by differentiating between the impacts of constraining government/regulatory forces and market forces.

Indeed, for these entrepreneurs, constraint of any and all kinds is ubiquitous. Yet, extant research continues to isolate individual constraints, focusing, we contend, on single and singular aspects of the developing country experience with constraint. However, we find that the entrepreneurs' ways of dealing with the very important and less important constraints, though different (we argue, opposite) are both simultaneously necessary components of their way of doing business. The entrepreneurs' strategy, value propositions and customer relationships are all equally affected by their passiveness towards government/regulatory constraints, and their active efforts to overcome market constraints. Therefore, while they may not have been driven by opportunity when they started, now that they are in business these developing country entrepreneurs' ways of discerning and dealing with constraint are indeed strongly motivated by perceived opportunities in their respective countries.

Comparing the qualitative findings to country-level conditions

Data was collected on country-level conditions related to each of the seven nominated constraints ranked by the entrepreneurs in our study. These conditions were compared to the average ranking and perceptions of each constraint for entrepreneurs in each country. Though we were not able to make generalisations at the country level, these comparisons shed more light on the entrepreneurs' perceptions of and responses to the challenges faced. These comparisons are summarised in Table 4.

First, the conditions presented in Table 4 confirm the entrepreneurs' perceptions of the constraint of *Access to finance* as a major constraint faced. For instance, that the entrepreneurs' countries are generally rated poorly in terms of investor protection resonates with the entrepreneurs' claims that they have been unable to attract investment in their ideas and businesses. Also, in countries where our entrepreneurs ranked the constraint of access to finance between 1 and 3 (i.e. a major constraint), the ease of "getting credit" was higher (66) than the average for all countries represented in the study (76). That is, despite country-level conditions being generally considered favourable, the entrepreneurs still perceive the issue of access to finance as a major, pervasive constraint. Conversely, entrepreneurs in less favourable finance environments perceive less constraint. Looking to the entrepreneurs themselves for an explanation, we found that all three of the entrepreneurs who ranked access to finance as a minor constraint are located in Latin America and the Caribbean (LAC) — in Barbados, Belize and Ecuador. Two of these entrepreneurs are distributors of RETs with previous industry ties that assisted with financing their businesses, and one is a consultant who reported requiring no financial assistance at start-up. Also, as the LAC countries in this study had the best overall ease of doing business conditions, it is possible that the support provided by other government/regulatory conditions eclipsed the perceived severity of the constraint of accessing finance.

In terms of *Inadequate or inappropriate government or policy support*, we observed differences in the averages for countries where this constraint was ranked as a major and a minor issue. We did not find that those entrepreneurs that ranked policy support as a major constraint are operating in countries where there are fewer renewable energy supportive policies in force. Instead, such entrepreneurs are operating in environments with slightly more (9) than the average (8) policies in force. This suggests (and our qualitative findings confirm) that the issue for these entrepreneurs is more than simply renewable energy policies, but is instead largely about entrepreneurial and start-up support. This is reflected in the entrepreneurs' more positive responses to the *Market Constraints* faced, as it appears they perceive certain otherwise unfavourable features of their local market environments as being opportunities to advance their businesses.

Based on our comparisons of the entrepreneurs' perceptions of the *Market Constraints* faced with the country-level conditions they face, we suggest there might be at least eight market conditions that have some bearing on the entrepreneurs' perceptions of the opportunities to advance their businesses: percent renewable energy consumption, purchasing power of the people, aid flows to the country, renewable energy installed capacity, education levels, electricity access rates, proportion of renewable energy in total electricity output, and logistics (the cost and time to import RETs). Regarding electricity access rates in particular, overall, participants in countries with relatively higher access rates ranked related challenges (such as local demand and physical infrastructure and logistics) higher than those in countries with lower electricity access rates. This resonates with other findings, which suggest that these entrepreneurs see opportunity (rather than serious challenge, per se) in the lack of access to electricity in the regions in which they operate.

In Fig. 1, we speculate about the potential nature of these relationships, based on the findings from our comparison of the qualitative perceptual data to our country-level data.

We suggest that these market conditions influence the entrepreneurs' perceptions of (1) the demand for the products and/or services they offer, and (2) the opportunity and their ability to supply these products and/or services to their customers in developing countries. These, in turn, may be influencing whether and how the entrepreneurs perceive overall opportunities to carry on with their renewable energy businesses. We also suggest that this framework may be used as the basis of a future, larger survey of renewable energy entrepreneurs, which may provide further insight into the relationships between these market conditions and the various aspects of renewable energy entrepreneurial endeavour.

Conclusions

Indeed, the challenges faced are often crippling, but we have gained some insight into how renewable energy market and government/regulatory constraints trickle down to individual entrepreneurs in developing countries. An understanding of which constraints are most important to entrepreneurs may be useful in helping budget-constrained development organisations to better arrange and prioritise their efforts. The findings may also assist start-up incubators with interests in developing countries to better develop and tailor their service offerings to the needs of entrepreneurs. Additionally, the focus on the development of grant applications as a business strategy illustrates how the international donor and aid environment is affecting the way entrepreneurs in developing countries approach and develop their businesses. This is striking as, although much of the research and discussion about ways to facilitate the socioeconomic development of these

Table 4
Constraint rankings and country-level conditions faced by entrepreneurs in the study[a].

	Government/regulatory constraints							Market constraints			
	Access to institutional finance				Government/policy support			Price of RETs			
	Rank	Getting credit	Protecting investors	Entrepreneurial finance	Rank	Gov't entrepreneurship programs	No. RE policies in force	Rank	GDP per capita	GNI per capita based on PPP	Net ODA received (% of GNI)
Barbados	6	126	166	3	2	4	2	4	15,366	15,190	0.4%
Belize	7	162	122	–	1	–	2	6	4831	7590	3.3%
Cambodia	3	15	111	–	2	–	–	4	1095	3080	5.6%
Cameroon	2	126	134	4	3	4	–	4	1407	2950	2.5%
Chile	5	79	36	4	4	5	11	7	14,528	21,320	0.0%
Costa Rica	1	7	166	–	4	–	–	8	10,415	14,420	0.1%
Ecuador	6	97	115	3	4	4	3	3	6346	11,190	0.2%
Ethiopia	1	167	166	–	5	–	7	5	574	1500	8.1%
Fiji	5	79	111	–	7	–	2	3	5112	8410	2.4%
Ghana	2	42	66	–	5	–	8	3	1442	3900	2.8%
Guatemala	1	15	174	3	6	3	–	5	3673	7250	0.9%
India	4	42	8	6	3	5	24	4	1582	5630	0.1%
Indonesia	4	70	88	5	2	5	21	5	3492	10,190	0.0%
Kenya	3	28	115	–	4	–	7	4	1358	2940	5.9%
Lao PDR	1	70	178	–	2	–	–	3	1794	5060	4.0%
Nigeria	2	59	20	–	2	–	3	6	3203	5710	0.5%
Panama	1	19	66	3	2	4	–	4	11,949	19,930	0.0%
Papua New Guinea	1	167	99	–	3	–	–	4	2268	2790	4.5%
Philippines	1	109	155	5	7	4	13	6	2873	8450	0.1%
Senegal	4	133	155	4	1	4	4	8	1067	2300	6.7%
Somalia	1	–	–	–	3	–	–	7	543	–	–
South Africa	5	59	14	4	4	3	15	1	6484	12,700	0.4%
Tanzania	3	152	122	–	6	–	7	5	955	2510	7.9%
Thailand	4	97	36	4	4	4	9	2	5977	14,870	0.0%
Tonga	3	42	115	–	1	–	–	6	4114	5270	16.8%
Trinidad and Tobago	1	42	36	–	2	–	–	4	21,324	31,970	0.0%
Uganda	3	42	99	–	3	–	9	3	715	1720	7.0%
Zambia	1	19	88	–	3	–	5	6	1722	3690	4.4%
Average for all countries		**76**	**102**	**4**		**4**	**8**		**4865**	**8612**	**3.1%**
Average for countries where constraint ranked 1–3		**66**	**112**	**4**		**4**	**9**		**3981**	**8264**	**2.4%**
Average for countries where constraint ranked 6–8		**128**	**134**	**3**		**4**	**7**		**4811**	**8594**	**4.0%**

The figures in bold are averages across the countries represented in the study, for those constraints ranked as major and those ranked as minor challenges.

[a] The data used in this table were sourced from a variety of renewable energy, development and entrepreneurship sources:

- Getting credit (derived from strength of legal rights and depth of credit information indices); Protecting investors (derived from extent of disclosure, extent of director liability and ease of shareholder suits indices); Cost to import; Time to import (days) — Source: WorldBank (2016a). Doing Business Data. Retrieved from http://www.doingbusiness.org/data
- Entrepreneurial finance (the availability of financial resources-equity and debt-for small and medium enterprises (SMEs) (including grants and subsidies) — higher rates indicate higher availability of financial resources for SMEs); Government entrepreneurship programs (the presence and quality of programs directly assisting SMEs at all levels of government (national, regional, municipal) — higher rates indicate increased presence and higher quality of government programs) — Source: Kelley et al. (2016)
- No. renewable energy policies in force — Source: International Energy Agency (2015). Interactive webmap retrieved from http://www.iea.org/policiesandmeasures/renewableenergy/
- GDP per capita; GNI per capita based on PPP (all values for 2014, except Barbados (data only available to 2012) and Belize (data only available to 2013)); Electricity access rate; Renewable energy consumption; Renewable energy output as a percent of electricity output — Source: WorldBank (2016a, 2016b). Retrieved from http://data.worldbank.org/
- MW renewable energy capacity — Source: Whiteman et al. (2016)
- Major RET (excludes traditional biomass) — Source: Whiteman et al. (2016)
- No. people employed in renewable energy — Source: IRENA (2016)
- Net ODA received (% of GNI); Percent labour force with tertiary education — Source: UNDP (2015).

[b] These were the only findings that do not appear to corroborate the qualitative findings of our research, as the entrepreneurs in countries with the lowest cost and time to import reported infrastructure and logistics as a major challenge. However, it is important to note here that only 4 entrepreneurs ranked this as a major constraint (rank of 1–3). All other entrepreneurs ranked it as a moderate (rank of 4–5) or minor (rank of 6–8) constraint. The averages for the countries where infrastructure and logistics ranked as a minor constraint match the overall for all countries represented in the study.

countries is focused on improving its energy autonomy (see Chendo, 1994; Giovannetti and Ticci, 2012; UNEP 2012 for example), we find evidence that development efforts may be creating an environment in which entrepreneurs are dependent on donor funds for survival. Also, ventures whose business models are dependent on donor funds may have trouble adapting in future, once less constraining environments are established. Conversely, donor projects may be giving the industry a much-needed kick-start, given the lack of local government/regulatory support; this may, in time, lead to a much more favourable environment for renewable energy entrepreneurship once the socio-political environment is stabilised.

Also, future research might focus on the country- or regional-level geneses of the constraints that have been identified by the entrepreneurs in our study, and how these path dependencies have affected the various territories' entrepreneurial culture or environments. It would also be of value to start at the beginning, with a more processual and longitudinal approach forming yet another area of future research.

From a policy perspective, despite contemporary criticisms of the status quo, we recommend that existing policies and international development support for renewable energy technologies and renewable energy businesses in developing countries continue as they are to date. Though imperfect, and though opinion is divided about whether they are having the intended effects, the shortcomings of such policies and interventions play into the nature of the entrepreneur to persevere in spite of these challenges, and to turn these constraints into exploitable opportunities. The findings also point to a need for policy and

Inadequate local demand				Physical infrastructure & logistics[b]				Power of existing players on energy market			Lack of skilled labour		
Rank	Major RET	Electricity access rate	RE consumption	Rank	Cost to import	Time to import (days)	MW RE capacity	Rank	RE as % of electricity output	Electricity access rate	Rank	No. people employed in RE	% labour force with tertiary education
1	Solar	91%	–	8	1615	8	9	7	0.0%	91%	5	–	19%
4	Large hydro	100%	–	2	1580	19	86	5	0.0%	100%	3	–	12.3%
1	Large hydro	31%	–	5	930	24	1205	7	37.7%	31%	6	–	–
7	Large hydro	54%	73%	5	2267	25	723	3	73.0%	54%	7	–	–
4	Large hydro	100%	30%	4	932	12	8727	5	36.5%	100%	4	5500	19.9%
7	Large Hydro	100%	39%	3	1070	14	2464	6	91.8%	100%	5	–	24.7%
5	Large hydro	97%	13%	8	1520	25	2593	7	54.9%	97%	2	–	21.5%
8	Wind	27%	93%	6	2760	44	2489	5	99.4%	27%	2	–	–
5	Large hydro	59%	–	3	753	22	199	6	0.0%	59%	4	–	–
5	Large hydro	64%	49%	7	1360	42	1384	6	67.1%	64%	5	–	–
8	Large hydro	79%	66%	3	1500	16	2095	7	66.9%	79%	4	–	7.5%
5	Large hydro	79%	39%	5	–	–	82,117	7	15.6%	79%	4	437,000	–
4	Large hydro	96%	37%	5	–	–	8320	8	11.4%	96%	5	223,000	7.1%
7	Large hydro	23%	79%	4	2350	26	1556	5	75.2%	23%	5	–	–
5	Large hydro	70%	–	7	1910	26	3948	6	0.0%	70%	4	–	–
6	Large hydro	56%	86%	4	–	–	2060	8	19.7%	56%	5	–	–
6	Large hydro	91%	23%	8	965	9	1906	5	62.9%	91%	7	–	38.7%
7	Large hydro	18%	–	6	1250	32	331	8	0.0%	18%	5	–	–
4	Large hydro	88%	29%	8	660	14	6186	3	28.4%	88%	5	4600	25.3%
3	Large hydro	57%	51%	5	1940	15	111	7	9.8%	57%	6	–	–
8	Wind	33%	–	5	–	–	3	4	–	33%	6	–	–
2	Solar	85%	17%	8	1980	21	5116	7	1.0%	85%	6	6400	6.6%
5	Large hydro	15%	–	5	1615	31	649	7	29.2%	15%	4	–	–
6	Bioenergy	100%	88%	8	760	13	8354	5	8.3%	100%	4	48,000	–
2	Solar	96%	–	4	490	25	4	5	0.0%	96%	7	–	–
3	Bioenergy	100%	0.3%	6	1260	14	5	8	–	100%	7	–	–
3	Large Hydro	18%	–	7	3375	33	782	6	0.0%	18%	7	–	–
5	Large hydro	22%	88%	4	6360	53	2362	7	99.7%	22%	8	–	–
	N/A	**66%**	**50%**		**1717**	**23**	**5207**		**34.2%**	**66%**		**120,750**	**18.3%**
	N/A	**68%**	**0**		**1226**	**18**	**1211**		**50.7%**	**71%**		–	**16.9%**
	N/A	**58%**	**68%**		**1618**	**23**	**2759**		**29.7%**	**63%**		**6400**	**22.7%**

international aid and donor organisations to tread more carefully when providing assistance to the renewable energy industry in developing countries. Based on the participants' descriptions of their experiences with such organisations, it is possible that they are having an unwanted negative effect on the local private sector in such countries, creating unrealistic price expectations among consumers, and almost spoon-feeding opportunities to entrepreneurs.

This study cautions against the blanket characterisation of developing country entrepreneurs as being motivated purely by necessity. We suggest that the entrepreneurs' decision to avoid dealing with government/regulatory constraints, but to find ways of taking advantage of market flaws and inefficiencies, reflects their ability to not only identify exploitable opportunities, but also discern which ones they are *able* to exploit. Therefore, while they may indeed have been driven by necessity when they started, once their businesses are underway these entrepreneurs are capable and inclined to exploit market opportunities to improve the day-to-day operation and success of their ventures. We would argue that they are doing just fine — they are viewing the constraints they face as opportunities to create and meet demand for the products and/or services they offer to end-users in developing countries.

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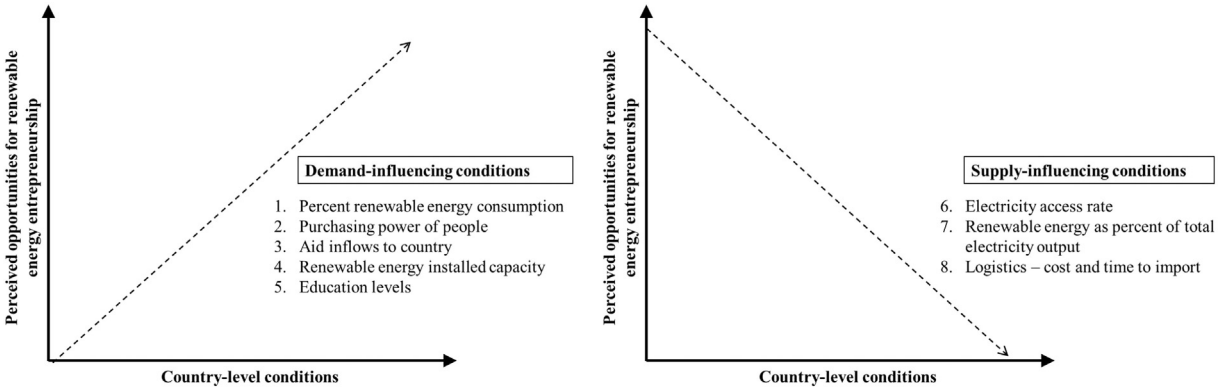

Fig. 1. Proposed relationship between country-level market conditions and renewable energy entrepreneurs' perceptions of opportunities for business.

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