

*Research article*

## **Micro-generation in conflict: The conditions necessary to power economic development in rural Afghanistan**

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**Abstract:** Access to reliable electricity eludes many poor rural Afghan communities despite plentiful renewable resources. Micro-generation seems particularly well suited to Afghanistan's mountainous, decentralised society but even with substantial investment since 2001 it has not lived up to expectations. Recognising the causes are likely to dwell in the human (rather than technical) domain, this study takes a qualitative, soft systems approach to deriving and validating the necessary conditions that might improve the success rate of micro-generation projects in enabling sustainable economic development. It acknowledges the governance limitations inherent in fragile states and the significance of the community as the most stable element of society, putting the latter at the centre of its thinking. Those conditions identified as critical are summarised as: a holistic approach that sees micro-generation as a component of broader economic development; an environment safe enough for project build and operation, and for the markets necessary for wealth creation; and external support to build community capacity to fund and maintain schemes through-life. These conditions are likely to have relevance for other fragile states; the next step is to develop them in the field before deployment as part of a comprehensive approach to poverty alleviation in Afghanistan and similar states.

**Keywords:** micro-generation; Afghanistan; soft systems methodology; critical conditions; rural electrification; failed states

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## 1. Introduction

### 1.1. Overview

Afghanistan scores poorly against almost every development indicator including access to electricity. One third of the population is recorded as being food insecure and approximately three-quarters of rural Afghan households do not have access to a reliable source of electricity. Grid-level generation and distribution is limited to a few urban centres only. In keeping with the Afghan tradition of decentralisation, energy is typically acquired and used at small community or dwelling level. For most rural Afghans that has meant wood, dung and possibly diesel. Since 2001 Afghanistan has been at, or near, the top of the development agenda for many of the world's most affluent nations [1]. Those states, having committed military forces, followed strategies that viewed rural development and counter insurgency as indivisible [2]. In other words, they paid for development programmes, including rural electrification, to reduce the risk of military and political failure. It is too early to judge the success or otherwise of Western efforts in Afghanistan but rural development, including access to electricity, remain important factors in the viability and development of the Afghan state. Moreover, progress in those sectors has not lived up to expectations; a recent national survey found access to electricity to be the second biggest "local" concern amongst the rural population after unemployment. This despite Afghanistan's hydro potential alone being assessed as up to 25 GW. Installed capacity is well under 1 GW, hydro providing most of Afghanistan's electrical power [3,4]. Despite sustained investment, there remains much to be achieved. Western military intervention has now ended; and thus 2015 marked a new beginning for Afghanistan's civil society. Increasingly it will need to find its own solutions to rural development, and by implication, access to electricity. Through its focus on micro generation, this study is intended to play a part in meeting that challenge. Its unique contribution lies in its methodology and its perspective: it will take a soft systems approach to understanding, from a community viewpoint, the necessary conditions for micro generation to successfully support economic development in rural Afghanistan. Its objectives are:

- (1) To understand the Afghan rural community context;
- (2) To derive a series of models representing facets of community micro generation. From these, to extract candidate conditions for successful micro generation;
- (3) To validate findings by comparing model outputs with real-world studies;
- (4) To elicit the critical and desirable conditions for successful micro generation in rural Afghanistan, and to comment on their broader applicability for other fragile states.

### 1.2. Literature review

#### 1.2.1. Electrification and poverty alleviation

The link between electrification and poverty alleviation is assumed widely in literature although often with little substantiating evidence. One exception is the IEA's World Energy Outlook 2004, which states that "energy is a prerequisite to economic development" [5]. It then links this statement

to electrification by plotting human development indicators against electrical consumption, claiming a strong, non-linear correlation between access to electricity and human development. This means that disproportionate human development gains are associated with modest increases in access to electricity. But the report is careful not to ascribe this to a one-way causal relationship; instead it contends that energy development is a cause and effect of economic growth.<sup>1</sup> The direction of this correlation is the subject of a number of studies, summed up in a review of evidence conducted on behalf of the UK's Department for International Development [6]. It found "a strong causal relationship between consumption of modern energy and GDP growth but is inconclusive as to the direction of the causality and the magnitude of the impact". In an older study, Foley takes a less nuanced view, asserting that "rural electrification does not cause development" [7]. He does, however, acknowledge it is an essential enabler. Supported by some convincing arguments, and in agreement with others (Kirubi et al., World Bank), he goes on to say that timing the introduction of electricity to a community is critical: it must neither be too early (when it may not be economically viable); nor too late (when its absence stifles development) [8,9]. This implies that community electrification must be closely linked with economic development.

### 1.2.2. Global factors influencing successful electrification

In response to the challenges of poverty and limited infrastructure in the developing world, the cost-effectiveness advantages of standalone, renewable generation are made clear by Mainali et al., Lahimer et al. and others [10,11]. But successful electrification is more than just selecting the optimum technology; it depends also on the aligning of a range of economic, social, political and other human factors. In her study for the IEA, Niez conducted a top-down assessment of government-led electrification programmes in several emerging economies which included a detailed review of conditions required for successful stand-alone systems in a rural setting [12]. She found that a detailed understanding of the population, sustained governmental support, market infrastructure, community support and affordability all underpin success. A similar paper on behalf of the World Bank examined the generic reasons for failure to provide universal access to electricity [13]. Its findings support Niez's assertion that government commitment and financial viability are critical for successful electrification. Indeed Foley, Bailey et al., Peskett, Zalengera et al. and others agree (or at least imply) that organisational, economic and social constraints are likely to be key factors [14–16]. Given this weight of consensus it is perhaps surprising that the human dimension has not always attracted academic interest. As recently as 2012 Schillebeeckx et al. assessed 232 papers on this subject, finding that most focused on technical and institutional perspectives rather than understanding economic viability and user need [17]. This suggests that micro generation in the developing world is still being addressed largely as a top-down policy or engineering problem rather than a more holistic societal issue.

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<sup>1</sup> Energy development is defined as the transition to modern fuels, and then to mature energy end-use.

### 1.2.3. Micro generation in Afghanistan and other failing states

Afghanistan offers an interesting but challenging micro generation case study. Despite plentiful renewable resources [18,19], its rural communities feel the combined pressures of conflict, poverty and weak governance. The limited capacity and reach of government is of particular interest. Much of the literature reviewed here asserts the importance of effective instruments of government to form and implement policy in support of rural electrification. However, states considered to be failed or failing are characterised by the suspension of government functions [20]. Indeed, as a subject, rural electrification in failed states or areas of conflict seems poorly targeted by research despite predictions that intra-state violence will be a re-occurring theme [21]. It is touched upon by Weihe in his examination of the phenomena of local co-operatives where central government cannot deliver economic and social development [22]. He concurs with Neiz's finding that local communities must own their means of power generation, although in the case of failing states it may be aid agencies and other non-state actors that act as facilitators, rather than government. The subject of electrification in rural Afghanistan is less short of commentators. Several wide-ranging reports have been published that address the successes and failures of Afghanistan rural micro generation since 2001 [23–26]. The Afghan government itself has produced several policy documents that show a reasonable grasp of both human and technical challenges [27–29]. In conjunction with more general international literature, these will be used to validate this study.

## 2. Methods

### 2.1. Assumptions

Several assumptions are necessary to deliver meaningful outputs within the larger subject of Afghan development. This is an imperfect approach since development is a multi-faceted challenge; nevertheless, to derive useful conclusions in this study the problem must first be constrained to a sensible degree. These assumptions are described as followed in sections 2.1.1–2.1.4.

#### 2.1.1. Micro generation contribution to economic development

This study addresses micro generation's contribution to economic development. At its most basic level, it assumes economic development is a positive and desirable goal. This may seem self-evident but in the conflict of ideas in Afghanistan these views are not necessarily shared by the entire population.<sup>2</sup> It focuses on improving micro generation's contribution to near term (<5 years) economic development because the need is severe and urgent. The interaction of micro generation with longer term evolvers of aspiration, such as education, female emancipation and exposure to media, is implied but not considered in detail. These aspects would be appealing as a second stage to this paper (indeed Niez asserts such issues are highly relevant to long term economic development [12]).

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<sup>2</sup> Some of the more extreme fundamentalist organisations in Afghanistan and the Middle East might be said to be pursuing anti-development agendas.

### 2.1.2. Community as the primary stable entity

Afghanistan is classified as “highly fragile”. Such states are characterised by several dimensions of instability including: factionalisation; public service failure; legal violations; security failures; and economic instability. Other examples include Iraq, Syria, Yemen, Central African Republic, Somalia, and to add complexity, these states are often not in equilibrium; that is to say they may be becoming more or less stable, the direction and speed of which will also affect micro generation and economic development [30]. The literature review points to a gap here in that most papers addressing developing world electrification focus on high-level policy-centric solutions. These imply that governments control their own territory, provide and enact policy, and act in the interests of the population. But in highly fragile states this is often not the case. In Afghanistan, long term instability means villages and tribal groups have frequently been left to devise and implement their own “policies” and to chart their own course through conflict. This is not to belittle the substantial progress made by the Afghan government in recent years, however parts of Afghanistan at least may have an uncertain future in terms of governance, see Appendix 1 [31]. In such volatile circumstances the community becomes the most stable element; the anchor of certainty for individuals. Accordingly, a key element of this study’s unique contribution is its focus on the community as the primary organisational and executive entity, situated in a context of political, economic and other instability. There is estimated to be ~24,000 such rural communities in Afghanistan, each unique but having some affinity at least with the following characteristics (further details at Appendix 1):

- (1) Traditional leadership structure;
- (2) Severe poverty-subsistence economy, food insecurity, very low incomes and levels of capital;
- (3) Under-employment;
- (4) Very low levels of education and skills.

### 2.1.3. External organisations

The capital and educational limitations hold particular relevance for micro generation and lead to the next assumption. It is very unlikely a typical rural Afghan community will have the finances and technical wherewithal to develop a micro generation scheme without the support of an external organisation. This may be a governmental body. But in another district or province, for reasons of limited capacity, security or allegiance, it may be a different organisation. In highly fragile states the government may be too weak to fulfil this role or may even deny development opportunities deliberately. This has been claimed by at least one minority group in Afghanistan and seems likely in other fragile states with deep social divides. The trend in Afghanistan seems to be toward increasing government capacity. But given the range of bodies, including Western Governmental Organisations (GOs), International Organisations (IOs), Non-Governmental Organisations (NGOs) and even NATO military forces, that have hitherto implemented micro generation projects, this demands a more open approach to defining which organisations might set policy and assist communities. For this study, the following external organisations are defined. The ambiguity is deliberate and in keeping with the primacy of the community in this study:

**Overseeing Organisation (OO)**—that which has decided to commission the delivery of micro generation to groups of rural communities, and which sets the policies for implementation. It is the guiding mind and the intellect behind the process. Typically, a central government department or a GO/IO/NGO.

**Enabling Partner (EP)**—that which is providing practical assistance to individual communities to develop micro generation schemes. It may be one organisation, or many working together in a similar timescale for overall effect. Typically, a provincial or district government office, local NGO or contracted service provider.

#### 2.1.4. Other assumptions

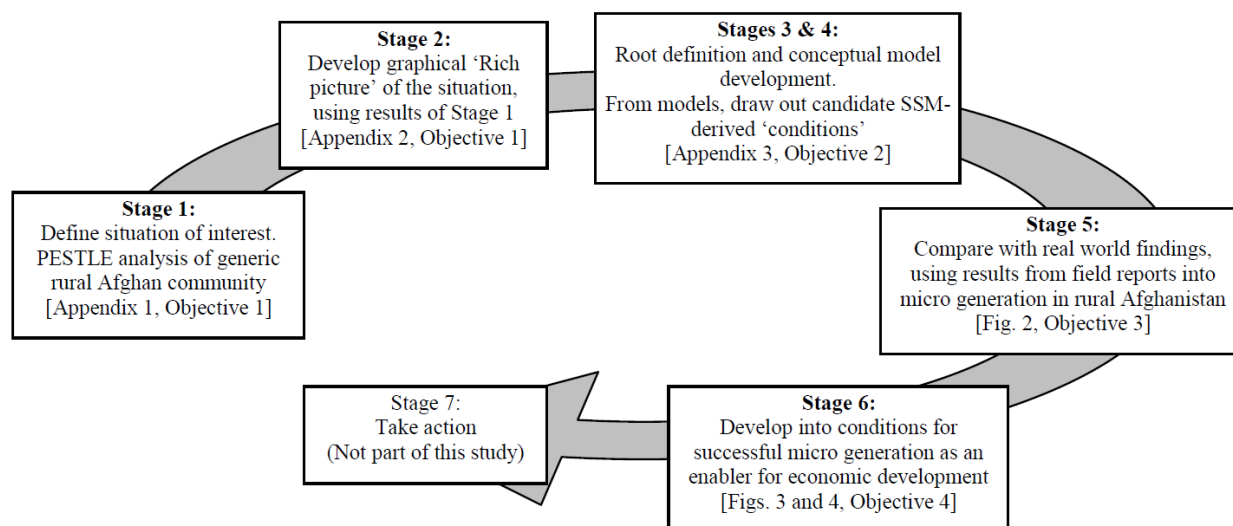
Micro-generation is a common but ill-defined term. This report uses the meaning: “...*generation of electricity ... on a small scale*, typically for domestic use and by methods that do not contribute to the depletion of natural resources...” [32]. There is no globally agreed scale and, in this context, it seems sensible to define by user community size. The Afghan Government delineation of 5000 individuals will be used here, although most rural communities will be smaller [29]. Furthermore, in pursuing the goal of economic development this study targets community, rather than household level, micro generation as the latter risks marginalising the poorest. Conversely, inter-community schemes are a possibility and could work well where resource ownership is shared (for example a river). They are not addressed specifically here but will have much commonality with the conclusions.

## 2.2. *Soft systems approach*

Engineering feasibility studies and technology cost-effectiveness comparisons are well represented in developing world electrification literature however they address only one part of the problem. Reasons for success or failure in such challenging environments are typically traced to less deterministic factors: social; economic; political; and the like. In seeking to address these influences, this study is by nature a qualitative assessment. It steers away from quantitative problem-solving; instead, it seeks to find the combination of qualitative conditions that offers the best likelihood of success in the context of micro generation as an enabler for economic development [33].<sup>3</sup> Establishing these conditions requires an approach suited to the complex, untidy (in a systems sense) environment that is rural Afghanistan. A range of frameworks and methodologies were reviewed, including simpler “PESTLE” and variants, and “hard” and “soft” systems approaches. Checkland’s “Soft Systems Methodology” (SSM) was finally selected as it offered a process optimised for the kinds of unstructured human problems toward which the body of literature points. In Checkland’s words, these are conundrums that are characterised by a “feeling of unease, which cannot be explicitly stated without oversimplifying the problem” or put another way, a “mismatch between actuality and what is perceived might become actuality” [34]. This is a good description of the nature of this study, which does not seek to define a required outcome. Instead it acknowledges a

<sup>3</sup> The term *condition* is defined as ‘a stipulation; something upon the fulfilment of which something else depends.’

feeling of unease, something like: surely micro generation could, and should, make more of a contribution to economic development in rural Afghanistan? It then sets about finding the conditions that could help unlock micro generation as a more effective contributor in narrowing this perceived mismatch. In essence, this study seeks to develop a range of conditions, based on a detailed understanding of the context. These independently-derived conditions are then compared with field reports, to both corroborate the independent conditions, and to spot potential new conditions that have not been noted in other studies. This process is shown in more detail at Figure 1.



**Figure 1.** SSM applied to micro generation in rural Afghanistan.

Stage 1 was derived using a range of online sources, in a PESTLE format, to describe in detail the context. Stage 2 took forward the findings from Stage 1, into a graphical representation of a generic rural Afghan community. Combined, Stages 1 and 2 forced an intimate understanding of a generic rural Afghan community (within the constraints of a desktop study). Stages 3 and 4 are at the heart of the SSM approach. Stage 3 saw the development of a series of “holons” (or “plausible perspectives”) associated with micro generation. Twenty-two holons were devised, through an iterative process based on the contextual understanding developed at Stages 1 and 2. In keeping with the nature of this study, holons were rooted primarily in the community, however in recognition of the criticality of both OO and EP, several holons addressed perspectives relevant to those organisations. Thereafter, at Stage 4, individual holons were developed into a system description, then a conceptual system model. Each modelling process prompted new insights into other holons and their conceptual models; in this way, the models were refined through several cycles of review. From examination of each system model, a total of 151 candidate conditions for success (or opposing threat conditions) were identified. Predictably, many candidate conditions were duplicated across holons, necessitating the grouping of similar or identical candidate success and threat conditions. Again, this process was qualitative and iterative, care being taken not to lose the meaning of the original candidate conditions. These 46 grouped conditions were checked for feasibility, uniqueness and completeness then scored for their criticality to the success of micro generation as an enabler for

economic development, from the perspective of a rural Afghan community. A variety of micro generation studies were then selected against which to validate these independently-derived conditions. These were chosen to include a broad range of viewpoints, purposes and data regarding the success or otherwise of micro generation projects and these are described below.

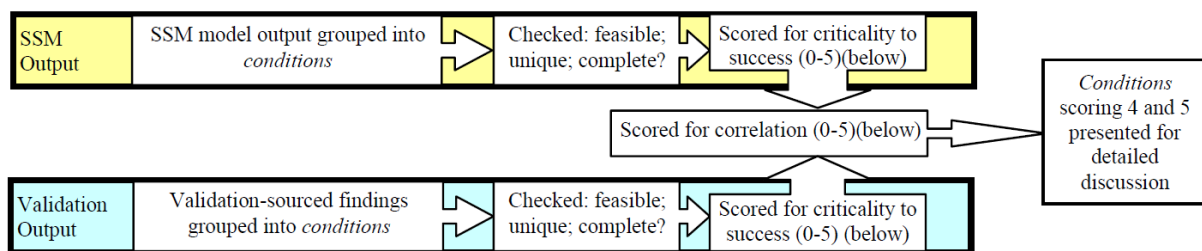
Specific to Afghanistan:

- (1) United States Agency for International Development: audit of 60 micro hydro schemes [26].
- (2) German International Development Agency: renewable energy sector capacity assessment [25].
- (3) Afghan Government Ministry of Rural Rehabilitation and Development: micro generation policy [27,28].
- (4) Journal of Sustainable Development of Energy, Water and Environment Systems: survey of 421 micro hydro installations [24].
- (5) Afghan Government: energy sector strategy assessments of sector weaknesses [29].
- (6) United States Department of Defense: results from 68 schemes were used to derive a distributed energy model [23].

International:

- (1) International Energy Agency: rural electrification policies in emerging economies [12].
- (2) World Bank: addressing the electricity access gap in the developing world [13].
- (3) UK Department for International Development and World Bank: best practices for sustainable micro hydro in developing countries [35].

From these reports, systematic analysis identified 86 validation conditions. Each SSM condition was scored 0–5 for the level of correlation with one or more validation conditions. The complete validation process is shown at Figure 2. It is fundamentally a qualitative comparison, in keeping with the nature of SSM and its emphasis on perspectives. Scoring allows importance and correlation to be ranked but further numerical manipulation is avoided as it risks losing meaning.



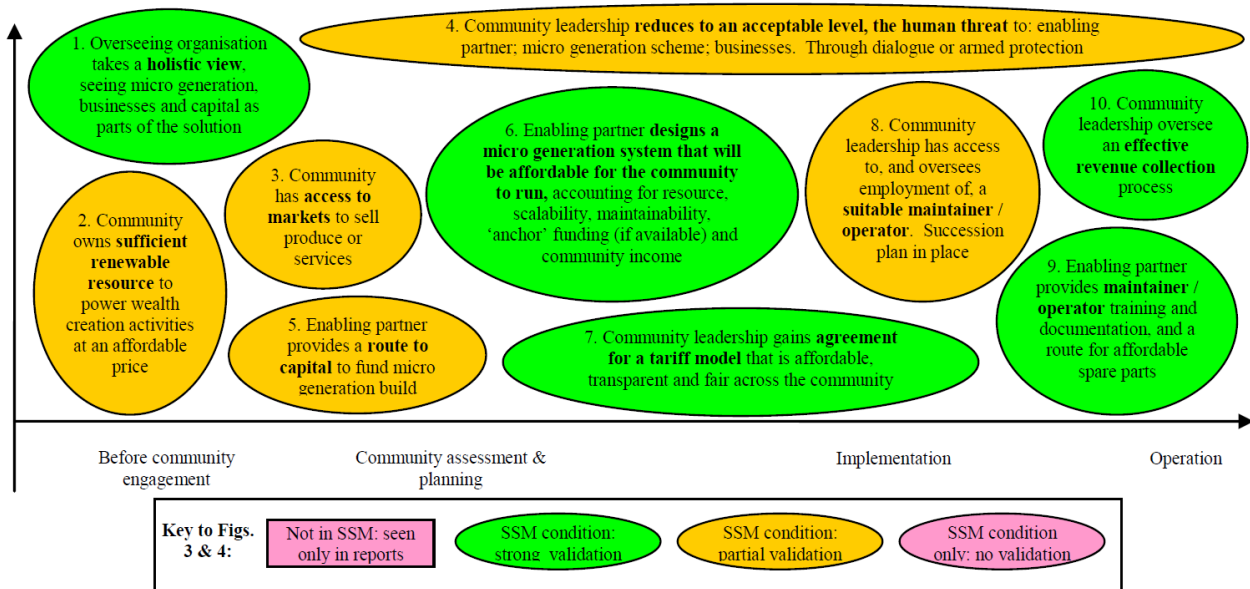
Scoring: Criticality to Success		Scoring: Level of Correlation	
Irelevant	0	No correlation	
Desirable - unlikely to fail without	1	Very weak single source correlation	
May fail without	2	Weak single source correlation	
Significant - likely to fail without	3	Strong single correlation or weak multiple source correlation	
Sub-critical - Highly likely to fail without	4	Very strong single or strong multiple source correlation	
Critical - will fail without	5	Very strong multiple source correlation	

Figure 2. Scoring and validation process.

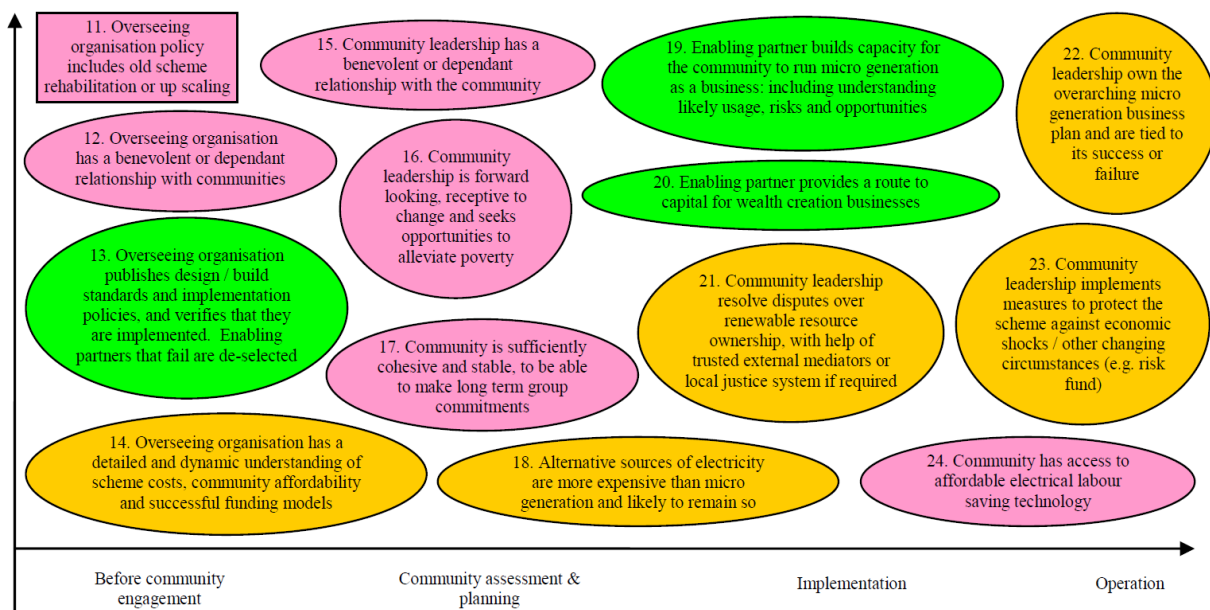


### 3. Results

The findings from Stage 6 of the SSM process are shown below. Figure 3 shows conditions scoring in the highest tier; these are considered critical for success in rural Afghanistan. Figure 4 shows conditions scoring “4” (referred to as “sub-critical”), without which success is deemed highly unlikely. Both are shown against an outline project timeline.



**Figure 3.** Critical conditions for micro generation to contribute to economic development in rural Afghanistan.



**Figure 4.** Sub-critical conditions for micro generation to contribute to economic development in rural Afghanistan.

## 4. Analysis and discussion

### 4.1. Critical conditions

Ten critical conditions were established. All correlated, entirely or partially, with conditions identified in field or policy reports and all are necessary but none, alone, is sufficient for success. Of course, the qualitative nature of this study and the critical and sub-critical conditions means that few derived conditions are binary in nature. Nevertheless, this does not detract from their importance. It will be apparent that many are universal in nature, in the sense that they are global requirements independent of context (for example sufficient resource). This study adds value by bringing to the fore those that are of the highest priority in rural Afghanistan, from a community perspective. This is analogous to Maslow's "hierarchy of needs", in that more developed states will assume the basic elements of stable government, literacy, business infrastructure etc are in place and instead focus on higher order, more evolved requirements. In contrast, the conditions identified here provide a glimpse of the baseline requirements for successful micro generation in the most tenuous of circumstances. These critical conditions group naturally into 3 themes: a holistic policy view; a sufficiently secure environment for project build, operation and wealth creation; and external support to build community capacity to fund and maintain schemes through-life.

#### 4.1.1. Condition 1: Holistic policy view

The genesis of success in the context of this study, is a holistic view, originating from the OO, which sees micro generation as a component of a broader approach to economic development. Indeed, because it relies on wealth to fund its operation, electrification as an end in itself is almost certain to fail if not accompanied by activity to develop the community's means to generate that wealth. This condition validated well. It is self-evident and recognised broadly in literature as a critical condition for creating the environment for the sustainable alleviation of poverty.

#### 4.1.2. Conditions 3 and 4: Sufficiently secure environment for build, operation and wealth creation

These conditions are a mark of fragile states. Firstly, the community must have access to markets through which to sell the goods or services that have been enabled by a reliable electricity supply. This stems from the assumption that the typical Afghan community possesses very little in the way of indigenous wealth. It must rely on the export of textiles or dried fruit, or the service provided by a flour mill for example, to the wider world, to import wealth. Condition 3, access to markets, correlated only partially perhaps because it is assumed. However, the least developed, most fragile societies may experience, through violence or other causes, the regular disruption or even prolonged absence of markets and transport infrastructure that underpin movement of wealth. Even with the help of electricity to produce goods more efficiently, the typical community is still surrounded by similarly poor communities. Without markets to move goods and import wealth from

further afield, it is unlikely to make significant economic gains [36].<sup>4</sup> Moving to Condition 4, through the life of a micro generation scheme violence is likely to touch the community itself and the businesses it tries to develop. The Taliban has been more accepting of development in recent years but there remains a significant threat to EPs (particularly to international staff) and the emergence of Islamic State could point to a more rejectionist, anarchic future across the region. Whatever the threat group (and it may be government forces in some states), the community leadership will need to keep the human threat below an acceptable threshold. Condition 4 is hard to judge; who can tell how a conflict will ebb and flow? Geography and allegiance will be factors, as will the leadership's ability to steer a safe course between the warring sides (see section 4.2.2) [31]. Dialogue or armed protection may be sufficient but in the worst circumstances, the community's best efforts may simply be overwhelmed by the tide of fighting.

#### 4.1.3. Conditions 2, 5–10: External support to build capacity to fund and maintain scheme through life

Affordability begins with community ownership of sufficient renewable resource. Condition 2 correlated only partially, again perhaps because it is assumed. Nevertheless, it must be satisfied and although much of rural Afghanistan is well served by rivers there will be many communities that are limited to more expensive and complex conversion technologies like solar PV. These may be less effective in meeting reliably and affordably; the capacity demands of businesses. Moving to Condition 5, severe poverty is a central and oft-repeated assumption in this study. It therefore follows that capital must be provided from an external source, in part or full, to fund the micro generation scheme build. This correlated well with Afghan policy documents but less so with other Afghanistan reports which tended to address lessons from implementation and operation phases, making the assumption that capital had already been provided. Condition 6 requires affordable operation by design. Implicit in this condition is that the EP designs the micro generation scheme since another characteristic of rural Afghan communities is an absence of education and technical skills. This is improving as the post-2001 education system infiltrates but rural Afghanistan still has one of the lowest literacy rates in the world. Explicit in this condition is that the design effort is focused on through life affordability. This is critical: in fragile states, like Afghanistan, lifetime subsidies are very unlikely to be practical. Through the life of a UK renewable energy tariff agreement (25 years), Afghanistan has had several violent regime changes and long periods of civil war. These conditions make tariff subsidies inappropriate; instead, to give the scheme the best chance of success, investment must be up-front, and the design optimised for low running costs. This condition also makes reference to "Anchor" funding, meaning a source of energy funding from outside the community, usually in support of a service like a school or health centre upon which the community can rely to provide uninterrupted "baseline" funding. This is highly desirable but, like subsidies, it may not be relied upon in the most fragile states. Conditions 8 and 9 focus on aspects of through life operation and maintenance. The former addresses more nebulous but nonetheless important requirements of having access to, and selecting suitable maintainers and operators. The

<sup>4</sup> There is a view that highly fragile states develop a form of extreme, unregulated market capitalism such as existed in Afghanistan during 1990-94. But this period was characterised by extreme poverty, concentration of wealth and the marketisation of violence; all highly undesirable outcomes.

phrase “access to” is a reference to the low skills base from which the maintainer must be found. Is the community large enough or educated enough to provide individuals with an aptitude for this work? “Selecting” refers to nepotism or power-base relationships which commonly drive appointments of this kind in Afghanistan. To give the best chance of success the maintainer/operator must be selected on merit rather than family ties. A succession plan is also vital; instability and limited healthcare make it prudent to have at least 2 individuals trained through the life of the scheme. Condition 9 lists more practical needs, specifically training, documentation and a route to spare parts. These are global requirements but made more difficult in Afghanistan by the general lack of education and the vulnerability and affordability of the supply chain. Finally, if the scheme is to be maintained and operated successfully it must be funded through life, to pay the maintainer and to buy parts. This is the subject of Conditions 7 and 10. For reasons discussed at Condition 6, through life subsidies are very unlikely to succeed. Instead, scheme operation must be self-funded. Condition 7 requires the agreement of a tariff that is affordable, transparent and fair. In an environment rich with corruption, transparency will lend credibility, particularly if the rate is linked to an external index. Fairness implies that it will benefit the whole community, which may point to different tariffs depending on ability to pay. Local circumstances will dictate which model best suits but pan-community buy-in will help lead to effective revenue collection, which is the subject of Condition 10. This requires similar transparency and fairness in the act of revenue collection itself.

#### *4.2. Sub-critical conditions*

##### *4.2.1. Condition 11: Rehabilitation of existing micro generation infrastructure*

Condition 11 was missed by the SSM approach which did not consider improving existing inadequate or failed schemes. This is an important policy component, particularly in states like Afghanistan, where infrastructure has been damaged by conflict, as it offers a cheaper way to develop latent capacity, both physical and human.

##### *4.2.2. Conditions 12, 15, 16, 17: Nature of the OO, leadership and community*

Conditions 12, 15, 16 and 17 did not correlate directly with any validation source. These are typical “soft” human characteristics and show the uniqueness of an SSM approach. Without the checks and balances inherent in a more stable state, the nature of, and relationships between, the OO, the community leadership and the people it serves, appear highly relevant for micro generation and development. Research focused on economic outcomes in small Afghan villages suggests that effective, progressive leadership matters greatly in steering communities through instability and the breakdown of the state [31]. The same research backs up the notion of accountability, particularly where the leadership is economically less secure (or put another way, more equal), which makes it more likely to act in the interests of the whole community. This should not be a surprise: accountability driving better outcomes is a global constant (it underpins democracy). The relationship between OO and community is of similar consequence; the closer their goals are aligned, the greater the likelihood that the OO will act in the interests of the community. But where the

OO (which might be central government), or the community leadership, is isolated, predatory or seeking short-term gains, for example pacification in counter-insurgent operations, a positive outcome is expected to be less likely. Community stability also appears very relevant for sustainable success. A community that cannot unite in supporting and funding a scheme through life is unlikely to reap sustainable economic benefits, and there is plenty of potential for generational dissent in the introduction of technology into such a traditional environment. It is acknowledged that these conditions are both dynamic and very difficult to assess objectively. This perhaps explains why they don't feature explicitly in the micro generation studies used for validation which tended to pick out more tangible conditions such as a lack of training or spare parts. Nevertheless, they could be inferred from higher level policy reports and are brought out in more general societal research. Thus, it is contended here that the nature of the OO, the leadership, and the community itself, and their relationships, is highly relevant to the likelihood of micro generation successfully enabling economic development.

#### 4.2.3. Conditions 13 and 14: OO Understands the context, and sets and enforces policies

Conditions 13 and 14 make requirements on the OO to understand the environment in which it operates and to mandate various policies that increase the likelihood of success for individual communities. Condition 13 also requires that these policies are audited, and non-compliant EPs removed, to act as an incentive to drive up build standards.

#### 4.2.4. Condition 18: Alternative sources of electricity

Condition 18 requires that alternative sources of electricity, including grid connection, are more expensive than micro generation. It can be argued that economic development is agnostic as to the source of its electricity so long as it is affordable (Conditions 5 and 8). But since this study is addressing micro generation specifically, it will have failed if displaced by a different source of cheaper electricity.

#### 4.2.5. Conditions 19–24: “Business” approach, dispute resolution and access to electrical devices

The importance of a holistic “business” approach within the community is recorded at Conditions 19, 20, 22 and 23. Condition 21 (dispute resolution) is typical of less developed states where land and water rights may not be recorded. Suspension of government justice functions in highly fragile states exacerbates such disputes, whose resolution will have a bearing on longer term success. Finally, Condition 24 draws attention to the importance of electrical devices in turning electricity into profitable output. Without access to affordable machinery such as mills or looms, communities are limited to the economic benefits afforded by electrical lighting only.

### 4.3. Lower order conditions

Summarising those conditions lower down the scale of importance, strong correlation was noted for those relating to community mobilisation, to encourage support for the scheme and to understand how to use electricity productively. These were deemed significant but did not attract a higher importance because the relatively high penetration of electrical goods like mobile phones and televisions indicates Afghans are already familiar with electricity and its uses [4]. Rushed implementation was deemed a risk to success, but only where the higher order conditions are not met (for example building capacity to run businesses). The dangers of corruption correlated well with other studies. It is, unfortunately, endemic in many fragile states but communities and businesses survive despite it. Of those conditions unique to validation literature, the creation of autonomous, apolitical organisations at each organisational level, featured often in higher level papers. This is a wise goal in the long term but of greater interest in this context are the natures of the various organisations and their relationships, and the running of the scheme in a “business-like” manner. It is the authors’ view that at this stage in Afghanistan’s development, in an environment of instability and traditional relationships, this typically-western approach will often be unrealistic at a community level. Similarly, the creation of open markets for micro generation is a sensible aspiration for longer term affordability, but less relevant in highly fragile states, where the investment necessary to sustain and develop such markets is unlikely to materialise. It will grow in importance when states transition from conflict, Rwanda being a good example, now an order further up the stability scale and seeing the benefits of private sector involvement [37].

### 4.4. Relevance for other highly fragile states

To assess broader relevance for other highly fragile states, it is necessary to consider the assumptions made about Afghanistan that led to the aforementioned conditions. By definition fragile states share macro characteristics such as factionalisation; public service failure; legal violations; security failures; and economic instability. More significant in assessing wider relevance are the specific assumptions made about rural Afghan communities, since they are likely to act as discriminators. They are: traditional leadership structure; severe poverty; under-employment; and very low levels of education and skills. Perpetually fragile states, (for example Somalia, Sudan, Yemen) will share most or all of these characteristics and the conditions identified are likely to be applicable in their entirety. Other states that have descended into fragility from more stable antecedents offer a greater contrast. Iraq and Syria are good examples of such “fallen states”, sitting well above Afghanistan in terms of wealth, education and infrastructure. Re-examining the critical conditions identified at Figure 3, Table 1 gives a summary of relevance to these “fallen states”. It shows that half the critical conditions (marked in green) are essentially universal in nature, applicable across all fragile states. The other half (marked in yellow) remain important, but the challenge they present is likely to be tempered by pre-existing national characteristics, for example wealth, education and infrastructure, which may mean that fallen states require less intervention in order to meet these conditions.

**Table 1.** Critical condition applicability to “Fallen States”.

Condition	Applicability
1. OO takes a holistic view of micro generation and business	Relevant, although the nature of the challenge will be different. Fallen states are likely to have pre-existing business capacity, as well as more capital and infrastructure, than Afghanistan.
2. Sufficient renewable resource	Highly relevant in all circumstances.
3. Access to markets	Relevant. Physical threat to markets will be similar however more developed transport and business infrastructure in fallen states will ease the challenge of selling goods.
4. Human threat reduced to acceptable level	Highly relevant, unfortunately.
5. Capital for micro generation build	Relevant, although richer states like Iraq are more likely to be able to afford part or all of these costs.
6. EP designs a micro generation system with affordable running costs	Highly relevant. Subsidies are unlikely in fragile states so the community must bear the costs of operating the scheme.
7. Agreed tariff model	Highly relevant. Agreeing funding for running costs is critical.
8. Suitable maintainer selected	Relevant. Nepotism and power relationships are factors across fragile states although with higher levels of education generally, these factors are less likely to influence long term success.
9. EP provides maintainer training & documentation	Relevant, although higher levels of education will reduce the training burden.
10. Effective revenue collection	Highly relevant. Again, funding running costs is critical to success.

#### 4.5. Study limitations

SSM is most often used in an iterative fashion through conversations with stakeholders. Applying it in a desktop study of this kind is valid, but its output is constrained to that derived, judged and validated by the authors. Without the direct voices of stakeholders, the “original thought” element is limited to secondary evidence and so this study can be considered a first step only in the evolution of useful output, a field phase being the next logical step in developing the proposed conditions. However, by way of balance, this shortcoming is common to all remote study methodologies. Furthermore, the authors assert that approaching this problem in a qualitative manner, validated against real-world studies, is worthwhile despite the challenges as it adds a new, softer perspective to a problem that has tended to be dominated by hard-systems analysis. And whilst the majority of understanding is derived from the references, one of the authors has first-hand experience of Afghanistan, which helped inform the soft systems process by lending a supporting validation perspective. Several other points are worthy of mention. The military intervention has generated an enormous quantity of literature however much of it is English language and western-authored with the bias that implies. Some Afghan government sources were used, but these are not necessarily representative of conditions on the ground. And not all the validation documents are from field studies; some are derived from policy or similar documents, removed one step at least from field work. Nevertheless, so far as possible within the constraints of a desktop study, it is contended that a reasonably accurate representation of rural Afghanistan has been derived, and that a meaningful outcome has been achieved.

## 5. Conclusions

Bringing electrical power to bear usefully in fragile states is amongst the most demanding human problems in the field of renewable generation. Physical violence is the most obvious challenge, but the lack of stable governance arguably has greater influence. It prevents a conventional government-centric approach, instead forcing the community and other organisations such as GOs and NGOs, to the fore. Such human complexity demands a qualitative “soft systems” approach and it is through this methodology, validated by field reports, that a set of critical conditions for successful micro generation in support of economic development has been developed. By thematic group, they are:

- (1) A holistic approach that sees micro generation as a component of broader economic development;
- (2) An environment safe enough for project build and operation, and for the markets necessary for wealth creation;
- (3) External support to build community capacity to fund and maintain schemes through-life.

A range of sub-critical and lower order conditions were also derived. Most validated well however the SSM approach produced a new set of conditions highlighting the importance of the nature of the OO, the community, its leadership, and their relationships. Conversely, it played down the importance of the more progressive ideas of creating autonomous bodies and opening up markets, finding these more relevant for states that have already emerged from conflict. The critical conditions were also found to have broad relevance for other highly fragile states. Recognising the limitations in the desktop nature of this study, the next step is to develop the higher order conditions, in the field, before deploying them as part of a comprehensive approach to poverty alleviation in Afghanistan and other similar states.

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## Conflict of interests

The authors declare no conflict of interest in this paper.

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