EVALUATION OF EXISTING STRATEGIES FOR THE COMMERCIALISATION OF MULTI-TECHNOLOGY RENEWABLE ENERGY SYSTEMS: THE CASE OF CONCENTRATING SOLAR POWER TECHNOLOGIES IN SOUTH AFRICA

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Abstract

The past decade has seen substantial investment in the renewable energy (RE) sector. However, the contribution of RE to global electricity production remains small. In order to accelerate the rate of commercialisation of multi-technology renewable energy systems (MTRESs), such as concentrating solar power (CSP), it is necessary to evaluate the effectiveness of existing strategies used to achieve such commercialisation. In this article, a number of strategies for the commercialisation of MTRESs are analysed. These include: methods to analyse technology, diffusion models, technological innovation systems, architecture frameworks, government policies, and business models. Analysis of the different approaches reveals a lack of harmonisation between the various aspects required for the commercialisation of MTRESs. Each approach tends to address only one aspect. Furthermore, the strategies tend to be generic in nature, not specifically focussed on, or applied to, a particular type of technology. Therefore, there is a need to develop a new type of strategy; one that incorporates the individual aspects of the strategies discussed, and is focussed on CSP. It is proposed that a management strategy be developed, incorporating elements of technology assessment (TA), market adoption, promotion and penetration strategies (MAPPSs), and analysis of the organisation responsible for the MTRES.

Keywords: CSP; commercialisation strategy; multi-technology renewable energy system

1. Introduction

In today's globalised economy, technology has come to assume the role as the primary driving force responsible for the development of local and international industries, gaining an advantage over competitors, the potential for trade, and the improvement in living standards worldwide [1]. Such progress has led to a greater demand for energy, coming at a price of increased climate change driven by the excessive production of greenhouse gases (GHGs). The production of GHGs is attributed largely to traditional energy sources, such as coal and oil. This has focused attention on renewable energy technologies (RETs) as a solution towards ensuring a sustainable future, by meeting growing energy demand, while alleviating the impact of climate change, amongst other (potential) benefits.

1.1. The development of the global renewable energy industry

The renewable energy (RE) sector has seen tremendous growth in the past decade, rapidly achieving the status of a multi-billion dollar industry. Fig. 1 shows how global investment reached nearly $329bn in 2015, almost six times the figure recorded in 2004. Such investment comes at a time when commodities, such as oil and coal, have experienced drastic price decreases, demonstrating continued commitment by investors to the RE industry [2].

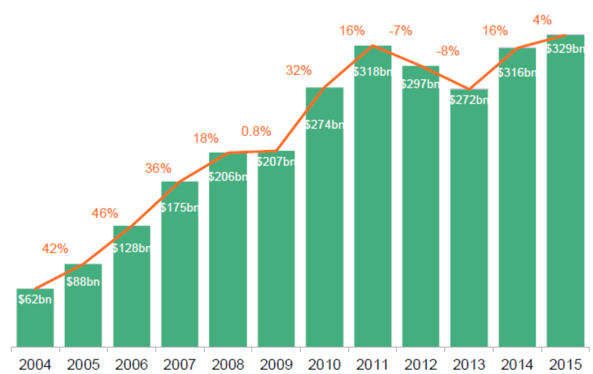

Fig. 1. Global renewable energy investment 2004 – 2015 [2]

Despite the billions invested in RE, the actual percentage of electricity generated by renewable sources relative to other energy types remains small. Fig. 2 compares the change in composition of the global energy supply from 1973 to 2013, revealing that the RE sector (biofuels and waste, and other) has grown by less than 1%.

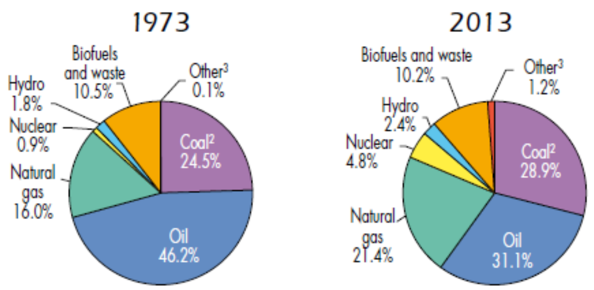

Fig. 2. Composition of global energy supply:1973 vs 2013 [3]

1.2. The commercialisation of renewable energy technologies problem

The investment in the RE sector over the past decade is at odds with the lack of substantial change in composition of the global energy supply. This perspective is shared by Balachandra *et al.* [1], who state that *'despite many efforts of governments, multilateral institutions, NGO's, and even a number of companies and investors, there has been no sustained take-off'*.

The lack of significant change in the energy contribution of RETs may be attributable to a slow rate of commercialisation, a challenge encountered by many new technologies [4]. The process of commercialisation is generally considered to follow an s-curve over time (Fig. 3). An s-curve consists of four primary phases: embryonic, growth, maturity and ageing [5].

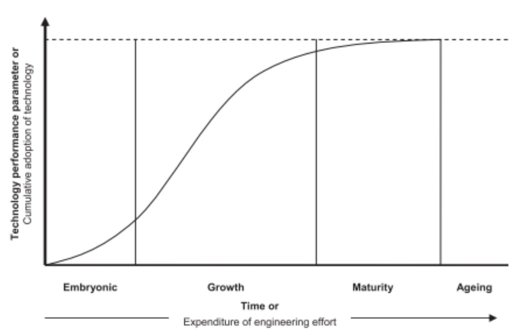

Fig. 3. A typical s-curve [6]

The inability to move quickly and effectively up the s-curve, namely: to progress from the embryonic life cycle phase to a growth phase; often results in technologies never achieving broad market adoption [5].

1.3. Objectives

The focus of this paper is limited to multi-technology renewable energy systems (MTRESs). The term 'multi-technology' is used to acknowledge the numerous integrated technologies comprising RE systems, many of which are considered established with no need for individual commercialisation, such as turbines and compressors. 'System' is used as an umbrella term to describe the integrated collective of technologies used to harness power from RE sources.

One of the prominent problems encountered with RE is the intermittent nature of supply. Energy is only able to be harnessed under certain conditions i.e. when the sun is shining or the wind is blowing. This has led to a strong focus on the use of thermal energy storage (TES), where heat is able to be stored for later use, thus extending the hours of electricity generation. One MTRES that is particularly suitable for integration with TES technologies is that of concentrating solar power (CSP) [7]. Furthermore, CSP technologies have the potential for system hybridisation, as well as being a scalable technology that can operate in off-grid situations. Therefore, the objectives of this paper are as follows:

1. Analyse current strategies, and associated approaches and techniques, used for the commercialisation of MTRESs;
2. Evaluate whether such strategies are applicable to CSP technologies in South Africa, and if not;
3. Identify means of adapting such strategies for use with CSP technologies in South Africa.

Achievement of these objectives is intended to improve the rate of commercialisation of CSP technologies, furthering socio-economic growth.

2. Technology commercialisation

The process of technology commercialisation is defined by Balachandra *et al.* [1] as: *'the creation of self-sustaining markets that thrive - without any kind of favour - in a level playing field with other competing technologies'*. This definition accurately captures the final objective of the commercialisation of MTRESs, namely: the development of MTRESs that are able to compete fully with traditional energy-producing technologies, without any aid, such as government subsidies. Through commercialisation, a technology is able to satisfy expectations relating to its performance, and reliability, as well as being available at a cost the consumer is willing to pay [1].

Fig. 4 illustrates the activities that form part of the commercialisation process. Any approach aimed at commercialising MTRESs needs to address each phase individually, while also ensuring that the collective whole acts toward fulfilling the goal of commercialisation. As a result, it is likely that a multi-faceted approach to the commercialisation of MTRESs may prove the most effective.

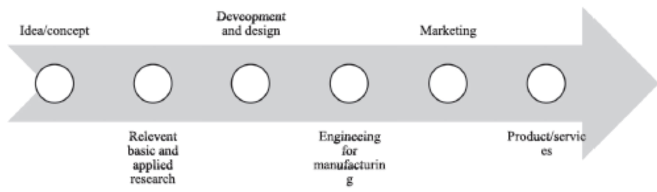

Fig. 4. Commercialisation process activities [8]

Balachandra *et al.* [1] examine the innovation chain in detail, the later stages of which form the commercialisation phase. In particular, Fig. 5 draws attention to the so-called *'technology valley of death'*, a transition period within the innovation chain characterised by large production costs and poor market penetration. It is this period that is often responsible for the demise of many technologies. Commercialisation is seen as vital in overcoming this challenge [1].

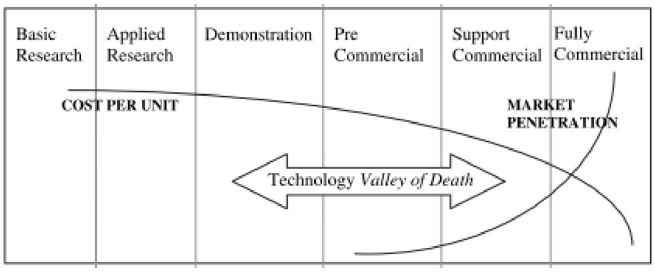

Fig. 5. Innovation chain - technology valley of death [1]

2.1. Emergence of a dominant design

One aspect of the commercialisation process worth considering is the tendency for a '*dominant'* design to emerge. A dominant design, defined by Cetindamar *et al.* [5] as *'a key technological design that is a de facto standard in its marketplace'*, is one that has a number of superior attributes relative to the competition, such as cost, performance, ease of use and favourable public perception.

It may not always be apparent which technological design has reached dominance in an industry, as several designs may exist and be in use. However, one model will typically come to hold a greater market percentage than the other designs, due to factors such as consumer preference and time spent in the marketplace.

2.2. Commercialisation of multi-technology renewable energy systems

Currently, the commercialisation of MTRESs is achieved mainly through government-related efforts, with little input from the private sector [1]. Aslani [8] identified a number of initiatives used by governments globally for driving the commercialisation of MTRESs. These initiatives include: feed-in tariffs (FITs), R&D support, tax incentives, and international cooperation between different industry players.

Many technological industries, such as automobiles and cellular phones have achieved rapid economic growth in a relatively short period of time. The growth realised by these technologies stands in stark contrast to that experienced by MTRESs. In order to achieve similar levels of growth, the investment potential and expertise of the private sector needs to be harnessed more effectively. Balachandra *et al.* [1] concur with this view, pointing to the existing structure of the energy industry as an example where the private sector has assumed a strong position in such technologies.

4. Strategies, approaches and techniques for the commercialisation of MTRESs

The following strategies currently used for the commercialisation of MTRESs were identified. In practice, these methods may not be used exclusively. The purpose of this section is to analyse each method separately.

4.1. Technology life cycle analysis

A technology life cycle analysis (LCA) divides the life cycle of a technology into a number of phases, from conception of the original idea to the end of the technology's use. The ability to evaluate the complete life cycle of a technology marks the LCA as a useful tool. The tool's importance is underlined by Taylor & Taylor [6], who claim that, for the effective management of technology, companies need to possess the ability to identify the life cycle phase of a particular technology as well as the phase's relevance with regards to decision making.

The use of an s-curve to model a technology's life cycle has grown into a widely used tool in order to understand technologies and their progression. The origins of the model lie in the fact that the growth of most technologies follows an s-shaped curve (Fig. 3), one that consists of four life cycle phases: embryonic, growth, maturity and ageing [5].

During the embryonic phase a technology is in its infancy, with the future path unknown. The growth phase is characterised by an increase in the rate of development as resources, such as time and capital, are invested into the technology. It is often during this phase that a technology experiences its greatest development. The mature phase is one dominated by a slow rate of incremental improvement, with great effort required for any meaningful development. Once the ageing phase is reached technological advancement ends [5].

Grobbelaar *et al.* [9] present an overview of the RET industry (Fig. 6), demonstrating the potential incorporation of a technology LCA with other data. Although focusing upon RETs, it also has value for MTRES technologies. The various RETs are positioned based on their current life cycle phase, together with the immediate steps and policy objectives required to aid their individual commercialisation process.

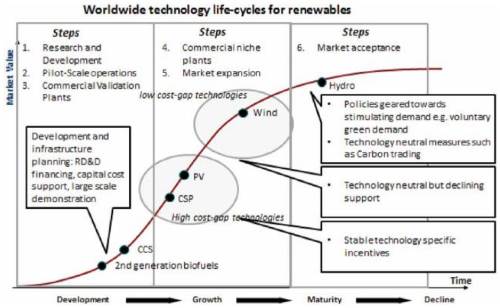

Fig. 6. Overview of RET industry [9]

The use of a technology LCA as a suitable means of achieving the commercialisation of MTRESs is highly debatable. While it does allow for the identification of the current life cycle phase of a technology, it requires integration with other methods and energy-related data to assist the commercialisation process. Furthermore, debate will always exist around the metrics used to determine the applicable lifecycle phase of a technology, as the boundaries between the different phases are not exact. Therefore, the independent use of a LCA is deemed insufficient.

4.2. Technology assessment

One could argue that any approach to commercialising MTRESs should consist of a technology assessment (TA). TA has become an important tool in the modern business environment, used by companies to analyse technologies to meet their needs and the needs of the consumer.

The origins of TA can be traced back to the 1960's in the United States. The original idea, proposed by the U.S. Congress, was to develop a system aimed at providing early warning of the possible risks that new technologies may pose to society [10]. Since then, the field of TA has grown to encompass a multitude of analytical tools and methods, as summarised by Peach [11] in Fig. 7.

Although TA does provide an in depth analysis of a technology, it fails to address sufficiently the nature of the organisation responsible for the respective technology. It is anticipated that to succeed in the commercialisation of MTRESs, an organisation needs to possess adequate internal 'strength'; that is, possess sizeable operational divisions, such as manufacturing, marketing, and R&D, or have the ability to finance the outsourcing of such activities when required.

Economic Analysis
- *Cost benefit analysis*
- *Cost effectiveness analysis*
- *Lifecycle cost assessment*
- *Return on investments*
- *Net present value*
- *Internal rate of return*
- *Breakeven point analysis*
- *Payback period analysis*
- *Residual income*
- *Total savings*
- *Increasing returns analysis*
- *Technology value pyramid*
- *Real options*
- *Technology balance sheet*

Decision analysis
- *Multicriteria decision analysis*
- *Multiattribute utility theory*
- *Scoring*
- *Group decision support systems*
  - *Delphi/group Delphi*
  - *Analytic hierarchy process*
  - *Q-sort*
- *Decision trees*
- *Fuzzy logic*

Systems engineering/ systems analysis
- *Technology system studies*
- *System dynamics*
- *Simulation modelling and analysis*
- *Project management techniques*
- *Systems optimization techniques*
  - *Linear, integer and non-linear programming*
- *Technology portfolio analysis*

Technology forecasting
- *S-curve analysis*
- *Delphi/ Analytic hierarchy process/Q-sort*
- *R&D researcher hazard rate analysis*
- *Trend extrapolation*
- *Correlation and causal methods*
- *Probabilistic methods*
- *Monte Carlo simulation*
- *Roadmapping*

Information Monitoring
- *Electronic database*
- *internet*
- *Technical/ scientific lit reviews*
- *Patent searches*
- *IP asset valuation*

Technical performance assessment
- *Statistical analysis*
- *Bayesian confidence profile analysis*
- *Surveys/questionnaires*
- *Trial use periods*
- *Beta testing*
- *Technology decomposition theory*
- *S-curve analysis*
- *Human factors analysis*
  - *Ergonomics studies*
  - *Ease-of-use studies*
- *Outcomes research*
- *Technometrics*

Risk assessment
- *Simulation modelling and analysis*
- *Probabilistic risk assessment*
- *Environ, health and safety studies*
- *Risk-based decision trees*
- *Litigation risk assessment*

Market analysis
- *Fusion method*
- *Market push/pull analysis*
- *Surveys/questionnaires*
- *S-curves analysis*
- *Scenario analysis*
- *Multigenerational tech diffusion*

Externalities/impact analysis
- *Externalities analysis*
- *Social impact analysis*
- *Political impact analysis*
- *Environmental impact analysis*
- *Cultural impact analysis*
- *Integrated impact assessment*
- *Life cycle analysis*

Fig. 7. Technology assessment tools & methods [11]

4.3. Diffusion model

Technology diffusion has been shown to reflect an s-curve, based on the assumption that the increase in use of a technology relies on the total (potential) adopters over time [12]. Rao & Kishore [12] highlight how the diffusion of MTRESs is driven primarily by environmental and energy security concerns, as well as government policies. These factors have led experts to concentrate on developing frameworks for the analysis of policies and obstacles that exist to the diffusion process of MTRESs. These frameworks have resulted in a number of different approaches to the analysis of MTRESs diffusion:

- Economies of scale, learning and experience curves for the purpose of cost reductions
- Economic analysis
- Stakeholders' perspectives, and barrier analysis and mitigation framework
- Policy analysis

Rao & Kishore [12] recognise two central issues regarding the use of diffusion models with MTRESs. One, the entire potential of MTRESs relies on the available natural resources, and thus has a natural supply limit. The potential for current diffusion models is typically determined from a free market scenario, while for MTRES diffusion models the finite potential is estimated and given. Two, the parameters of diffusion that are estimated from use of the models could form a foundation for successful comparison of different diffusion processes if they could be linked to explanatory variables. Such a comparison could then be made between different diffusion models and different factors of the MTRESs diffusion process.

While the use of a diffusion model has its merits, no model developed so far presents a systematic approach aimed at addressing the multiple aspects comprising the commercialisation process, in particular that of MTRESs. Diffusion models tend to make use of mathematical relationships to measure the rate of adoption of a technology over time. Such approaches make no provision for any kind of technical analysis, necessary to understand the underlying technology, nor do they mention the organisation responsible for the MTRES or the relevant capabilities it needs to possess.

4.4. Technological innovation system

Jacobsson & Johnson [13] argue for the use of a technological system in the diffusion of technologies. Carlsson & Stankiewicz [14], as cited in Jacobsson & Johnson [13], define a technological system as: a *'network(s) of agents interacting in a specific technology area under a particular institutional infrastructure to generate, diffuse, and utilize technology'*.

The three principal aspects within a technological system are classified as: agents, networks, and institutions. The most important agents are those termed 'prime movers', agents possessing significant technical, financial and political strength that can start or contribute to the diffusion process of a new technology. Support from these agents is essential in order to accelerate the rapid transition to market of MTRESs. Networks provide for the transfer of knowledge between agents, allowing for the discovery of issues and advancement of new solutions. Fostering and strengthening these networks also contributes to the commercialisation process [13].

Institutions are generally classified as 'hard' (legislation, financial markets, educational systems) or 'soft' (culture), and are able to dictate the future direction that a technology takes. The importance of institutional support should not be underestimated, in particular the impact that political will and support have regarding the development of any new technology. The challenges surrounding the formation of a new technological system are represented through forces causing market, institutional, and network failures. These forces, while acting independently, often combine to cause a failure of the technological system [13].

The use of a technological system appears to present a suitable approach for the commercialisation of MTRESs. However, it does not make mention of any specific TA techniques that could be used, nor does it focus on the particular interfaces that exist between the agents, networks and institutions.

4.5 Architecture framework

Any approach that seeks to integrate a number of different methods to serve a common goal needs to consider carefully the impact that the interfaces may have on the collective whole. For this reason, it is perhaps better to utilise an architecture framework approach for commercialising of MTRESs, described by Davis, Mazzuchi & Sarkani [15] as dealing *'not only with the form and function of systems themselves, but also with interfaces between systems and with external factors and processes'* (see Fig. 8).

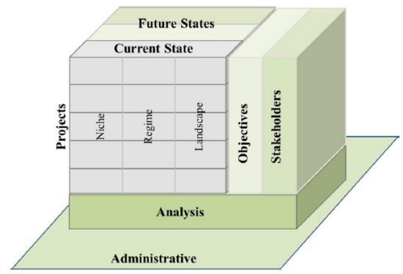

Fig. 8. Architecture Framework [15]

Davis *et al.* [15] identified seven major aspects: Administrative, Analysis, Projects, Current State, Future States, Objectives, and Stakeholders. The key role played by architectures lies in their ability to handle problems containing inherent uncertainty and poor organisation by simplifying the problem and concentrating on the primary issues [15].

4.6 Government action and policy

The responsibility of government with respect to the commercialisation of MTRESs is complicated. New and innovative governance is required to meet growing energy demand, and mitigate the detrimental effects of climate change, while simultaneously balancing the interests of, and pressures from, various sectors. A number of different plans and policies have been developed and (to some extent) implemented by governments worldwide relating to the inclusion of renewable energy into their energy mix, with varying levels of success. Balachandra *et al.* [1] acknowledge the changing activities of government used to promote an environment for the transfer of MTRES technology, with government's role now seen as that of an implementer of policy and initiatives designed to encourage the adoption of MTRESs by the private sector.

Lund [16] classifies policy into two principal types: technology push (R&D measures focused on technology innovation), and market pull (market-based measures aimed at fostering demand for the respective technology through various incentives). Haas *et al.* [17] elaborate on market pull type policies by dividing them into two categories: price-driven, where the price is fixed and the quantity (quota) determined by the market, and quantity-driven, where the quantity is fixed and the price determined by the market.

The primary discussion regarding market pull policies revolves around the choice of FITs (price-driven) versus tradable green certificates (TGCs) based on quotas (quantity driven). A FIT is a set price per unit of electricity (typically kWh) generated from a MTRES that a utility, supplier, or grid operator has to pay for by law. The price is determined by government and can take shape in one of two ways:

1. A fixed amount is paid per unit of green electricity produced, or;
2. An additional amount is added to the existing electricity price, which is then paid to green electricity suppliers. This approach tends to be more volatile due to changing market prices.

FITs are able to target specific MTRES technologies. A popular variation is a stepped FIT, where the amount paid to MTRES developers decreases over time as the technology achieves greater cost reductions and increased profitability [18].

TGCs operate on a system where government establishes a set quantity or percentage of electricity to be generated from RE sources by one or more players in the electricity value chain, such as generators, retailers, or end-users. A market is developed to assist the role players, one where TGCs can be traded. The price of the certificates is determined through market forces. Each certificate represents the price paid for one unit of electricity (normally 1 MWH) produced from MTRESs, with the total capacity equal to the quantity set by the government. Players have the option of either producing electricity from RE sources themselves, or buying a certificate from a green electricity supplier, thus meeting their quota. Penalties are enforced should the quota not be met within the allocated time span in the form of a higher buy-out price for the TGCs [18].

One issue with this approach is the lack of focus on individual MTRES technologies. One could introduce separate TGCs based on the different MTRESs, but this would result in smaller markets with lower liquidity. An alternative is to add weightings to the certificates to distinguish electricity supplied from different MTRESs (biofuel = 1, wind = 6, solar = 3 etc.). However, this raises questions regarding what the optimal mix of weightings should be, bearing in mind it is likely to change over time [18].

Another popular quantity-driven approach is that of a tender system. Two types of tender system exist:

1. A fixed quantity of electricity to be generated from RE sources is announced, followed by a bidding process. Contracts are subsequently awarded to the winning tenders. These contracts provide an advantageous investment environment, such as financial grants per installed kW.
2. A bidding process is also held, except that in place of immediate financial support government offers a bid price per kWh for a defined period of time.

Tender systems have placed a greater focus on the role of the private sector, challenging them to deliver the lowest economically feasible price possible. It is worth mentioning that some tendering processes, such as the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) in South Africa, have included certain conditions that potential bidders need to fulfil, such as utilising local content that leads to increased socio-economic growth. However, many of the systems have encountered lower levels of success than FITs, partly as a result of unrealistic winning bid prices and the inability to secure the necessary operational permits [18].

Although FITs, particularly those favourable to investors where the tariff is greater than the cost of generating electricity from RE sources [18], have encountered a significant degree of success, it must be stated that this success has occurred predominantly in developed countries. The deployment of FITs requires a certain degree of financial capital, capital which many developing countries simply don’t have.

Government action is not limited to market pull policies. Many research institutions and centres of learning, such as universities, are funded by governments focussed on technology push initiatives. The role played by these institutions in fostering learning, new knowledge, and innovation should not be underestimated. The development of many new ideas has resulted in start-up companies that have gone on to be successful, contributing greatly to the technological capabilities and socio-economic growth of countries [19].

Although the impact of government policies on the commercialisation of MTRESs cannot be understated, government cannot manage nor finance the entire MTRES industry. The private sector needs to work together with government to ensure a suitable environment is created conducive to the development of a sustainable MTRES industry.

4.7. Business model approach

Balachandra *et al.* [1] present a business model approach to the technology commercialisation process, as shown in Fig. 9. The model considers numerous aspects, with a strong focus placed on the role that the business sector has to play. The links that exist between entrepreneurs and the end-user are highlighted, together with mechanisms used to foster technology adoption. Often these links prove pivotal to technology commercialisation. However, the shortcomings of such a framework are exposed when considering the commercialisation methods already discussed, namely a lack of TA. Without a firm understanding of the underlying technologies of a MTRES, the success of such an approach is questionable.

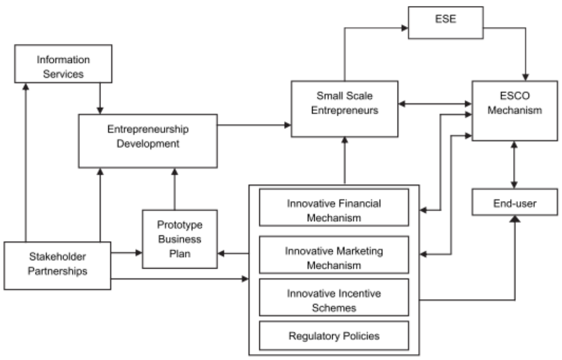

Fig. 9. Business model commercialising MTRESs [1]

5. Conclusions and recommendations

Having evaluated a number of strategies for commercialising MTRESs, it is clear that there is a lack of harmonisation between the different aspects required. Each method tends to address only one aspect, such as TA, the role of government or business strategy. While each strategy is fairly generic in nature, not limiting itself to a particular type of technology, it is necessary to consider the specific case of CSP technologies when assessing the applicability of each strategy.

5.1. Applicability of strategies to CSP technologies in South Africa

The application of a technology LCA is useful in positioning CSP technologies on their respective s-curve. However, as with MTRESs, it fails to indicate the means of achieving such commercialisation. In addition, a lack of available data in South Africa, a developing country, may cause difficulties in accurately positioning the technology upon the s-curve.

TA offers a more inclusive approach, addressing multiple elements of commercialisation. In the short-term it may prove to be sufficient for the commercialisation of CSP technologies, yet the long-term requirements necessitate an analysis of the respective organisation, and measures to form a sustainable market. The issue surrounding the potential lack of information features more prominently with this technique, as a much larger quantity of data is required for the various assessment methods.

Diffusion models tend to limit their focus to one particular aspect. CSP technologies are complex systems, and the inclusion of TES technologies further complicates the issue. A technological innovation system requires strong institutional support, which presently is not at an adequate level in South Africa. The country possesses relatively poor technical capabilities, with underdeveloped networks and a lack of will to change from the established agents in the energy industry.

Government action has achieved some measure of success in South Africa, such as the REIPPP Programme. However, policy uncertainty continues to provide a threat to investors' confidence, together with the higher priority that is often given to socio-economic goals.

While a business model does address the role that various stakeholders have to play, it neglects mention of TA and the internal strengths that would allow an organisation to successfully manage the commercialisation process. Furthermore, there is no mention of how such a model might be tailored to the specific needs of the CSP technology and industry.

It would appear that an architecture framework is most appropriate for use with CSP technologies. The attention given to the various interfaces between the elements of the commercialisation process is important in developing an integrated approach that seeks to harmonise existing efforts towards the commercialisation of MTRESs.

5.2 Recommendation to management practitioners

It is recommended that practitioners develop a management strategy; one that utilises the concept of an architecture framework as a base in order to incorporate all aspects necessary for commercialising MTRESs. The primary components of the management strategy will consist of certain TA tools and methods (Fig. 7), a selection of market adoption, promotion, and penetration strategies (MAPPSs) to expand the existing market and boost consumer demand for CSP technology, and an organisational analysis.

5.3 Guidance to facilitators

The development of such a management strategy should seek to involve input from the private sector, government and academia. Any TA method used needs to be justified, and aligned, with the ultimate goal of commercialising MTRESs. A list of metrics should be determined in order to monitor the progress of the management strategy over time. The role of facilitators is vital in ensuring that all relevant stakeholders are engaged in the strategy's development, thereby improving the potential for success and raising awareness of all relevant concerns, limitations, and issues.

5.4 How can decision-makers and/or policy-makers apply it?

The application of the management strategy will require close partnership between the private and public sectors. Recent events in South Africa have fuelled the level of distrust between the two sectors, slowing the rate of commercialisation of CSP technologies.

The potential role of decision-makers is pivotal in the strategy's application. If government and business professionals do not implement the strategy, or only utilise certain aspects, it will have little effect on the commercialisation process. The tendency for decision-makers to concentrate only on aspects that seem relevant to them has contributed greatly to slowing the rate of adoption of MTRESs. More attention needs to be given to the cumulative effect of all aspects on the commercialisation process. In particular, close collaboration is required to ensure that all relevant parties have a common understanding of the relevant objectives towards improving the rate of commercialisation of MTRESs.

Acknowledgements

The first author would like to thank the South African National Research Foundation for the financial assistance received.

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