Briefing

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Policy pointers

Attempts to promote new or improved technologies must look beyond the 'hardware' and consider the socioeconomic, institutional and policy factors hindering adoption.

Policy support is vital, but may require new ways of working that blend skills and broaden understanding of both the technology and its social constraints.

Small, local initiatives need to link with others if they are to be able to connect with global and national technology development processes and become the launch pads for widespread adoption of new or improved technologies.

Widespread studies suggest key drivers for success include mobilising resources, priority setting, capacity development, encouragement for entrepreneurs and markets, supportive governance, and local buy-in.

Driving new technology adoption in South Africa's energy sector

In South Africa's energy sector, several renewable technologies are mature enough to roll out, but need the right support in the right contexts. Around the world, attempts to adopt new or improved technologies often fail because they focus on the 'hardware' and ignore the complex mix of interconnected social, institutional, economic and policy issues that can limit success. Academic studies reveal the main ingredients for successful technology adoption, and this briefing outlines these for policymakers and practitioners, along with some practical guidance in the context of energy access and rural development in South Africa and the CHOICES project.

It's easy to get carried away by the thought of how a new technology could transform people's lives — the temptation is often to roll it out as quickly as possible.

But focusing on the hardware may be the wrong start. Getting people to adopt new or improved technologies does not happen overnight. A whole raft of influences, such as skills, institutions, policies and economics, affect the process.[1]

This is particularly pertinent to the energy sector. Renewable energy technologies have differing success in different countries, and this often has little to do with the technology and a lot to do with one or more socioeconomic factors. Many technology options — such as solar photovoltaics, small-scale hydropower, or biomass to power — are approaching both technical maturity and economic parity with conventional power sources.

But South Africa has seen much lower uptake of renewable energy technology than some other countries. By 2012, South Africa had achieved less than 25 per cent of its 10,000 gigawatt hours target (set for 2013), and renewable energy was less than 10 per cent of the country's overall generation. So if the technology is ready, why aren't people choosing it?

Why technology adoption sometimes fails

There are many reasons why a new energy technology might not be adopted. The most common are listed below.[2]

- **Technological factors.** The technology does not work well, is unstable, or lacks complementary technologies needed to make it effective.
- **Demand.** People don't want the new technology (for instance, it is too expensive; they have working alternatives).
- **Cultural/perception factors.** People feel that the new technology does not fit with their values and preferences (for instance, lower income groups may think they are being foisted with second-rate technologies).
- **Skills and knowledge.** People don't know what the technology can offer, or don't have the skills to use and/or maintain it.

- **Production factors.** Firms do not want to scale up production (perhaps because they think customers don't want it; or because it could compete with existing core products), so the technology cannot benefit from economies of scale.
- **Infrastructure and maintenance factors.** The infrastructure for delivering the product and/or spare parts is inadequate; or a maintenance network does not exist.
- **Undesirable social and/or environmental effects.** Technologies intended to solve one problem may introduce new ones.
- **Policy and regulatory framework.** A new technology may not fit with existing regulations and policies; policies may actually be a disincentive to investment in new technology (for instance, by prohibiting subsidies that might 'kick start' its adoption).

Clearly technology adoption is complex, and getting the technology right is only part of the process. Policymakers need to devise a suitable 'delivery model' that addresses all the issues in this list. Such a model must be flexible enough to ensure that new or improved technologies meet real needs — that is, they adapt to fit specific social and economic contexts.

A conceptual framework

A large field of academic literature, known as 'technology innovation systems thinking', discusses how technologies are developed and adopted, emphasising the socioeconomic aspects.[3] It stresses that understanding and responding to this wider context is often more important than how efficient a technology is in engineering terms. It also underlines how institutional and policy change are crucial in making technology adoption successful. A subset of this approach, known as 'critical niche management', examines how global- and national-level technical innovations (and associated policy and regulatory changes) link with small-scale innovation and adoption of new technologies 'on the ground'.

In summary, the academic approaches highlight three major factors in technology adoption:

1. Policy support. Policy strongly influences success. Enabling policies for renewable technologies may support feed-in tariffs or remove constraints on linking new, renewable power sources to the grid. South Africa's experience of feed-in tariffs, for example, has suffered from institutional arrangements that failed to ensure that government ministries and agencies accepted the tariff structure and understood how to implement it. Designing policy that can be translated into action is a frequent renewable energy policy shortcoming and the attempt to introduce the agreed Renewable Energy Feed in Tariff (REFIT) is no exception. Here, South Africa's government-owned electricity utility, Eskom, agreed the REFIT in design stage but then used flaws in the policy's implementation design to alter the mechanism, resulting in would-be power producers having to bid in a tender process to develop energy projects. To date, progress has been limited to wind projects.

2. Building networks. Building networks and other links ensures that small-scale initiatives become part of a wider platform of activity focusing on a common set of innovations. This encourages sharing of experiences and learning. It is also the route to managing expectations so there is a shared understanding of risks and opportunities. This is particularly important for small-scale initiatives.

3. Other key drivers. Specific sets of activities and institutional arrangements drive success in technology development and adoption. They combine to create and develop markets, and support entrepreneurs and investors. Table 1 lists these key drivers. Getting them in place frequently requires shifts in policy and changes in the way national and sub-national institutions work. Certainly, it is virtually impossible for small-scale, local-level initiatives to develop these drivers single handedly. Yet local-level initiatives are vital if national and sub-national processes are to reflect

The CHOICES project

In the Blue Crane Route Municipality of South Africa's Eastern Cape Province, the CHOICES project (Community and Household Options In Choosing Energy Services) is exploring the energy options available to people who are not connected to the national electricity grid, or who do not enjoy reliable and affordable power, both for households to improve their quality of life, and for businesses to expand and innovate.

Within any community, different groups have varied resources, capacities, needs, priorities and aspirations. So CHOICES has presented technical alternatives for people to examine and evaluate. Doing this without overselling any one technology, or misrepresenting its strengths and weakness, is a balancing act. No particular product is likely to be suitable for all users, usually because of one of the social, institutional or economic factors discussed in this briefing, rather than because the technology does not work. Care is necessary when presenting 'new' options to help people make informed decisions on whether a specific technology suits their situation.

CHOICES is a collaboration between OneWorld Sustainable Investments (South Africa), The Energy and Resources Institute (TERI, India) and IIED. Funded by the Renewable Energy and Energy Efficiency Partnership (REEEP), it has worked in close partnership with the Blue Crane Development Agency and the Blue Crane Route Municipality as well as with the Cacadu District Municipality.

the needs and priorities of the people who stand to benefit from technical change.

Practitioners, who can actually promote new technology options, are not inclined to wade through academic papers and their complex language. But if they are not exposed to these concepts they are not necessarily alerted to the usual stumbling blocks, and may keep on focusing on the hardware aspects of technical change. After all, the hardware is something you can see and touch and seems the obvious starting point. The end result can be machines and gadgets left rusting unused behind sheds or gathering dust — and the potential gains from new or improved technologies remaining just dreams.

South Africa's water sector provides a relevant example from outside the energy sector. A study by the South Africa Water Resources Institute and the South African Local Government Association[5] examined wastewater technologies used by local municipalities. It found that 44 per cent of wastewater treatment plants in South Africa might have opted for inappropriate technologies. In a drive to meet compliance with water quality regulations, many municipalities were making inappropriate and expensive technology choices, ending up with wastewater systems that were beyond their financial and technical capacity to maintain. Alternative, more appropriate options were not chosen because the criteria for selection looked narrowly at water quality standards, and ignored financial, technical and institutional capacity. National policy is also criticised for failing to adopt design principles appropriate to small rural municipalities.

Practical approach

A useful practical approach to the broader socioeconomic constraints on technology adoption is to look for 'limiting factors'. Environmental sciences use the concept of limiting factors to understand what is holding up an active biological process. For example, plants need various nutrients, water, light, warmth, and so on. It is no use adding fertilisers if there is insufficient water supply. Technology adoption can take a similar approach.

The reasons why technology adoption often fails, listed above, provide a starting point to identify and understand the likely limiting factors. There may be no technological sticking point at all. For example, there are a few proven energy technologies in South Africa that just need the right support, in the right context.

Arguably the most feasible of these are solar water heaters. Initially established in the 1970s during the sharp increases in international oil prices, this industry predictably collapsed once oil prices normalised in the mid 1980s. Although many blamed this failure on poor technology, in reality there was little incentive to keep the industry going. The subsidies that were implemented from 2008 to 2011 — triggered by the nationwide electricity crisis and pressure to diversify South Africa's highly centralised electricity supply, but not sustained — are the type of government policy instrument that, if implemented earlier and more comprehensively, might have resulted in a vibrant industry.

Table 1. Key drivers of successful technology development and adoption[4]

Key drivers	What has to happen
Resource mobilisation	Mobilise relevant human, financial capital and other resources, including identifying people with relevant skills and offering training.
Prioritisation mechanisms	Produce incentives for stakeholders to set priorities; ensure there is capability within any particular sector to allow stakeholders to agree priorities across competing technologies, applications, markets, etc.
Capacity development and diffusion	Develop and expand the breadth and depth of stakeholders' knowledge in both technology and application sectors with an explicit focus on changing behaviour and perception.
Entrepreneurial experimentation	Develop an institutional infrastructure that favours entrepreneurial activity, firm establishment and growth.
Market formation	Develop market places, identify customers and users, develop viable business models, consider possibilities for exports and/or needs for imports.
Legitimation and governance	Work to raise the social acceptance for technology, develop mechanisms for influencing such acceptance, and ensure compliance with requirements of relevant institutions and policies.

Blend of skills

Once technology is seen as having both social and technical components, it is more likely to succeed. But this still requires a change in mindset and ways of working. For example, if government policies are a limiting factor, it is unlikely that the engineers who understand the technology will have sufficient knowledge or influence to instigate changes. A successful approach will need to combine people with different skill sets. To continue the solar water heater example, consider Cape Town's N2 Gateway Project. This was an initiative to replace the squatter shacks either side of Cape Town's major intercity highway, the N2, with low-cost housing. It was an ideal opportunity to install low-cost solar water heaters and increase access to hot water for Cape Town's poor. But for many years the city engineers and town planners were opposed and it took them a long time before they understood the technology and saw

the benefits. The initial failure to match new skills to old resulted in huge delays and far fewer people being able to access hot water than should have been possible.

Institutional change is often required at both high and local levels. An organisation may have to refocus efforts. It may need new skills and staff. And inevitably there may be frustrations. Policy, regulatory and institutional changes can be slow, and final results uncertain. Engineers are used to adjusting equipment and using design methods that follow the reassuring mathematical certainties. Now they are faced with the uncertainties, and sometimes the apparent irrationality, of human behaviour and political expediency.

A further challenge for local entrepreneurs and/or staff of small development projects is that any technical change is situated in a relatively small niche — their project or local business. This limited exposure and experience is rather like an isolated experiment and can be difficult to scale up. Even where there is local success, it does not mean that either the approach or the technology will be adopted elsewhere.

High-level and local-level technology development

Technology development happens at two levels: a high-level process and a local-level one. At the high level, there are global and national processes where scientific and industrial research and development is carried out by specialised, often well-resourced, groups of engineers and scientists. Formal institutions, active at national or sub-national level, are a vital ingredient here, as they can foster and support knowledge creation, learning and capability building.

But there are rarely strong, viable and vibrant connections between these high-level processes and local ones. Those adopting the technology struggle to access the knowledge created at higher levels. And they rarely have enough political power to influence technology design or technology-related policies.

This puts small, locally driven initiatives — such as those that could benefit the Blue Crane Route Municipality (where the CHOICES project operates, see Box 1) — at a disadvantage. Without links to high-level processes, they cannot be sure that they have access to the latest developments; cannot easily share their own experiences; are unable to influence the way the high-level technology development process unfolds; and do not have influence on national and global policy.

In developing countries, where formal institutional frameworks are not always strong or well established, informal linkages are extremely important for sharing knowledge and developing capability.[6] This is why it is important for small local initiatives to ensure they link with others. This practical action goes back to the second recommendation from the academic literature — to build networks. It can be through both formal and informal networks and by building alliances to share information with others who have similar goals and aspirations. This builds a critical mass of local voices that can eventually be heard at the high level.

The Blue Crane Route Municipality communities in the CHOICES project have demonstrated just how effective this can be. The project has encouraged the communities to focus on their own energy priorities and engage with each other through information sharing and workshops. They have now formalised an oversight committee comprising ward councillors, and municipal and community members. They have also started to engage much more closely with provincial government and its sustainable energy strategy. Time will tell whether this ultimately leads to the selection, implementation and maintenance of long-lasting sustainable energy solutions, but so far local buy-in is strong — an essential component for successful technology adoption.

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Notes

[1] Croxton, S. and Appleton, H. 1995. The role of participative approaches in increasing the technical capacity and technology choice of rural communities in: Proceedings of Workshop on Rural Mechanisation. Technology for rural livelihoods: current issues for engineers and social scientists. NRI, Chatham, UK, 6-7 Sept. 1994. Silsoe Research Institute/Natural Resources Institute. / [2] Adapted from: Kemp, R., Schot J., Hoogma R. 1998. Regime shifts to sustainability through processes of niche formation: the approach of Strategic Niche Management in: *Technology Analysis and Strategic Management* Vol.10 (2), 175-95; Mourik, R., Raven R. 2006. *A practitioner's view on Strategic Niche Management. Towards a future research outline.* Energy Research Centre of the Netherlands; Wilson, E., Godfrey-Wood, R., Garside, B. 2012. *Sustainable energy for all? Linking poor communities to modern energy services.* IIED, London; and Bellanca R., Garside B. 2013. *An approach to designing energy delivery models that work for people living in poverty.* CAFOD & IIED. / [3] Bergek, A., M. Eckert, Jacobsson S. 2008 .*Functions in innovation systems: A framework for analyzing energy system dynamics and identifying goals for system-building activities by entrepreneurs and policy makers.* Institute for Management of Innovation and Technology, Göteborg / [4] Piirainen, K. *et al.* 2012. *An Analysis of the Drivers for Emerging Sectoral Innovation Systems in Developing Economies: Cases Tanzania and Vietnam.* ESIS Final Report, Ramboli Management Consultancy, Helsinki / [5] v.d. Merwe-Botha M., Quilling G. 2012. *Drivers for Wastewater Technology Selection – Assessment of the selection of wastewater technology by municipalities in relation to the management capability and legislative requirements.* Water Resources Institute, Pretoria / [6] World Bank, 2010. *Innovation Policy – A Guide for Developing Countries.* World Bank, Washington DC

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