DEVELOPMENT AND ENHANCEMENT OF ENDOGENOUS CAPACITIES AND TECHNOLOGIES

A preliminary study

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Executive summary

In December 2015, the Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) adopted the Paris agreement. To support the implementation of this Agreement, further work related to the development and enhancement of endogenous capacities and technologies should be undertaken by the Technology Executive Committee (TEC). This is the motivation for the realization of this preliminary study, in order to support the work of the TEC related to this mandate.

The consequences of global concerns like climate change are experienced on a local level and their impact varies with geographical, social and economic factors, characteristic of each country. Therefore, it is imperative that efforts in addressing global climate change involves and finds synergies with local efforts. To achieve a more independent and sustainable development process, developing countries should be able to build up national capacities, based on their potential and resources.

The study presents an initial approach to the definition of endogenous development taking into account different contexts and establish a number of elements which could represent the endogenous characteristics. It then presents examples of how these elements were applied in different contexts in order to give a more comprehensive and realistic idea of the concept. Six case studies that involve both mitigation or adaptation technologies around the world were selected and lessons learned drawn from their implementation.

Further, initial conclusions and recommendations were drawn, taking into account the limitations of this preliminary study. These include the need to identify internal needs and define priorities to determine the means for building capacity, taking into account a participatory approach. Further, it was also observed that external cooperation and processes are effective only when the internal conditions are understood and taken into account. And finally, to ensure the acceptance of the development process and its sustainability, social capital has to be empowered and community ownership has to be boosted. The creation of local institutions and local markets also plays an important role on the sustainability of the projects.

A number recommendations made to the TEC include a further in-depth study in the endogenous capacity and technology, taking into account the need to develop a clearer understanding of the concept “endogenous” as it relates to climate technology development and transfer and look into areas where examples are lacking. The TEC may also wish to develop greater understanding of country’s needs with regard to development of endogenous capacities and technologies and to look further whether the inclusion of specific mention of endogenous elements of technologies and capacities in the TNA documents could be a useful and added-value exercise. Finally, the TEC may wish to consider work together with the CTCN in this area.

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1. Introduction

A. Relevant mandate

The Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) at its twenty-first meeting in December 2015 adopted the Paris Agreement. The Agreement reflects the global response to the threat of climate change and has a goal to keep a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. In addition, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change.

To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework.

Along with the adoption of the Paris Agreement, Parties also agreed on a number of decisions to give effect to the Agreement. In one of these decisions, Parties through decision 1/CP.21 paragraph 67, agreed to strengthen the Technology Mechanism and requested the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN), in supporting the implementation of the Agreement to undertake further work relating to, inter alia:

a) Technology research, development and demonstration;
b) The development and enhancement of endogenous capacities and technologies.

B. Rolling workplan of TEC 2016-2018

The TEC at its twelfth meeting in April 2016 adopted its three-year rolling workplan for 2016-2018, taking into account the new tasks from Paris. With regard to the COP mandate relating to the development and enhancement of endogenous capacities and technologies, the TEC considered it as a cross-cutting issue. As such, the TEC agreed to consider this issue while undertaking its work in the six thematic areas indicated in its 2016-2018 rolling workplan.[1] These thematic areas are: adaptation, climate technology financing, emerging and cross cutting issues, innovation and research development and demonstration, mitigation, technology needs assessment.

C. Purpose of this study

To facilitate the work of TEC in addressing the issue of endogenous capacities and technologies, the secretariat initiated an internal preliminary study. The aims of the study are two-fold: (i) to better understand the concept of endogenous capacity and technology, and (ii) to examine how these concepts have been applied in various contexts.

[1]. The full workplan can be accessed via: <http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TEC_column_M/0fb1009f2d3b4f43b7ebcb16bbb60c8d/dcdf79ce412d46159ba7311252c9be18.pdf>.

It is expected that the findings of the preliminary study could shed some light on how the concept of endogenous capacity and technology have evolved and how they have been applied in various contexts that are relevant to the work of the TEC. Through this, the study may help the TEC to develop further understanding on how it can effectively respond to the COP 21 mandate on endogenous technologies and capacities.

The study is a pure desk study (literature research) and was undertaken with the assistance of a research intern through an internship programme.

2. Background

Addressing global challenges requires not only an overall perception but also a local vision. The consequences of global concerns like climate change are experienced on a local level and their impact varies with geographical, social and economic factors, characteristic of each country. Therefore, it is imperative that efforts in addressing global climate change involves and finds synergies with local efforts. Local initiatives meeting specific needs and using the countries' capacities and resources (also known as endogenous initiatives) could be more efficient and effective to cope with the challenges. (Sanabria, Pedraza, & Hurtado, 2014).

In order to achieve a more independent and sustainable development process, developing countries should be able to build up national capacities, based on their potential and resources.

To define the scope for this study, it is important to clarify the definition of the term "Endogenous". Since discussion of endogenous aspects could a broad topic, the study will focus on endogenous capacities and technologies at the national and local context. In section 3 we will look into a definition of the term endogenous.

3. Definition and evolution of Endogenous concept

In this section, the term Endogenous is reviewed from different perspectives, in order to give a broader and more comprehensive framework.

In the most general context, the term 'Endogenous' refers to "an internal origin or cause", according to Oxford (Press, 2016).

In the economy context, the term Endogenous is addressed as a growth theory. Endogenous growth theory notes internal processes based on new technologies and improved means of production, also referred as innovations, that lead to regional and national economic growth. In this context, human capital, innovation and knowledge are drivers for economic growth (Investopedia, 2016).
Endogenous growth theory links the creation of innovations to the number of people involved in the academic sector. These innovations generate higher productivity rates and economic growth (Morley, 2017).

A perspective in the development context approaches the concept as "Endogenous development".

This model is based mainly, though not exclusively, on "locally available resources, local knowledge, culture and leadership". It acknowledges specific components like "openness to integrate traditional as well as external knowledge and practices", and includes "mechanisms for local learning and experimenting" in order to build "local economies and retain benefits in the local area" (Practical Action, 2007)

In the same context, the objective of this model is "to empower local communities to take control of their own development process. While revitalizing ancestral and local knowledge, endogenous development helps local people select those external resources that best fit the local conditions" (Millar, Apusigah, & Boonzaaijer, 2008).

Within the United Nations, this term has been referenced for some time now. In 1991, the Intergovernmental Committee of Experts for Science and Technology Development (IGCESTD) of the United Nations Economic Commission for Africa held a meeting in Addis Ababa, Ethiopia discussing "Endogenous Capacity Building in Science and Technology in the African Region". In this meeting, some key elements for the concept in relation to capacity building were highlighted, including that "Endogenous capacity building implies the building up of both human capability and institutional infrastructures, besides setting up suitable mechanisms for policy formulation and implementation at the government level" (United Nations E. C., 1991).

In 2014, The United Nations Centre for Regional Development (UNCRD) organized a training course called "Endogenous Regional Development through Community Initiatives" in Aichi and Gifu Prefectures, Japan. Within this training, the concept of endogenous capacities took the shape of Endogenous Regional Development (EnRD). It was defined as a development strategy that implies a "process promoted by the initiative of local people using local resources based on local culture, traditions, and skills". This concept can be applied in different fields, but it has been linked mainly to capacity building, emphasizing that capacity refers also to governance, political initiatives and not only to knowledge and technical skills. "UNCRD regards endogenous capacity- building as a process of enhancing developing countries capacity in solving problems based on their wisdom, resources, policies, institutions and social system as well as their own initiatives and governance" (UNCRD, 2014).

To sum up, in the context of sustainable development there is no a unique definition of the concept "Endogenous". The concept has also has evolved over time and can be approached from different contexts. For the purpose of this study, the concept definition offered by the United Nations, non-governmental organizations, and the economic perspectives were used as the basis to identify and select elements that reflect the concept and that may be relevant in the context of technology development and transfer. These elements are: ***National Innovation systems, local/national ownership, human capital, local/national knowledge, local/national economies, external resources that best fit the local/national conditions, participatory approach, institutional infrastructures and policy mechanisms that boost internal developments***.

Of course, other elements may also be used to represent the "Endogenous" concept. However, the idea here is to provide a simple and clear reference which can be used as a basic tool that would allow the identification of endogenous elements in real life situations.

Finally, it is also important to note the difference between the concept of "Endogenous" and "Indigenous". Although they are related, indigenous is distinct from endogenous.

Using an UNESCO definition, indigenous knowledge refers to "Local knowledge that is unique to a culture or society. This knowledge is passed from generation to generation, usually by word of mouth and cultural rituals, and has been the basis for agriculture, food preparation, health care, education, conservation and the wide range of other activities that sustain societies in many parts of the world". (Fien, 2010).

While the paper will focus on examining the "Endogenous" elements, any observation with regard to "Indigenous" elements will be reported.

4. Case Studies: examining endogenous capacities and technologies in various circumstances

After identifying elements representing the endogenous concept, the next step is to look into how the concept is applied in various situations through an examination of a number of case studies. It is expected that by going deeper into real cases may bring a clearer vision of how endogenous issue have been addressed and would also allow identification of challenges, enablers and barriers during the implementation process.

As a starting point, a number of programs/projects and initiatives presented on the supporting document of the Mapping climate technology [2] (UNFCCC, 2016) were selected and reviewed as examples of actions that may involve endogenous capacities and technologies development and that are being implemented all over the world. In addition, case studies were identified through the work of the United Nations and development organizations. Efforts were done to ensure broader representations of different circumstances, taking in to account the following:

- **Presence of endogenous elements:** Each selected case includes at least two elements that may be classified as endogenous, either on the planning or in the implementing phase, for example participative approach, solutions proposed by national institutions and National Innovation Systems, built of local committees, training and building of human capacity, adoption of new technologies that best fit local needs and entrepreneurship.

[2] The Mapping climate technology development and transfer activities and initiatives under and outside the Convention relevant to the implementation of the Paris Agreement prepared in response to the mandate from the Subsidiary Body for Scientific and Technological Advice.

- **Cooperation strategies:** Examples analyzed represent different sources of funding and support and a variety of cooperation strategies including external and internal financial institutions and development organizations.

- **Technical diversity:** The cases selected include mitigation as well as adaptation technologies, and cover a wide range of sectors, from water access and sanitation, land use to sustainable energy access.

- **Geographic diversity**: The cases selected are implemented in different geographical regions, representing a wide variety of cultural, social and economic contexts.

- **Potential for widespread application:** To the extent possible, cases selected include solutions that have potential for replicability and widespread applications. Additionally, planning and implementation models that include the community´s participation and engagement can be developed all over the world.

- **Success stories and lessons learned:** To the extent possible, results from the implementation of the projects/activities are included, and any lessons learned including barriers and enablers are presented.

Case study 1: Access to drinking water in rural and low-income regions of Colombia- Inter-American Development Bank IDB

Description

The Inter-American Development Bank has an initiative for the member countries focused on innovation, science and technology (UNFCCC, 2016). In Colombia this initiative is called Ideas for change, depends on the Colombian Administrative department of science, technology and innovation COLCIENCIAS and aims to support the development of innovative solutions from science and technology with active participation of the society and the scientific community to improve local's quality of life. (COLCIENCIAS, 2012). The initiative is still running on its second phase and the selected successful project for the case study started on April 2012 and is already closed.

"In Colombia, access to potable water has increased significantly during the last decade. However, there is still insufficient coverage of the service, especially in rural and poor areas such as the departments of La Guajira, Risaralda and Putumayo, where the coverage of drinking water is around 70%, much lower than in the rest of the country." (COLCIENCIAS, 2012)

A huge effort was made to disseminate the "Ideas for change" initiative, to involve the communities in identifying their needs and developing of viable and cost-effective solutions to them. Thus, improving access to potable water for this isolated and hardly web connected communities, while ensuring its participation in the process of innovation.

Through intensive fieldwork, 166 needs were identified by the communities themselves. A departmental committee, which included the participation of the beneficiaries, prioritized 15 problems for which COLCIENCIAS organized a contest of solutions directed to national companies and national universities. Proposals should include a strategy for participation and ongoing work with the community. (COLCIENCIAS, 2012)

Of 61 proposed solutions, the National Agency for Overcoming Poverty ANSPE and the IDB financed 10, one of this solutions were implemented in La Guajira, where Wayuu indigenous communities in collaborative work with the Colombian enterprise Hybrytec S.A.S, in partnership with the Aguayuda Foundation and Corpoguajira obtained potable water through the drilling of a deep well and the extraction of groundwater from a pump powered by solar energy. This solution was complemented by the use of LifeStraw filters for water purification at home.

All these actions were accompanied by educational processes and the formation of a local management committee to ensure technological sustainability and cultural transformation.

Results:

- **Transformational changes:** 10 innovative scientific-technological solutions for access to potable water were developed through a collaborative work between implementer and

community, generating transformations in the environmental, economic and social conditions of 585 beneficiary families.

- **Social appropriation and potential of replication:** Beyond the improvement of quality of life, the Ideas for Change program generated an important process of social appropriation of scientific-technological solutions thanks to the active participation of communities throughout the process and served as an experience to be replicated in other sectors such as renewable energy.

Lessons learned:

- The importance of locally-valued benefits, when there is a direct and visible local benefit, communities engage themselves on the implementation and sustainability of the projects.

- The importance of Identifying internal needs and priorities by asking the community itself, ensuring community's participation in the process of innovation is crucial to ensure technologies acceptance and community ownership.

- It is essential to strengthen centers of excellence in developing countries, in this case the support of IDB to COLCIENCIAS was key to the success of the project.

- Educational processes and the formation of a local management committees are important to ensure technological sustainability and cultural transformation.

- National scientific community as well as public and /or private companies in conjunction with community, should always participate in the application and formation of solutions banks.

Case study 2: The Biogas Programme for the Animal Husbandry Sector of Vietnam

Description

In 2003, the Ministry of Agriculture and Rural Development (MARD) in Vietnam in cooperation with the Netherlands Development Organisation (SNV) and using funding from the Netherlands Ministry of Foreign Affairs (DGIS) founded the "Vietnam Biogas Programme" as a response to the problematic situation generated with the increase of piggeries in the country and the limitations to appropriately manage its waste (SNV, 2010). Since 2013 this initiative counts with the support of Energising Development EnDev, and is currently on a monitoring phase. The funds received up to date through the sales of the Voluntary Emissions Reduction credits account for about 50% of the Programme's budget. (SNV, 2015)

According to (MARD & SNV, 2010) over two million Vietnamese families have piggeries. A considerable amount of pig manure is discharged on water bodies whereas a small portion is used as fish feed or as fertilizer. This situation generates serious environmental problems like eutrophication of waters and sanitary issues in rural areas.

On the other hand, ensuring access to energy for lighting and cooking purposes is becoming a challenge. Commercial fuels are expensive and not reliable in rural areas, whereas traditional cooking fuels are limited, its collection consumes time, represents depletion of natural resources, and even more, its combustion increases the risk of respiratory illnesses.

Biogas plants decompose manure and toilet waste to produce biogas, which replaces traditional and commercial fuels for cooking. Two models of brick-dome shaped domestic bio digesters are used in the program, the first one has a standard design, whereas the second one was modified to suit the local needs and special hydrology in southern Vietnam where there is and presence of ground water tables.

This particular design has a flatter and shallower shape and the waste collection system uses gravity, ensuring minimum human contact with waste. (MARD & SNV, 2010)

According to (SNV, 2010), the ministry established a formal division that works with guidance, advice and technical assistance from SNV. The main purpose of this is to ensure maximum national ownership and sustainability of the program after the project ends.

The implementation process involved training of local masons and government technicians, who also provided quality control, crucial on ensuring end-user's satisfaction. In addition, activities for research on the use of bio slurry and pilot plants to demonstrate its effectiveness were financed, an innovation contest to find alternative uses for biogas was also organized, contributing in this way on the generation of local solutions to local problems.

Results:

- **Transformational changes:** "Between 2003 and 2009 the programme directly facilitated the installation of over 78,000 biogas systems, which are benefitting more than 390,000 people" (MARD & SNV, 2010) improving household's sanitary conditions, increasing income through better crop yields by using the bio slurry as fertilizer and by selling its surplus to the neighbors and finally improving health by reducing indoor air pollution from cooking fires.

- **Market creation:** Trained masons are building systems out of the program, more or less as many as within the program. It is a clear indicator that a new commercial market for biogas has been created.

- **Human capacity building and job creation:** Over 1,800 local masons were provided with technical training and work. Technicians and managers have been also provided with training and work, in total 15 full time employees and 360 part-time employees. Lead masons have been provided with an extra business training, it helps to enhance the market development and allows them to work more independently.

- **Political benefits:** Vietnam has other targets in the political scenario under other programs, that can be reached with the assistance of the biogas program, those include "The green

growth strategy", "Vietnam's Intended National Determined Contribution to reduce greenhouse gasses" and the "Action Plan for Renewable Energy" of the Ministry of Industry and Trade.

- **Emissions reduction:** By April 2016, "the Biogas Programme has already reduced 429 tonnes of carbon pollution" (SNV, 2016)

Lessons learned:

- The importance of national ownership and local empowerment to ensure the acceptance of the program on a local level and sustainability of it, once the external organization leave the program.

- Mentioned on SNV's webpage, "the success of the Biogas Programme is largely attributable to SNV's specific approach to sector development. The programme does not construct the bio-digesters, but acts as a facilitator that focuses on the development of a strong market-driven private sector so that private biogas entrepreneurs can serve the market on their own" (SNV, 2010)

- The critical role of supporting internal design technologies and entrepreneurship initiatives that become the seed for further markets development.

Case study 3: AGRUCO - Integrated Community Programmes for Self -Management and Sustainable Development in Bolivia

This case study was presented on Practical action's publication "Learning endogenous development" (Practical Action , 2007)

Description

AGRUCO (Agroecology Programme of the Universidad Mayor de San Simón UMSS) is a "university-based centre of excellence in Bolivia that supports sustainable endogenous development through the revalidation of local wisdom and knowledge, and the culture of indigenous rural peoples, and by enhancing and strengthening peasant systems of production and agro-ecology" (Practical Action , 2007).

AGRUCO began its activities in 1985 within the framework of a general agreement of bilateral cooperation between the governments of Switzerland and Bolivia. It also has been financed by the Dutch government through the international program COMPAS. Starting July 1998, the UMSS assumed through the executive direction the total responsibility in its management.

AGRUCO developed a program called PICADS (Integrated Community Programmes for Self Management and Sustainable Development) focused on the implementation and management of projects according to the priorities set by the community. This program acts as a bridge between the

communities and the municipalities, who manage government funds for development programs under the "law for popular participation" established in 1992. (Practical Action , 2007)

The PICADS program was implemented in 1998 in the community of Jatun Mayu watershed, Bolivia involving three main steps:

1) Orientation: This phase involved a participatory community diagnosis and led to the creation of action plans tailor made for the Jatun Mayu watershed context and based on their indigenous knowledge. It included semi-structured interviews, oral histories and community workshops that involved the participation of AGRUCO technicians and community members.
2) Consolidation: In this phase a concrete strategy, based on the local resources is developed. It addresses land use and water management and includes support and participation in indigenous research activities.
3) Submission and implementation: This step includes the submission of the projects and the consolidation of strategic alliances between the community and the financing institutions, generally the municipalities. Followed by the implementation phase, where AGRUCO provides follow-up support and management training. The final idea is to reach a self-management state. (Practical Action , 2007)

Results

- **Replication potential:** The PICADS model can be applied to other cases where it is necessary negotiate funding for development projects.

- **Transformational changes:** The Jatun Mayu watershed has become a focal point for development in the Sipe municipality, it has gained importance in the annual plans of operation and the dynamic between the community and its partners has ended up on a strategy for the development of the river basin.

- **Strengthening relations between local and government entities:** The PICADS program has encouraged local organizations to work in cooperation with financial entities, governmental and non-governmental organizations. In this extend, the work from AGRUCO is not limited to individuals and rural communities but has reached other stakeholders in a higher level.

- **Human capacity building:** Locals were trained on project management and technical topics such as organic agriculture and irrigation techniques.

- **Strengthening of adaptation capacity:** The program addressed land use and water management in vulnerable communities.

Lessons learned

- National scientific community as well as public and /or private companies in conjunction with community, should always participate in the application and formation of solutions banks.

- Development institutions can operate as catalyzers and advisors in the development process but the main roll should be played by the community.

- University based institutions can act as facilitators to connect the financing bodies to the communities needs and proposals, filling the gap that exists between government and people.

Case study 4: Bamboo processing industry in Sri Lanka

Description

The project aims "to develop a Bamboo supply chain and product industry in Sri Lanka, leading to reduced global environmental impact from green-house gases (GHG) emissions and a sustainable industry base" (UNIDO, 2015) The second objective is the restitution of the soil in degraded lands of the country.

The new industry is intended to generate direct and indirect employment in the villages, improving the quality of life of rural households and addressing fuel wood demand for the domestic and industrial sectors.

The Ministry of Industry and Commerce of Sri Lanka in cooperation with The United Nation's Industrial Development Organization (UNIDO), and the Global Environmental Facility GEF initiated the bamboo processing industry in Sri Lanka in 2012. The GEF has financed US$ 2.7 million and US$ 21 million are expected to be co-financed by the government, UNIDO and the private sector. The financing of the project is expected to be finished by 2019.

"So far, it has been implemented for about 1.5 years and total expenditures were around USD 610 000 by October 2014, representing 25% of the total allotment". (UNIDO, 2015)

The project has focused on strategic elements such as assessment of existing policy framework, finding that the regulatory framework in Sri Lanka is slowing down the process of a market development.

UNIDO has supported regional cooperation between India, China and Sri Lanka by bringing together the locals engaged in the business and the experts from the bamboo processing industry. It has involved bamboo tissue production, reproduction, plantations establishment and operation and industrial processing including pelletizing, briquetting and chipping technology. Additionally, a pilot plant Bamboo shoot processing facility was setup at the Industrial Technology Institute of Sri Lanka (ITI). Some processing machines and testing equipment were received from China and some of the equipment required in the processing line was constructed by the Engineering Services department of ITI". (ITI Industrial Technology Institute, 2009)

Another key point is the development of new applications for bamboo in order to create new markets and make the process sustainable in the future, this process seems to be slow, not strong enough by now and has challenged the Research and development sector in the country.

Last but not less important is the CO2 emissions reduction and the recovery of the soil in the river banks, around 10000 Ha are envisaged for this purpose.

There have been successful case studies around the bamboo industry, for example in China several years ago, the bamboo sector was forced to innovate due to timber scarcity in the country. A pre-processing method that allowed maximum resource utility was developed and with it, new processing and production strategies, resulting in a consolidated industry. It involved the engagement of research institutes, government and other key market stakeholders. (YOGARATNAM, 2012)

Results:

- **Capacity building:**
  - In 2009, the staff at the Department of Agriculture of Sri Lanka were trained by experts on techniques to harvest bamboo and to increase the production yield by for example, preparing soil beds.
  - To provide the technical support required for the bamboo production, the tissue culture laboratory at the University of Jayewardenepura has been expanded.
  - Sri Lanka National Bamboo Association was established to manage the Revolving fund system of low interest loans, destined for expanding the bamboo industry. It includes members from the entire Bamboo value chain in Sri Lanka.
  - In Paddukka Sudahariha, a village close to Colombo, a pilot demonstration site has been created. It is run by 30 workers who cultivate bamboo with the support of bamboo plantation experts. The workers also produce and sell handicraft bamboo products on a small market. (UNIDO, 2015).

- **Positive environmental impact:** Although it is clear that a positive impact is expected from this project, assessing progress related to soil degradation and CO2 emissions reduction has been difficult due to weaknesses on monitoring and reporting.

Lessons learned

- The critical role that a market study plays on the realization of a project and the importance of the support required from stakeholders to develop a market. In this case, although there has been capacity building, there is no a strong market developed, risking the sustainability of the project.

- The critical role of policy regulations that can provide the right framework to enhance the industry development, in this case, legal constrains are slowing down the process.

- Technology transfer processes as well as regional cooperation can be seen as seeds for the development of new industries and new capacities in a country.

- Environmental solutions can end up in economic development for a country.

- It is not only important to trigger the Innovation systems in the country, it is also important to provide them support and raise awareness mobilizing the academia around a topic to be more effective on the process of research and development.

Case study 5: Solar powered kiosk for mobile phone battery charge.

Description

African Renewable Energy Distributor (ARED), is a company founded in 2013 by the Burundian entrepreneur Henri Nyakarundi, who studies computer science in the US and is son of Rwandan refugees. The company's aim is to provide real business opportunities for the poorest people in Rwanda, by means of technical training and a portable business solution, based on solar photovoltaic technology.

By 2016, less than 15% of the population in East Africa had access to internet and 30% of the youth were unemployed or under-employed. On the other hand, according to the World Bank about 70%of the population have a mobile phone but only 18% have access to the grid. With a population explosion, Africa must find alternatives to employ the labor force that is coming to the market. (ARED, 2017)

Entrepreneurship could be seen as an important tool to cope with this challenge, and so ARED was born, offering a business in a box solar kiosk, to strengthen the micro level sector of the telecommunications systems.

ARED offers a Smart Solar Kiosk SSK, designed to deliver as a primary service, the charging of small electronics by using solar energy, complemented with other services like prepaid electricity, airtime, electronic vouchers and recently intranet/internet connection through Wi-Fi. It has the advantage of being mobile, so it can go directly to customers instead of waiting for them.
It works with a franchise model, controlled by an own-design software / mobile-app called SHIRIKI. It records transactions and calculates commissions, allows technical calls for equipment

maintenance, monitors the sales performance and gives access to the intranet to download content available in local languages free of charge.

This is a tailor made solution for the African context and can be spread to other east African countries. Currently there are 25 kiosks operating in Rwanda, some in the rural areas, where there is a higher lack of energy and information access. (Eastaugh, 2016)

This project has attracted the private sector, counts with the advice from GreenTec Capital network and has synergies with other companies operating in Africa, interested on the Bottom of the Pyramid market. It also works with the support of business development companies like INKOMOKO, Growmovement, Catapult design, the BID Network and grant funding provided by Microsoft. (ARED, 2017)

Results

- **New business opportunities:** New business opportunities have been created by using the solar kiosk, not only on the phone battery charging sector but on the delivering of key services like digital content, mobile money and airtime.

- **Decrease of displacement to urban areas:** Although it is still early to assess the social impact of this innovation, the one stop shop structure can be seen as an option for young people to develop their business within their rural areas, avoiding their forced displacement to the already dense urban areas.

- **Job alternatives in other vulnerable contexts:** This innovation can be presented as a realistic business option for vulnerable scenarios like refugee camps. In this extend, refugees could be seen as contributors to economic development of the host countries. Again, due to the early phase of implementation of this innovation, this possibility has not been tested.

- **Empowerment for vulnerable social groups:** Women and persons with disabilities are the recruitment target for this micro-franchise model. "Enabling and empowering people, is most effective through autonomous micro-business solutions that foster local know-how, as opposed to forming dependencies and knowledge monopolies". (ARED, 2017)

- **Human capacity building:** "All ARED micro-franchisees receive extensive business and technological training – creating knowledge that is then shared with the community. Training workshops cover topics such as business management, customer service, information on local taxes and regulation, financial basics, Point-of-Sale systems, and recycling of waste". (ARED, 2017)
- **Access to digital content:** Access to internet is normally out of reach in communities where the coverage of other needs is prioritized. This innovation facilitates the access to relevant content like health and education at no cost or very low cost to the end user.

- **CO2 emissions reduction**: Providing energy from renewable sources, using solar technologies for example, will avoid the emissions generated if carbon intense technologies were used for the same purpose. According to GreeenTec, through this project, 3.8 Tons of CO2 were saved in 2016. (GreenTec, 2017)

Lessons learned

- The importance of building human capacity in developing countries. In this case, the entrepreneur knew beforehand the problems in the country, he studied and then he was able to design a personalized solution for his community.

- Livelihood projects have a higher likelihood of success when a variety of skills are promoted.

- Triangular partnerships, including with the private sector promotes efficiency, effectiveness and development impact.

Case study 6: Bioethanol- Revolution in Brazil

Description

During the 70's Brazil's economy was severely affected by Oil rising prices. Between October 1973 and January 1974, oil prices quadrupled and as consequence in 1975, the government launched a national program, called Proalcool (Programa Nacional do Alcool) to cope with the crisis and to reduce national dependency on foreign oil by using ethanol internally produced as an alternative fuel. Sugar cane was envisaged as a domestic source of raw material, knowing that the country has been producing it for around 500 years and the expertise was already there.

The program involved a close collaboration between universities, research institutions, government and industry. The government encouraged the construction of ethanol plants, offering low interest loans to sugar companies and subsidies to keep the price of fuel low. Some national institutions like the São Paulo Research Foundation FAPESP supported research projects in the field of bioenergy since 1962.

On the other hand, the production industry developed new and more efficient transformation processes, the automobile industry adapted quickly, and in some years the vast majority of vehicles run on a mixture of alcohol and gasoline. (Ecogreen4us, 2012)
In 2007 the ethanol exports increased by 70% and by 2011 the industry employed around 1 million Brazilians. In the same year, and with the arrival of flex sky engines it was possible either to use alcohol, gasoline or any mixture of the two.
This initiative has been also useful to address environmental concerns. According to the United States Environmental Protection Agency, for a unit of energy, the production and use of sugar-based ethanol generates only two-fifths of the carbon emissions of petrol. (Soccol, et al., 2005)

However there are other impacts identified as part of the implementation of this initiative e.g an increased use of pesticides, deforestation and increase of price of traditional crops due to the less availability of fertile soils to cultivate. (Halász, 2011)

Results

- **CO2 emissions reduction**: With the use of bio-ethanol Brazil has became a global leader in cutting emissions and oil imports. " In 2011 it was estimated that the country's greenhouse gas emissions were reduced by 600 million metric tons of carbon dioxide since 1975 due to the use of sugarcane ethanol in Brazil". (Halász, 2011)

- **Local economic growth:** By 2011, economists estimated that with the implementation of Proalcool, Brazil's total economic output was 35% higher than what was expected without the program. Whereas in 1975, Brazil produced 555 million liters of bio-ethanol, in 2015 the production reached 28 billion liters. Brazil is the world's leading sugarcane producer. (FAPESP, 2016)

- **Capacity Building** Besides the building of production plants and facilities, the BIOEN program was created with the aim of integrating researchers, universities and research institutions in Brazil and abroad engaged in bioenergy, to ensure Brazil's leadership position on the field. (FAPESP, 2016)

Lesson learned

- The process to develop a national industry requires the perseverance and the joint work of industry leaders, government and national researchers.

- A strong policy can boost and generate the creation of a new industry.

- It is important during the planning phase, to take into account possible positive and negative long term effects and develop a parallel strategy to cope with the negative impacts.

- The quick response of the National Innovation systems is crucial to support the evolution of the industry and cope with the technological challenges that it implies.

- Taking an internal resource and the expertise that the country has developed for a long period, in this case around the sugar cane; could be seen as the ground and the bases for the development of a new industry and a new local and even international market.

5. Analysis and observations

Two cases of adaptation, three cases of mitigation and one case that involves both strategies have been studied in-depth. In both adaptation and mitigation projects, endogenous elements were found. Additionally, there are a number of observations that can be drawn from examining these case studies.

5.1 Participatory approach: The participatory approach seems to be key in the planning and implementation phases and it is present in four of the six case studies. The case of the bamboo industry in Sri Lanka shows a lack of community participation in the planning phase, and also some failures related to project design, elements that are interfering with its successful implementation.

5.2 Capacity building and training : All projects involve a form of training or capacity building, in the range from creating local management committees in Colombia, Vietnam, Bolivia and Sri Lanka, supporting innovation centers in Bolivia and Colombia, supporting entrepreneurship in Rwanda, offering training in all cases to different stakeholders in technical, management and marketing skills, designing or adjusting technologies that fit local needs in Vietnam, Bolivia and Rwanda to the building of processing facilities and pilot demonstration sites in Sri Lanka and Brazil. The recipients are local communities, local governments, scientific community, local leaders, technicians, project managers and local organizations.

5.3 Creation of new local economies: In three of the six cases studies a new local economy is developed as a key to ensure sustainability of the projects. In Brazil a bio-ethanol national and international market was created and is growing. In Vietnam a Biogas market was created, masons say that they have built as many systems outside the programme as within it. On the other hand, in Rwanda a market of solar kiosks is being developed and in Sri Lanka, the intention is to create a market around processed and raw bamboo. For that, it is essential to empower social capital and boost community ownership.

5.4 Ensuring sustainability: Local management committees have been established in five of the six case studies, in order to ensure the sustainability of the projects once the implementation institution has left. It is precise to highlight the importance of the fact that innovation systems work aligned with the national needs and priorities; and their ability to retain the human capacity that has been already built.

5.5 Important roles of the governments: In five of the six cases, governments have played important role. It covers a range from initiators through specialized dependent entities, like COLCIENCIAS in the Colombian case, or through ministries that normally deal with economy and development, to facilitators. Governments create strategic alliances with funding bodies or with development organizations. In the Bolivian case, the government besides its role as funder and creator of cooperation took the role of policy maker to catalyze the development process. In Brazil, a decree from the government was the initiator of a whole industry. In the case of entrepreneurship in Rwanda, the government did not have any specific role, implying that in this sector there are opportunities for governments to engage in the development process.

5.6 Technology transfer: Transfer of technologies is present in all case studies but always including a process of adjustment to local conditions, although the main purpose of the projects/activities are not specifically about transfer of technologies.

5.7 Indigenous knowledge: Indigenous knowledge is not identified as the main element in the cases studies analyzed, however it is taken into account in the planning phase of the projects, specifically in the projects developed by AGRUCO in Bolivia and plays a role also in the implementation phase, where could be constituted as key factor to approach in an assertive way to the communities.

6. Conclusions and recommendations

As mentioned in the Introduction section of this study, the purpose for reviewing these cases is to understand better how the development of endogenous capacities and technologies appear in real situations and how they may be relevant to the work of the TEC.

Due to limited resource and time and other limitations, there were only a handful of case studies were examined in-depth. This may hinder the drawing of a robust conclusions on this issue. Despite this, we can draw some initial conclusions from the various projects and activities. Among of them, to successfully strengthen and enhance endogenous technologies and capacities:

- A participatory approach, where all the stakeholders but specially the beneficiary community could express its point of view, is crucial to identify environmental and economic needs and then define priorities to determine the means for building capacity.

- External cooperation and processes such as technology and know-how transfer are effective only when the internal conditions are understood and taken into account

- Empower social capital and boost community ownership is essential to ensure the acceptance, integration and sustainability of the development projects.

- The creation of local markets is an element that contributes to the sustainability of the projects.

The initial conclusions above could be strengthened with more in-depth study while addressing the limitations of this preliminary study. Below are a number of limitations identified while undertaking this study and possible recommendations for follow up actions.

Limitations

The first and foremost is the absence of a clear guidance on the definition of “endogenous” and consequently how to understand what are endogenous capacities and endogenous technologies. Consequently, the study needed to define its starting point, namely definition of endogenous, and arbitrarily select elements that may be relevant in the context of technology development and

transfer. This in turn limited the scope and, quite likely, limited the number of case studies that can "fit" into the definition.

The second is the challenge to find examples of projects or activities containing endogenous elements from developed countries. This possibly be due to selected elements used in the definition of "endogenous" as explained above. But it may be due other reasons which this study could not confirm.

The third is that there appear to be not enough case studies on research, development and demonstration, but many have innovation elements, including promotion of entrepreneurial capacity.

And the last one, limited information is available in country's documents related to technology needs, in this case TNAs, related to endogenous elements. This may be due to no specific requirement in the TNA process to indicate elements of endogenous capacity/technology as part of the process undertaking the TNAs.

Recommendations

a) It is recommended that the TEC reflect on the findings of this preliminary study, in particular on the general observations/trends and the initial conclusions, and take into account these issues as it implements its workplan, as part of a response to the relevant mandate from COP21.

b) If further study is to be undertaken in this area, it is recommended that the TEC firstly develops a clearer understanding of the concept "endogenous" as it relates to climate technology development and transfer.

c) It is also recommended to have further study in areas where activities appear to be lacking, for example in the area of research and development.

d) It is recommended that the TEC also develop a greater understanding of developing country needs regarding developing and enhancing endogenous capacities and technologies. So it may respond more effectively to the needs of developing countries in this area.

e) It is recommended to look further whether the inclusion of specific mention of endogenous elements of technologies and capacities in the TNA documents could be a useful and added-value exercise.

f) The TEC may also consider undertaking collaborative work with the CTCN on this issue, as both bodies received this COP 21 mandate.

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