ARC – ZFEP – TGSN Project Assessment & Workshop February 2015

TRIP REPORT

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A. Executive Summary

In 2014, Zayed Future Energy Prize (ZFEP) approached ARC initiative (ARC) to help with the implementation of the Tanzania Green School Network's[1] (TGSN) proposed learning centers, and help design a curriculum that they would advance the TGSN objectives. Accordingly, ARC has proposed to conduct a workshop that aims to kick start the learning centers to empower the Tanzanian Green School Network to achieve its vision, and primarily facilitate the completion of the proposed ZFEP 2013 application outcomes. In addition, in January 2015, after personal discussions with Mr. Thomas Kaniki the Head of TGSN, and ZFEP, it was decided that ARC initiative will act as a facilitators among TATEDO (a local contractor in Tanzania), TGSN and ZFEP, overseeing and mediating the installation of the energy systems proposed in the 2013 ZFEP high school category.

As part of preparing the ground for the kick-off workshop, ARC initiative along with EWB-MI traveled to Tanzania between 15th -21th of February, 2015. During the needs assessment trip, ARC team met the local contractor to assess their reliability and engaged in several discussion with them about the energy systems implementation plan, conducted technical assessment activities to assess the feasibility of the proposed energy systems, held a mini-workshop for the environmental club in Makomu school, conducted a Teachers' co-designing session, and met with potential trainers and collaborators for the workshop and the learning centers.

According the technical assessments that ARC initiative and EWB-MI have done during needs assessment trip, it was concluded that some proposed components in the original proposal of TSGN ZFEP high school category were proven to be infeasible, and thus, ARC worked with TGSN and the local contractor on a new design for the energy system components and learning center components.

The mini-workshop presented concepts of climate change, fossil fuels, carbon emission, and renewable energy options. The teaching session was followed by a hand-on activity where students had to construct an anemometer (a device for measuring the speed of wind), analogous to a wind turbine and then they calculated the "wind-speed" of their breath using a simple mathematical approach.

The teacher co-designing session aimed to get teachers of TGSN and ARC together to finalize the objectives and learning outcomes of the workshop in summer based on the discussion of the past & current issues related to climate change and sustainability in the Kilimanjaro region. The workshop was designed to facilitate discussions and share experiences among participants. The workshop participants were expected to come up on their own with the common visions for a community and define teaching outcomes of schools to achieve intended vision of a community as a whole.

[1] Recipient of the 2013 Zayed Future Energy Prize in the Global High Schools Category.

B. Trip Objectives

1) Understanding of local conditions affecting the implementation of the TGSN proposed project
2) Assess the technical and economic feasibility of the proposed renewable energy systems and the reliability of the local contractor
3) Prepare the ground for designing a workshop to kick-start their proposed learning center, scheduled for later in the year.

The lower level objectives of the trip were:

- Trust Building with TGSN
- TGSN needs assessment
- Assess the technical feasibility of the systems
- Conduct participatory workshop co-design activity
- Assess local contractors
- Meet with potential collaborators for the workshop in June

C. Background

Kirya, Makomu and Kileo secondary schools are governmental schools in the Kilimanjaro region of Tanzania. These three schools form the Tanzanian Green School Network (TGSN) a community based organization established in 2008 and led by Thomas Kaniki, current head of Makomu secondary school. The vision of the Tanzania Green School Network is to be a community knowledge center for practical environmental education and implementation, monitor climate change and engage in dialogue and experiments with the surrounding villages. In 2013 TGSN applied to the Zayed Future Energy prize (ZFEP) for the high school category and they won 100000 $ to implement their project. The following table lists their project components:

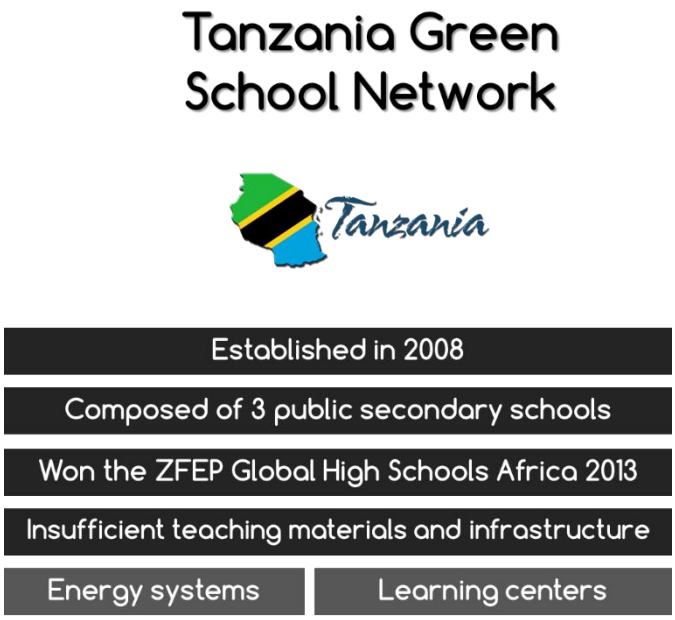


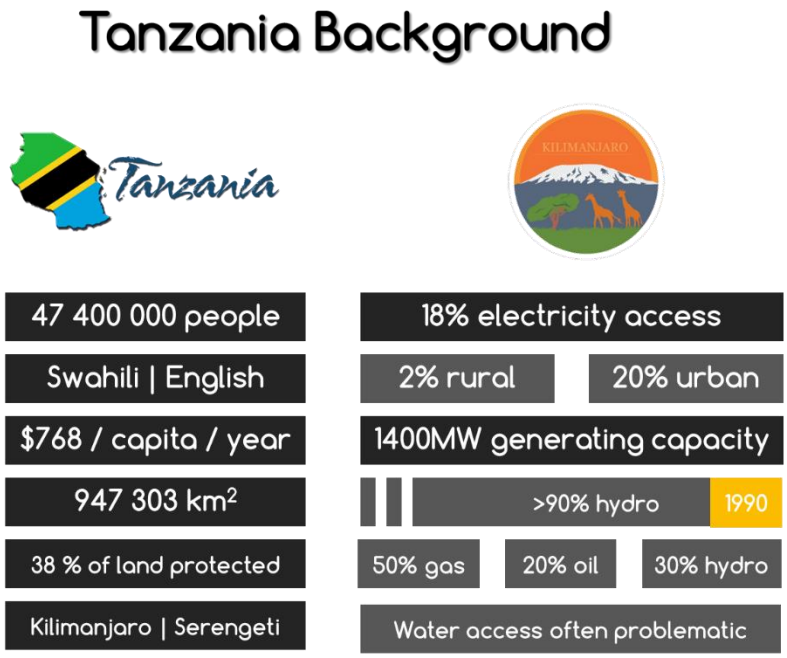
Table 1. Initial project components in the ZFEP application

Component	School	Cost (USD)
Windmill power project	Kirya	14000
Electrical Pump for water	Kirya	2000
Solar system	Kileo	10000
Water Storage Tank	Kileo	4000
Biogas plant	Makomu	20000
Water Storage Tank	Makomu	4000
Incinerators for waste	All schools	1000
Fencing	All schools	27000
Learning center computers	All schools	18000
TOTAL		**100000**

Other funds of 11000 $ were raised by Professor Ben Wisner (who acted as an advisor for the TGSN and engaged the school in his climate adaptation project which is called, LKCCAP[2]) for water supply in Kirya, and Kirya paid the same amount for pipes, transport, contractor, while the students provided labor.

[2] Local Knowledge and Climate Change Adaptation Project

Out of their initial plan, and after a year the schools only installed the fences, spending the budgeted $27000 out of their prize. Upon the delay, ZFEP stepped in and hired a contractor (ALSA Solar Systems) to assess the situation and finish the Installation of the proposed renewable energy systems. ALSA came back with a proposal to implement the project amounting to more than 90000$, considerably more than the remaining budget.



Apart from renewable energy systems, TGSN also plans to have three active learning centers, one in each school, but currently these centers lack the proper equipment. The learning centers currently have a project coordinator and geography teachers that work with the student clubs and facilitate the parent meetings and seminars. Still there needs to be a well-organized plan to vitalize the learning centers. Some of the activities that the TGSN intends to do through the learning centers at schools are:

- Arrange workshops about climate change and adaptation, sustainability and agro-forestry experimentation and production.
- Arrange parent meetings and seminars with village leaders and the local community.
- Monitor climate change and engage in dialogue and experiments with the surrounding villages.
- Develop relevant teaching material.

D. Situation Analysis

Five of ARC and EWB-MI team members traveled to the field to the Kilimanjaro area (schools' location) and Dar Es Salaam (former capital) in Tanzania between the 15th -21th of February, 2015 to achieve the high level objectives outlined in section B. The team found out that the schools have limited resources, and rely on scarce government funding. Also, the number of teachers is very low compared to the school requirements. The team has held a series of meetings in Moshi, the regional capital, followed by a half-day visit to each of the schools. The team finished their assessment trip in the national capital. In this section the key findings and observations are presented for each of the venues. Table 1. lists the location and size for each of the TGSN schools.

Table 1. Location and size of the TGSN schools

School	Location	Number of students
Makomu	(-3.822674, 37.478832)	Around 400
Kileo	(-3.466535, 37.567932)	Around 200
Kirya	(3.822674, 37.478832)	Around 300

Meetings with TATEDO and Professor Emmanuel

The assessment started in Kilimanjaro, where the team has met Mr. Thomas from TATEDO who is the designated local contractor of the project and Professor Emmanuel from College of Wild Life Management. They met with Mr. Thomas several times over the course of three days and advance the discussions were revolving around the new energy system components and action plans that need to be taken from TATEDO's side until June. Also, Professor Emmanuel has committed to lead the sessions regarding climate change in the summer workshop.

Moshi town had frequent electricity cuts and lines along the road for water were a usual sight, especially in the morning times. Internet access is almost exclusively from mobile phone operator dongles, but the phone signal is not always reliable.

Visit to Makomu School

Makomu Secondary School is a medium-sized rural school in the Kilimanjaro region of Northern Tanzania, in the district of Moshi town. The nearest town is the popular Kilimajaro trekking destination of Marangu, about 3 kilometers away.

The school comprises of 5 buildings, of which 3 are for classes, 1 is administration, and 1 serves as a kitchen to provide cooking for the students. There is also a farm with some vegetation, nurtured by the students.

While still in a very rural setting, the school is in a densely populated area, and therefore its land is in scarcity for its 463 students. But land is not the only scarce resource: so is water and electricity.

The school is connected to the TANESCO (Tanzanian National Electricity Company) power grid, however, continuous power surges are experienced. And on top of that, the tight school budget renders electricity rather a luxury than a norm.

There is a 1000L water tank in the school yard. While there is plenty of rainfall due to the school being located on the slope of the Kilimanjaro Mountain, lush with vegetation, the water stock is not managed properly, leading to intermittent water shortages. The school shares its water tank as a common resource and makes it available for the communities of the nearby villages. This, however, places a high pressure on the on the stored water, especially in the morning and oftentimes it runs out before everybody could fill up.

Makomu School




Makomu has a kitchen, as students get lunch everyday. During the lunch hours a dense smoke covers the entire yard. Cooking is done on traditional three-stone type cook stoves, on open fire. The wood is purchased from Marangu and it is about one third of all of the schools expenses.

The schoolchildren wear colorful uniforms and they are distinguishable by grades. Each grade has its own color for its uniform. We were surprised by the level of discipline of the students and the tidiness of the school in general.

The school has a seedling nursery, where different types of trees are grown and distributed to the community, whenever they grow high enough. This activity is lead, in collaboration with the headmaster, by the students.

The school bell is an old car wheel rim and a hammer.

Makomu school has an existing computer lab (from a Canadian donation), but they do not work because of the lack of electricity. It is important to note that the school chooses not to use electricity primarily due to economic constraints (~30 US cents/kWh price of electricity) and not because of grid instability or another ancillary grid issue. However, we saw that they are still trying to have occasional computer classes. This starts with the explanation of "what is the mouse" and "how do we turn the computer on and off" - the notes of former, including usage instructions were sketched on the blackboard with a chalk.

The school also has a very good reputation among the parents and team has met with of the representatives of parents union. The villagers are very open-mined and willing to learn for any renewable energy installation that might be installed in the future. Communities' values definitely seemed to be higher than average and they have considered the school and integral part of their environment and hub for learning.

Visit to Kileo School

Kileo secondary school is another rural high school about 2 hours driving away from Moshi town in the Mwanga district of the Kilimajaro region of Tanzania. Despite its relative proximity to Makomu, the climatic conditions are drastically different, with many arid and hot days occurring throughout the year.

The school comprises of 6 buildings – in rather bad shape, of which 4 are for classes, 1 is administration, and 1 serves as a kitchen to provide cooking for the 326 students. There is also some vegetation, mostly arid climate trees. The surrounding area has a small forest that the villagers share and use for gathering wood fuel.

The school is currently not connected to the electricity grid, but TANESCO is expected to extend the electricity grid to the school in 2015 or 2016 latest. They have experience with solar panels though, from at least three previously installed systems.

There is a small roof-top PV installation (8 photovoltaic modules) on the administrative buildings, seemingly installed several years ago. The system was not operational at the time of visit due to the bad quality of the system components (inverters, batteries) and possible wiring anomalies. After a quick assessment, the team has judged that the panels are operational and the system could be rehabilitated by replacing the damaged components, without the need of acquiring new photovoltaic modules. There was also another solar PV system, which ran a pump from a well, into a 10,000L water tank. This solar PV system was operational and covered the schools water demand.

The school used to have another solar water system, albeit the installation was on the ground. This lead to somebody stealing the panels, while taking the life of a guard. Since then security is a top priority for Kileo. When asked about the importance of fencing, whether it is for protection against animals or humans, the answer was clearly the latter.

The school is in the immediate neighborhood of a primary school of comparable size. Given the fenced separation between the two, the relationship might be less amiable than expected. Although, the area of the secondary school, Kileo is much bigger, with a large back-yard and open space.

Kileo School




Currently, the students gather wood for the cooking from the nearby forests. Due to the increasing population as well human migration of crop field into more forested areas, the future of the free wood commodity is in danger. Just like at Makomu, cooking here is also done using the traditional three-stone fireplace, although they have one modernized, clay cook stove, with a chimney.

The school representatives boasted that the solar water-pump have been a great success so far, with not only the 10000 storage tank filling up but also a 5-10 times larger concrete overspill reservoir, water from which is used for the nearby communities – therefore greatly improving the social status and importance of Kileo school.

Visit to Kirya School

Kirya was the last school to be visited, much further away from Moshi than the previous two. Currently, there is no asphalt road that leads to the school, only a gravel road in a bad shape. The drive from the main Moshi-Dar Es Salaam road takes about an hour. The school is right beside on of Tanzania's medium-sized hydroelectric power plants, Nyumba Ya Mungu dam and lake. Therefore the road is mostly frequented (and probably maintained) by workers of TANESCO. There was some major construction going on the hill opposite to the school and the team has been told that there are great plans for extending water access from the reservoir to the region.

Kirya school is the largest TGSN school by far with alleyways and yard vegetation and live-in quarters for both students (only female) and teachers. The school comprises of 6 buildings, of which 4 are for classes, 1 is administration, and 1 serves as a kitchen to provide cooking for the students. It has been established only a few years ago and the terrain was completely reclaimed by then-principle-in-charge Thomas Kaniki – current headmaster of Makomu and head of TGSN. Mr. Kaniki, together with few teachers planted vegetation, cultivated areas to build this school and educate students in the region few years ago.

The school is not connected to the grid – and there are no imminent plans of doing so, despite being in the close proximity of large hydroelectric dam. They had experience in using a diesel generator, to supply power to the pump, which pumps water from the nearby lake to the 11000 liters reservoir. However, the pump is not operational anymore due to mechanical failure. Personnel from the school informed the team that the local municipality is planning to connect water supply to the school throughout the next year. Electricity, however, will still remain an issue, as it is already the largest cost component of the school's budget.

Kirya School




Dar Es Salam meetings

After the assessment in Kilimanjaro, the team flew to Dar Es Salaam, where a number of meetings have been arranged with different stakeholders that might help facilitating the workshop in June with TGSN. The primary purpose of the meetings was to seek for the collaboration opportunities and most of the parties reacted positively and promised strong support on the summer workshop. Considering the focus of their work, the team asked for supports on the teaching materials written in Swahili, seeking for local experts in the field of climate change adaptation and agroforestry as well as evaluating the prices of local products such as improved cook stoves.

- Professor Adolfo from the Commission of Science and Technology (COSTECH)
- TAYEN (Tanzania Youth Energy Network)
- ARTI (Appropriate Renewable Technology Institute)
- CAN TZ (Climate Action Network, Tanzania)
- Professor Jasson John (University of Dar es Salaam)

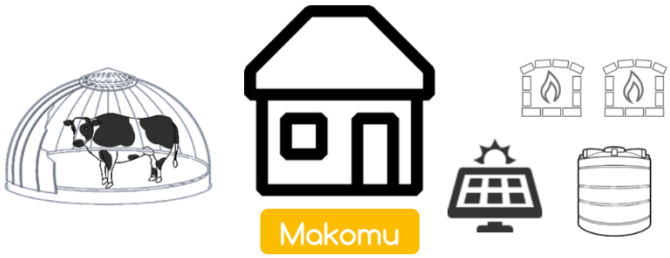
E. Energy systems and learning centers assessment and redesign

Overview

According the assessment that ARC initiative and EWB have done, some proposed components in the original proposal were proven to be infeasible, such as the wind energy system for Kirya school, for the lack of sufficient wind speed or the large biogas plant for Makomu. In addition, other components were added such as improved cook stoves to replace the traditional cook stoves in the schools, that are unhealthy because of the smoke that they produce and also consume a lot of wood which accounts for the significant amount of school's expenditure. Therefore, coordinating with the TGSN and TATEDO, ARC and EWB MI proposed a new design for the energy system components and learning center components, as presented in Table 2.

Table 2. New Project Components and Budget

Component	School	Cost (USD)
Solar PV system	Kirya	16570
Improved cook stove x 1	Kirya	1010
Solar system (repair old + install new)	Kileo	21202
Improved cook stove x 2	Kileo	2021
Solar system	Makomu	13428
Biogas plant	Makomu	2695
Water Storage Tank	Makomu	2050
Improved cook stove x 2	Makomu	2021
Learning center workshop	All schools	5000
Learning center materials Computers, LED light bulbs, projector, internet	All schools	14000
TOTAL		**80000**



Technical assessments

- Water
    - Makomu Water Demand:
        - Cooking: 400L/day
        - Students use/ washing: 3L x 463 students = 1389 L/day
        - Gardening and Vegetation: 500L/ day
    - Kileo Water Demand:
        - Cooking: 400L/day
        - Students use/ washing: 3L x 326 students = 978 L/day
        - Gardening and Vegetation: 500L/ day
    - Kirya Water Demand:
        - Cooking: 400L/day
        - Students use/ washing: 3L x 330 students = 990 L/day
        - Gardening and Vegetation: 500L/ day

- Solar

Given the Equatorial position, the solar irradiation in the region is high, and solar PV system installations are feasible. Except for Makomu, on the slope of the mountain, the schools do not usually experience thick cloud-cover. A preliminary sizing of a solar system for Kileo and Kirya is presented in Table 3.

Table 3. Kileo and Kirya solar system sizing

AC Device	Watts	Hours/Day	Watt-Hours/ Day
Lights	1500	6	3000
Computers	250	6	1500
Fans	75	6	450
Miscellaneous	100	6	600

- Average Peak sun hours per day: 6
- Percentage of power to be generated by solar: 100%
- Electricity demand per month: 166.5 kwh/month
- Number of panels: 12 x 100W

The Makomu system would be 2/3 the size of the Kirya and Kileo systems. Being connected to the grid, the school electricity demand is 40 kWh/ month as estimated by the principal. Meter data reads about 50 kwh/month. For the case of Kileo, the existing, non-operational solar PV system would also be rehabilitated as part of the project agreement.

- Wind

Wind resource in the region is generally is not sufficient for efficient operation of wind turbines and therefore they are not recommended. In TGSN's original proposal, Kirya school was to receive a wind turbine. After surveying the site though, it has been found that the usual wind speed is much lower (3m/s) than necessary (>10m/s) for normal turbine operation. While there have been attempts to cater for the installing of a small wind turbine for educational purposes or a specialized low-speed wind turbine, these ideas have all been dropped subsequently, in agreement with TGSN. Therefore no wind power system is getting installed at any of the TGSN schools at this time.

- Cooking Requirements

Cooking for all of the students is done in the school kitchens. Usually several 20-30L (sometimes 60-80L) pots are placed on top of wood (which has been purchased or collected from nearby lands). A lot of wood is consumed, which emits a lot of smoke, and it severely pollutes the air of the court yard and he school's environment. The team has explored many options for delivering improved cook stoves to the schools,

including TATEDO and a supplier in Dar Es Salaam (ARTI Energy). Each of the schools will get at least one improved cook stove and eventually all cooking is aimed to be covered in an improved cook stove – significantly reducing ambient smoke in the school yard and therefore bettering the health of the children. Kileo and Kirya already have at least one improved cook stove in place.

- Biogas

The initial proposal for ZFEP included a 30 m^3 biogas plant at Makomu. This was sized according to the number of cows (20-30) that the neighbors were holding next to the school. This number of cows, however, has drastically declined during the last 3 years. Therefore, a biogas plant of such a high volume would require students carrying cow dung from home to keep the biogas digester running. Thomas from TGSN did not feel very comfortable with that because it would be difficult to convince the parents for this and to find people transporting cow dung during the school holidays. In addition, he was afraid that when he will be replaced by another headmaster, no one would be there anymore to push parents and students running this digester. Therefore the biogas digester size has been reduced to cater for approximately two cows only.

- Waste

Food waste and human feces could be co-digested in the biogas plant. Yet, almost no food waste is produced at the school. At the day of visit, cooking for 463 students lead to a negligible amount of approximately 10 liters of food waste. Thomas from TGSN also confirmed that the food waste generation is very low on other days. Thomas was open to but not enthusiastic about using human feces, and it seemed socially not very well accepted. Therefore, cow dung alone is the system of choice. In the Makomu area, biogas is not well established yet, despite the high amount of cows. Cow dung is already used as fertilizer. Biogas production can lead to reduce the cost of cooking for the community while the effluent of the biogas plant can still be used as fertilizer. Pathogens might not be completely destroyed in a biogas plant, and therefore the use of the biogas plant effluent as fertilizer needs to be done with care.

F. Activities

Mini student workshop

One of the interesting activities while at Makomu was a student-activity, conducted in the form of a mini-workshops by ARC and EWB members for 6 and 7th grade students.

The main objective of the workshop was to present concepts of climate change, fossil fuels, carbon emission, renewable and alternative energy options towards a sustainable future, placed into the local context of rural Tanzania. The children were remarkably well-versed in sustainability concepts, physics, mathematics, but also sustainability in general but also interdisciplinary sustainability spanning over the economic, water or social systems.

The highlight of this activity was when the teaching session was followed by a hands-on activity. The main purpose of the activity was to familiarize the students with general energetic concepts, in particular that of wind energy. Wind energy was chosen because of its simplicity to simulate in a classroom environment, as well because there are large number of misconceptions about the ease of use of wind power.

Mini Student Workshop

The students had to construct an anemometer (a device for measuring the speed of wind), analogous to a wind turbine and then they calculated the "wind-speed" of their breath using a simple mathematical approach. Then the obtained results (about 1-2 m/s) were compared to the actual measurements taken by a digital anemometer, found to be 3 to 4 times higher. The students were very engaged, jumping and shouting in this activity, but they also demonstrated that they have learnt a lot in such a short time span of only a few hours.

Meeting with the environmental club

During the visit in Kileo, the team have managed to have a short meeting with the environmental club of the school, compromised of about 40-50 students. The group meets regularly to learn about topics on sustainability, and they also have a seedling nurturing program. They are very excited and proud to already have renewable energy systems on their school campus and even more excited for the new systems to come.

Teachers' Co-Designing Workshop

One of the highlights of the visit in Kirya School was when ARC has conducted a workshop that was intended to come up with specific learning outcomes and design the educational objectives for the upcoming main learning center launch workshop in the summer. This activity lasted for the entire day.

- Workshop Time and Venue

8:00-17:00, 17th February, 2015. Kirya secondary school.

- Objectives of the Workshop
  - Develop a vision and objectives of the workshop in Summer
  - Brainstorm and co-design the workshop activities that are aligned with the objectives
  - Define teacher's roles in the workshop in Summer
  - Discuss teacher's/student's role in vitalizing learning centers
  - Build action plans until June

- Summary of the program

The workshop was divided into four sessions. The primary purpose of this workshop was to get teachers of TGSN and ARC together (Session 1) and to finalize the objectives of the workshop in summer based on the discussion of the past & current issues related to climate change and sustainability in Kilimanjaro region (Session 2). The workshop was designed to facilitate discussions and share experiences among

participants. The workshop participants are expected to come up on their own with the common visions for a community and define teaching/learning outcomes of schools to achieve intended vision of a community as a whole. The Session 3 was planned for teachers and ARC members to co-design and customize the learning activities suitable to the local context and student's strengths and weaknesses. The Session 4 was to define our roles until June and receive feedbacks of the workshop.

- Workshop program

Session 1. Introduction: Ice Breaking Activity

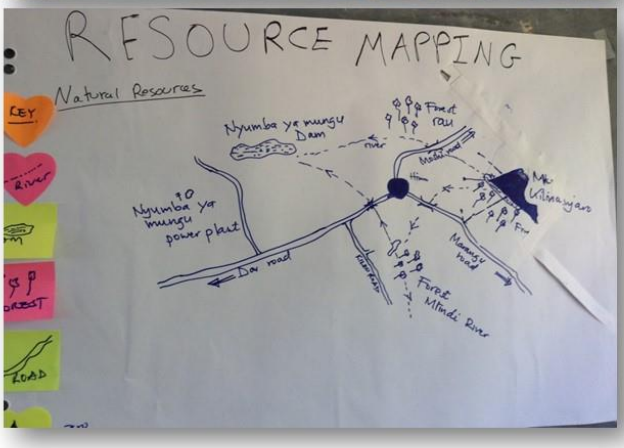
The objective of Ice Breaking Activity was to introduce each other among teachers and get familiarize with others while introducing ARC's systematic approach.

We randomly distributed the small cards that sustainability-related topics are written on: energy, population growth, income, electricity, food, climate change, agriculture etc. The common question posed was: "how my topic is connected to <the other's topic>?". One person holding the starting point of the thread conveyed the thread to the other person whose topic is of his/her interest. Then (s)he explained the connection between two concepts and this was repeated until the thread was completely entangled.

Teachers seemed engaged in explaining "why A is connected to B" and most of teachers gave the positive feedback of this activity afterwards. At the end when threads were tangled, we asked everyone to pull the end of thread they are holding, teachers sensed the message we were trying to convey and laughed: All problems are interconnected so if one part of our nature goes beyond the carrying capacity (the threshold), the balance of whole system gets destroyed. Considering this interconnectedness, the energy solution also has to come from a "systematic" approach[3].

Session 2. Sustainability in Kilimanjaro: Resource Mapping

In order to share common understanding among teachers and be self-reflective, we had a resource mapping session in four different topics: Governance, income, physical resource and seasonal calendar. The concept of resource mapping is to encompass not only physical, natural resources but also human resources and cultural resources.



[3] Arc initiative believes the strength of systematic approach in the process of energy system planning and design by taking into account of three pillars of sustainability- environmental, social-economic and engineering sustainability.

Each of group drew their maps and presented to the others.

Governance: The governance group focused on the hierarchy of professions in the region. They have created the organizational chart on the paper.

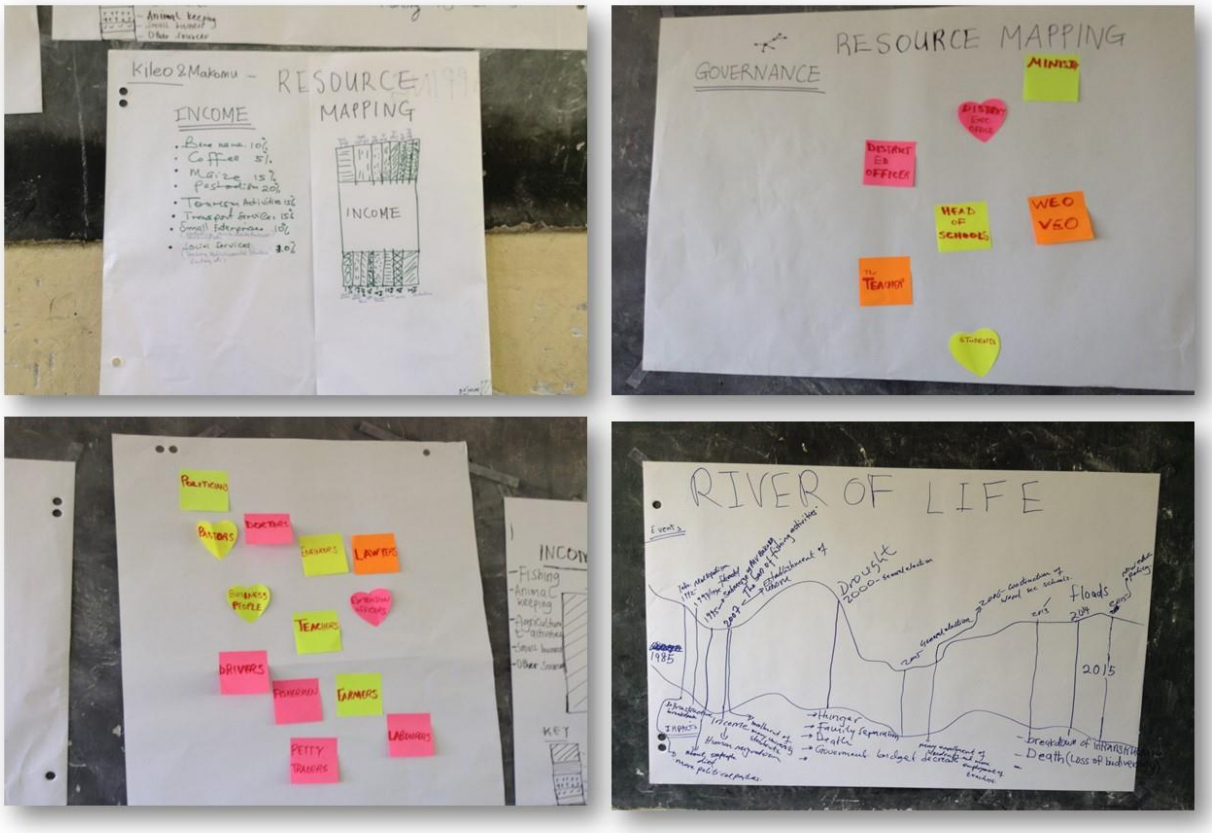
Income: The group was initially mixed with teachers from two different schools. When they are asked to do income source and expense mapping, teachers naturally felt the need to divide the group into two as the main economic activities were totally different: One was fishing oriented culture (Kirya) and the other was dairy and pasteurization (Kileo & Makomu). In case of Kileo and Makomu, due to the coffee crop disease few years ago, they had to change their crops into maize and banana. The income generating activities of all three schools seemed to be dependent on their natural environment. Small group discussions made the horizontal atmosphere among teachers and headmasters in expressing their own opinions.

Physical/natural resources: The group mapped the physical and natural resources in the region such as dam, river, mountain and fields.

Seasonal calendar: Seasonal calendar group created a monthly calendar over a year and noted down the key events for their economic activity (harvesting, rainy season) as well as educational activity (government exam). This activity was informative to analyze monthly fluxes of their resources and seasonal variations over a year to infer which period people would require more energy or resources.

Session 2. Sustainability in Kilimanjaro: A River of Life

Teachers reflected their historic events of the region in terms of political structure, recent changes in the education policy, natural disasters and the lessons learned from those. Teachers came up to the chalk board and drew the important events in the river with lessons learned. There were numerous interesting discussions among them on "what was an important event" and "why". One notable point was that there was a general tendency to focus on the negative events such as natural disasters and to point out mostly high level changes rather than their community/school issues. For example, in Kileo the implementation of a solar driven water pump lead a significant improvement for the school and the surrounding community, but no one was mentioning that. Events in the community might be easier to understand especially for the younger students compared to rather abstract and complex political events.



Session 2. Sustainability in Kilimanjaro: Community vision mapping and learning outcomes

Teachers then discussed common visions of a community and described what future they aspire to. The objective of the session was to align their visions of a community with the students' in a school to achieve the visions. Teachers were active in speaking up the visions and learning outcomes. The below are the outcome of the discussion.

Community Learning Center Visions

- Equip villagers with principles in basic science, the concept of sustainability and renewable energy
- Highlight local opportunities and resources
- Improve parent outreach
- Reflect the historic events and lessons learned
- Apply hands-on activities
- Create site visiting activities with local experts
- Transfer knowledge and share experiences of Kirya and Kileo
- Diversify income sources
- Reflect and apply local knowledge of Masai (indigenous community)
- Empower students as ambassadors of sustainability

Workshop Intended Learning Outcomes

These are the intended learning outcomes we came up with for our sessions in June, and we assigned the teachers to the subject areas:

- Explain the concept of climate change, sustainability, global warming and GHG emissions and identify importance of planting **(Emmanuel P Temu, Gerin Siimay, Yoda Tohn , Zakharia Sammly)**
- Apply basic science of renewable energy systems and apply in operating/maintaining the systems and identify interconnections between resources and energy systems **(Anwar Ally, Henry N Mkiti)**
- Describe environmental dynamics of the village surrounding **(Rashid Mohammed)**
- Governance structure of the community
- Identify potential income sources and expenses
- Enact behavioral change in relation to sustainability and climate change **(Valeria Henry)**

Session 3. Activity Design, "Mapping Moshi Island" developed by Practical Action and teachers' role division

Before starting the activity design, teachers were asked for the self-reflection on their teaching experiences. We asked teachers to share their teaching style and materials and find out what are parts that can be improved. This could have been better by providing some specific examples of teaching styles prior to making them reflect their own experience or having a small group discussion rather than presentation. It seemed difficult for one to be self-reflective in front of the public. In this sense, hearing from students about the classes can be a good alternative

We then distributed the ready-made learning activity developed by Practical Action to teachers to customize it. The objective of "Mapping Moshi" activity is divided into three parts: 1) map the local resources in their village such as wind, solar, biomass or hydro, 2) list the energy needs of the village and 3) design the energy system which can meet the village needs given the information on the potential energy generated from each resource (i.e-how much energy can be generated from 4m/s of wind).

Adopting "Mapping Moshi" seemed to be a bit difficult, because the teachers needed some time to understand the game first, and did not seem to really understand what their task was. Especially, teachers from the subject not related to geography or science found difficulties in seeing the value of resource mapping and connecting it with energy system design. There were no visible activities even after half an hour. The good thing was that two lecturers joined each group to support teachers. Lecturers were the local experts in the field of renewables so they led the discussion which teachers found it difficult to proceed. However, this would not be the best solution as it gives the power to a person from outside who has more knowledge in a specific topic and teachers from the community could not fully participate in the discussion.

Learning Center Launch Workshop

TGSN and ARC will conduct the main workshop in summer 2015 (originally planned for the month of June) that aims to kick start the learning centers to empower the Tanzanian Green School Network. We hope TSGN to achieve its vision, and primarily facilitate the completion of the proposed ZFEP 2012 outcomes. In the long term, ARC plans to facilitate the development of a sustainable workshop model for an active-productive learning center.

The workshop targets secondary students as well as teachers, where teachers would be incorporated in the workshop design and act as co-instructors to prepare them to replicate the workshop in the future. In addition, the local people would give sessions in the workshops to promote their local knowledge of environmental conservation and sustainability. The workshop is designed to teach theoretical and practical knowledge on local resources, climate change and adaptation with a focus on agroforestry, renewable energy and sustainability. ARC will act as coordinators and facilitators of the workshop, by working with the TGSN and other collaborators in Tanzania and Masdar Institute.

Workshop objectives

The ARC-TGSN Learning Center Launch workshop aims to:

- Introduce concepts of renewable energy and sustainability into the day-today vocabulary of not only TGSN teacher and students, but also the wider Kilimanjaro area.
- Oversee and build the human and logistical capacity necessary for the sustainable operation of the 3 TGSN learning centers, one at each of the 3 schools.
- Ensure the long-term sustainability of the teaching activities:
    - by building capacity in sustainability education of teachers, as well bridging and connecting them with local talent as well as leveraging local customary sustainability practices.

- by stirring interest of the student participants in the workshop in all areas of sustainability: environmental, economic and social.

- Establish support of learning centers from local school authorities, parents and villagers through actively involving them in the workshop activities
- Design an action plan for the TGSN schools to becoming sustainability pioneers of the Kilimanjaro region and potentially become a role model for other schools and districts.

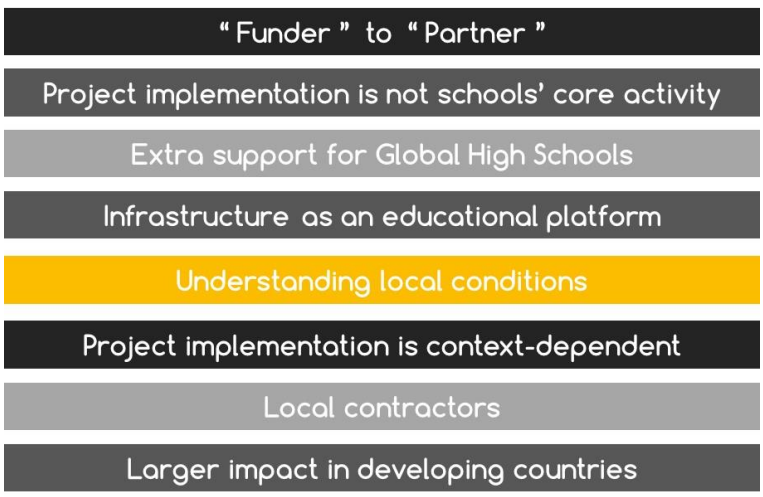
G. Challenges and recommendations

Donor impression

An important lesson for ZFEP and similar projects is the creation of ownership and control mechanisms of a proper use of donor money and systems. The pitfall of donor money is that the community or school usually does not show much of responsibility for taking care of the system installed. One possible solution for this is that, school staff and community members should be included in financing renewable energy systems to ensure efficient use of donor money and sustainability of the systems. For example, if individuals from the community, teachers and headmaster put funds together that cover operation and maintenance cost. Some of the school savings can be redistributed to these stakeholders from what they earn in the end of the life time of the system. The maintenance and use of the system for the benefit of the school is not only a good thing for the community as a whole but serves the direct financial interest of the stakeholders.

Interests of TGSN

TGSN seemed to have focused to a big part so far on reforestation, also supported by donors. Teachers generally seemed excited about learning new concepts in the workshop. On the other hand, we also met teachers who had a second job what poses a question mark on the time the



teachers are willing and able to spend on the learning centers. Thomas seemed willing and capable of running TGSN and he seems to be the driving force behind the activities. There is the risk that things might fall apart in cases he leaves the school. In this regard, capacity building for the teachers in other areas than reforestation is necessary. The teachers in general seemed very open to learn new things and probably would appreciate other workshops to advance their knowledge.

Impression about the local contractor, TATEDO

TATEDO has gained a lot of experience in small scale renewable energy systems and has the trust of Prof. Adolofo Mascarenhas. In addition, Thomas from TATEDO Kilimanjaro was investing a lot of his time to meet with us and join our visits to the schools, underlining the interest and commitment TATEDO has for this project. Thomas also showed a personal interest in the success of the projects and offered to come if service on the technical equipment is required. The meeting with TATEDO in Dar Es Salaam showed TATEDO in general as a trustworthy partner.

The major point of concern is the capability of Thomas in deciding for the best renewable energy systems for the schools. Both his approaches for Biogas and Wind seemed risky and little sustainable. He proposed the transport of a big amount of cow dung by the students to run a biodigester. This is, as pointed out by Thomas from TGSN, a huge burden for the school principal and challenge for the school holidays. He did not propose himself the investment in more efficient cooking stoves despite very obvious air pollution in Makomu. Furthermore, he was very eager to stick to investing a large sum into a wind turbine that we found given the low winds a waste of money. TATEDO in Dar Es Salaam was also not very optimistic about wind energy in Tanzania except the coastal areas. In conclusion, both TATEDO and Thomas in particular seem capable of installing and offering service for the renewable energy systems. On the other hand, Thomas seemed to be a bit careless in choosing the best technologies for the given demand and budget. Therefore, especially the choice of technology needs to be checked and reconfirmed.

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