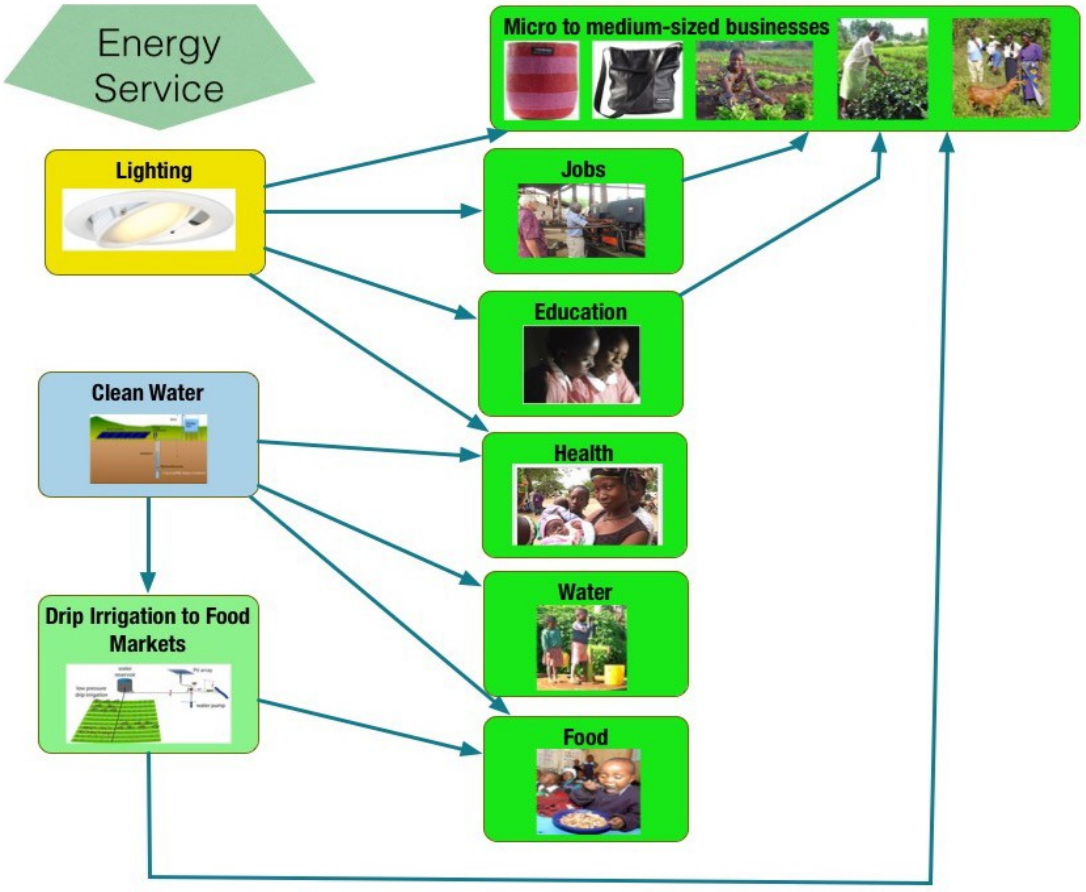
Aalto University
School of Electrical
Engineering

TAMAA Case study report:

Wellbeing of African villagers
within their community
Empowered by
sustainable new energy services



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Acronyms

BC	Black Carbon
BOP	the Bottom Of the Pyramid
CSR	Corporate Social Responsibility
DALY	Disability-adjusted life year
EPOPA	Export Promotion of Organic Products of Africa
FBO	Faith Based Organization
GNI	Gross National Income
GINI Index	standard economic measure of income inequality
LCA	Life-cycle Assessment
LED	Light-Emitted Diode
MDG	Millennium Development Goal
NGO	Non-Governmental Organization
PM	Particulate Matter
The UN	The United Nations
WASH	Water, Sanitation, Hygiene
hectoliter	hl, hL, 100 liters, 100 L, 100 l
USD, $	US dollar

Abstract, Tiivistelmä

The TAMAA (Hope) Case study inquired with the in-depth interviews, how to build a sustainable flourishing learning village community even though the poverty is widespread, agriculture practices are ineffective without irrigation systems, and lack of energy prevents to make the most of the African enormous resources. George Pindua, one of the interviewees expressed: 'The basic needs of people in Africa include food, shelter, clean water, electricity, education, hospital and infrastructure'. Therefore, this case of African villagers' wellbeing explored the insights, knowledge, experiences, and visions of people involved in development co-operation works for years, giving voice to these professionals who have worked within people in the developing countries and especially in Sub-Saharan Africa. Furthermore, the goal was to identify change levers, which foster the society to satisfy rural Africans' basic needs and broaden these needs to business opportunities.

The research strategy was the case study research with in-depth face-to-face interviews. The TAMAA research first assessed the general basic customer needs as education, food, water, sanitation, health, lighting, cooking, income, safe and sustainable environment, electricity, and general market opportunities. Then, the face-to-face interviews revealed that the most weighted needs, which contribute to wellbeing, were Clean Water, Nutritious Food, Lifelong Health, Education at all levels, Safe and Healthy Lighting, Agricultural Productivity, Jobs, opportunities for Micro to medium-sized businesses and Electricity as well as clean cooking. The interviews were complemented by reference interviews and cases. New sustainable services were discovered and assessed: Safe and Healthy Lighting, Clean Water, and Drip Irrigation to Food Markets, which have capabilities to produce these identified needs. These services were based on solar technologies and they integrated human needs, energy services, and technology to socio-technical systems.

Clean Water decreases water-based diseases and, together with Drip Irrigation, enables a prolific agriculture with versatile crops, increases yields and ensures safe access to Nutritious Food. Equally important, Drip Irrigation generates Micro to medium-sized businesses and offers village-farmers opportunities to sell diverse products to local markets. The service, Safe and Healthy Lighting, reduces the serious indoor air problems due to the use of traditional kerosene lamps. In addition, this Lighting service makes Education, Jobs, and Micro to medium-sized businesses possible in the evening. Lighting is based on the LED lights and solar panels, which are considered stable technologies, and this service provides a safe and healthy environment for schools, hospitals, and other buildings.

The findings of this TAMAA Case suggest further research and pilot projects, which can implement these new energy services as concepts and broaden them to the exports in potential food markets.

TAMAA (Hope) tapaustutkimus selvittää, kuinka voidaan rakentaa kestävän kehityksen mukainen kukoistava oppiva kyläyhteisö, vaikka köyhyys on laajalle levinnyt, maatalouden käytännöt ovat tehottomia eikä kastelujärjestelmiä ole, sekä

energian puute estää hyödyntämästä laajasti Afrikan valtavia voimavaroja. Kuten George Pindua ilmaisee: ‘Afrikkalaisten perustarpeet ovat ruoka, suoja, puhdas vesi, sähkö, koulutus, sairaala ja infrastruktuuri’. Siksi tutkimus kyläläisten hyvinvoinnista tarkastelee ihmisten ajatuksenjuoksuja, tietoja, kokemuksia, ja näkemyksiä, joita pitkäaikaisissa kehitysyhteistöissä mukana olleet voivat tarjota. Lisäksi arvioidaan muutoskeinoja, jotka edistävät yhteisöä tyydyttämään afrikkalaisten perustarpeet maaseudulla ja auttavat laajentamaan liiketoimintamahdollisuuksia.

Tutkimusstrategia oli tapaustutkimus ja syvälliset kasvokkain tapahtuvat haastattelut. TAMAA-tutkimus määritteli ensin yleiset asiakkaan perustarpeet kuten koulutuksen, ruoan, veden, sanitaation, terveyden, valon, keittämisen, ansiot, turvallisen elinympäristön ja kestävän kehityksen ja sähkön sekä yleiset markkinamahdollisuudet. Kasvokkain tapahtuneet haastattelut paljastivat, että Puhdas Vesi, Ravitseva Ruoka, Elinaikainen Terveys, Koulutus kaikilla tasoilla, Turvallinen ja terveellinen Valo, Tuottoisa Maatalous, Työpaikat, mahdollisuudet mikroliiketoiminnasta keskikoiseen liiketoimintaan, sekä puhdas keittäminen, muodostavat tärkeimmät hyvinvointia edistävät tarpeet. Haastatteluja täydennettiin referenssihaastatteluilla ja -tutkimuksilla.

Uudet kestävät palvelut, Turvallinen Valo, Puhdas Vesi ja Tihkukastelu Ruokamarkkinoita varten, mahdollistivat tuottamaan ruokaa, vettä, terveyttä, koulutusta, työtä, tehokasta maataloutta, luomaan pientä ja keskikokoista yrittäjyyttä sekä viilentämään maapallon ilmaston lämpenemistä. Nämä aurinkoteknologiaan perustuvat palvelut muodostavat sosio-teknisiä järjestelmiä, jossa ihmisten tarpeet yhdistyvät palveluteknologioihin.

Puhdas Vesi vähentää sairauksia, mutta Tihkukastelu Ruokamarkkinoita varten Puhtaan Veden kanssa mahdollistaa tuottoisan maatalouden ja monipuoliset kasvit ja enentyvät sadot, siten luoden edellytyksiä Ravitsevaan Ruokaan. Myös on tärkeää, että tämä palvelu synnyttää yrittäjyyttä mikrotasolta keskisuuriin siten, että kylämaanviljelijät voivat myydä monipuolisia tuotteita paikallisille markkinoille. Turvallinen ja Terveellinen Valo vähentää vakavia sisäilma ongelmia, jotka aiheutuvat perinteisen kerosiinin käytöstä sekä tukee opiskelua, työskentelyä ja yrittäjyyttä myös pimeänä aikana. Tämä palvelu, Valo, perustuu LED-valaistukseen ja aurinkopaneeleihin, joita pidetään vakaina teknologioina, ja Valo antaa turvallisen ja terveellisen ympäristön kouluihin, sairaaloihin, työpaikoille, ja muihin rakennuksiin.

Seuraavaksi suositellaan tutkimuksen laajentamista ja pilotteja, jotka voivat implementoida nämä uudet palvelut konsepteina sekä soveltaa niitä pontentiaalisille ruoka vientimarkkinoille.

Executive summary

The purpose to create this TAMAA Case was to illuminate new perspectives for building a flourishing co-learning community, where new sustainable services satisfy the general basic needs of villagers and even empower them to run their micro to medium-sized businesses. Thus, they can enter food markets and get out of poverty.

Problem area: TAMAA Case acquired shared knowledge and meaning in widespread poverty, as well as in lack of education, jobs, livelihood opportunities, clean water, irrigation, health, and in reasons why hunger and malnutrition exist among villages in Africa? With in-depth face-to-face interviews, reference interviews and cases, and literature reviews, TAMAA Case suggested new sustainable services as solutions for the problem area shown in Figure 1.

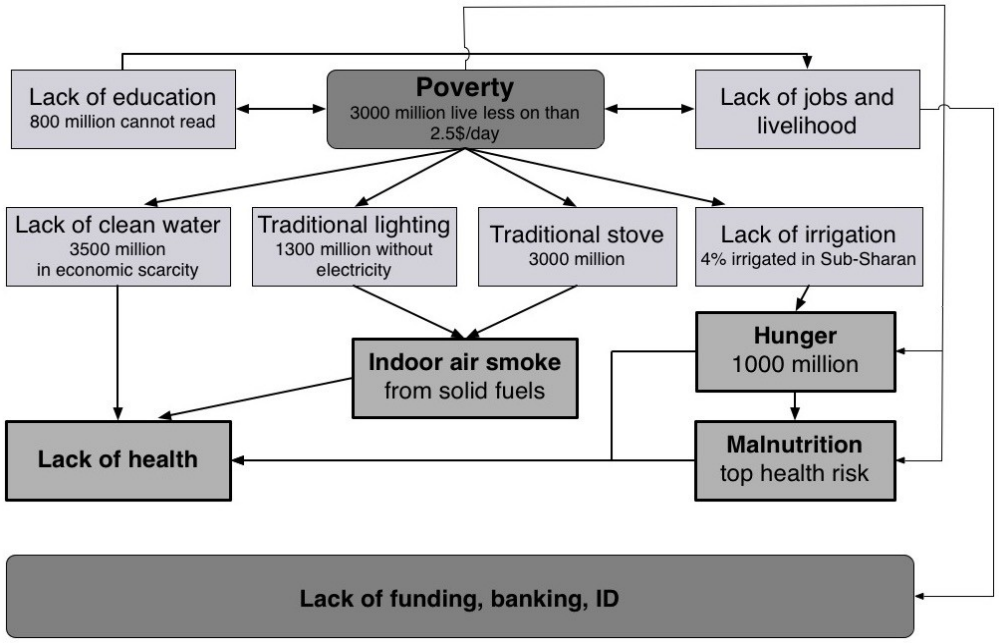

Figure 1. Problem Area to be studied, Saarinen, R., (2015b)

Needs: This TAMAA Case reviewed general basic customer needs and energy services, which met these discovered needs. These needs of customers, villagers, were analyzed to be Clean Water, Nutritious Food, Lifelong Health, Education at all levels, Safe and Healthy Lighting, Agricultural Productivity, Jobs, Micro to medium-sized business opportunities, and Sustainable Electricity. These needs were mapped to Maslow's hierarchy of needs as illustrated in Figure 2, which emphasizes the role of self- actualization, empowerment, co-learning in supporting others to become the beneficial community members.

Gap to bridge: There exists widespread poverty and a lack of diverse basic needs, as Figure 1 reveals. Indeed, the gap to meet the African needs in rural areas is substantially wide when comparing this status with the needs in Maslow's hierarchy in Figure 2.

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Therefore, TAMAA Case aimed to inquire, which change levers as vehicles enable to bridge the gap in building a flourishing village community and how new sustainable services are capable to empower villagers (Figure 3).

Figure 2. Summary of Basic Customer Needs, Saarinen, R., (2015b), based on Maslow's hierarchy of needs (Maslow, 2000), Sprit based on e.g. Frankl, (2010), Photos (Photo Ref.)

Figure 3. Bridging the gap from poverty and lack of basic needs to Flourishing Village Community, Saarinen, R., (2015b).

Services to meet villagers' needs: This TAMAA Case evaluated how Needs, Resources, and Technologies matched with the new energy services: Safe and Healthy Lighting, Clean Water, and Drip Irrigation to Food Markets as illuminated in Figure 4. These services are based on solar technology and integrate Needs, Energy Services, and Technology to socio-technical systems. The cornerstone was co-generative learning in the innovative knowledge system network, which relies on participants and their interactions in sharing tacit and explicit knowledge during face-to-face interviews. This TAMAA Case first reviewed general customer basic needs, which are universal in developing countries in Chapter 2.1, and then applied the interviews for weighing the identified needs in Chapter 4.1, proceeding by introducing the new services, which were able to gratify these identified needs in the rest of Chapter 4. On the other hand, Chapter 5 introduces the Village Community concept.

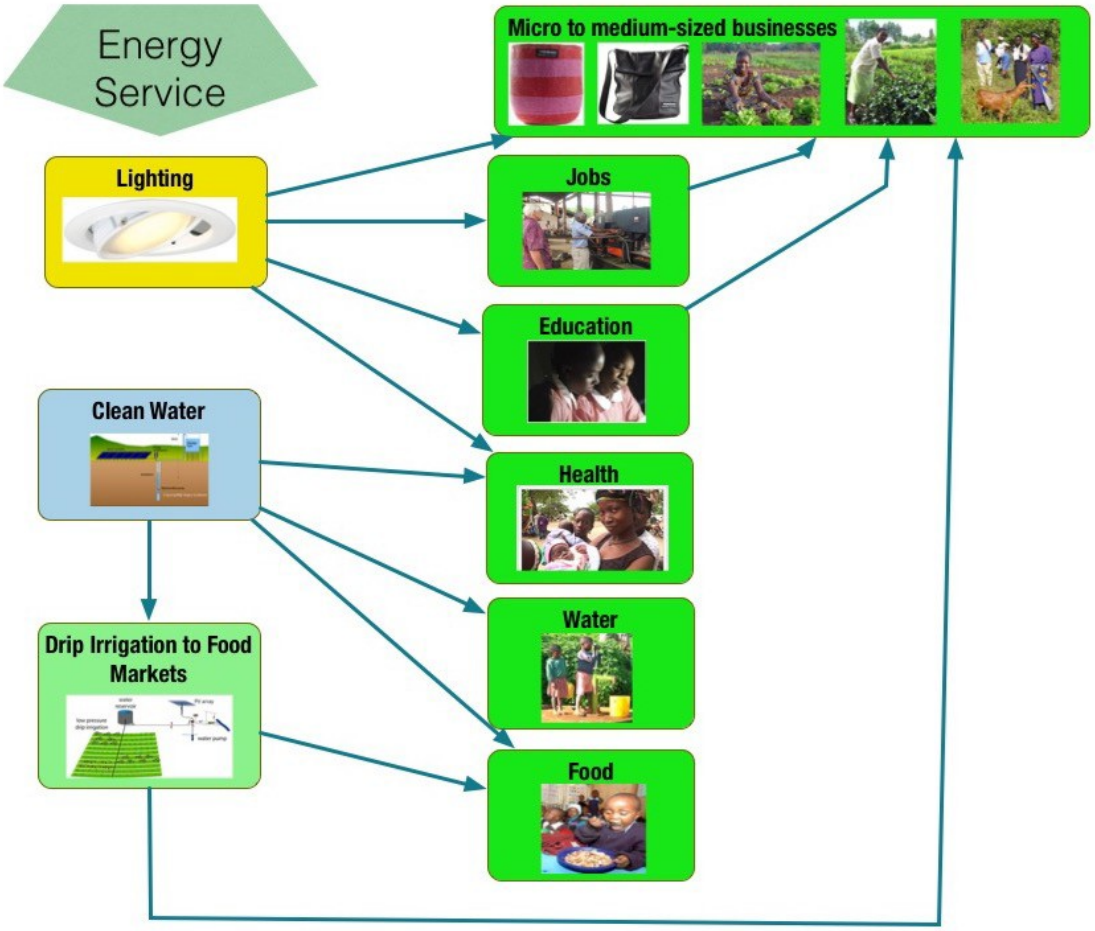


Figure 4. New energy services related to basic needs, Saarinen, R. (2015a), Photos, (Photo Ref.)

1. Introduction

1.1 Aim of TAMAA Case

TAMAA (Swahili) in English Hope: ‘uso wake umejaa fahari, tabasamu na tamaa, his/her face is full of glory, smile and hope’ (shown in Figure 1.1, Irja Aro-Heinilä). This TAMAA Case targets a flourishing village community as an African proverb expresses: ‘It takes a village to raise a child’.

Figure 1.1. Tanzanian children in a kindergarten, Photo: Irja Aro-Heinilä

In recent years, there has been an increasing interest in poverty elicitation, agricultural improvements and mitigating climate change in developing countries. Therefore, this research addresses the question how to build a sustainable flourishing learning village community (as shown in Figure 1.2) in the environment, where you have poverty, as well as lack of clean water, food, health care, education, prolific agriculture, and lack of other living opportunities (as shown in Figure 1 in Executive Summary). The flourishing village community might be just a dream, but what if it were possible by establishing a collaborative learning environment within the village and such outside partners as non-governmental organizations (NGOs), researchers, companies, and universities, and together seeking solutions to identified problems. TAMAA Case conducts face-to-face interviews and takes advantage of participatory action research; these interviews involve the participants who have gained real-life-experiences of development cooperation and solutions in meeting basic needs of rural people in developing countries. The aim is to acquire meaning and knowledge in the needs of villagers and in the services to meet these needs. With these interviewees this research work investigates the services and change vehicles, which are capable of leveraging villagers to higher levels of the hierarchy of needs (see Figure 2 in Executive Summary). Consequently, they have opportunities to achieve their full potential, self-actualization, and they can even empower others to come out of poverty.

One major change motor is an African woman: according to studies and real-life experiences, helping women is one of the best ways to support whole families and reduce poverty at grass-roots: 'Educated mothers, healthy children'. Therefore, the role

of educated women is crucial in achieving healthy village communities, as expressed in Figure 1.2. (see Appendix B). (Corvalán et al., 1999; EFA, 2014; Järvinen, 2007; Women's Bank, 2014).

Figure 1.2. Educated mothers, healthy children and community, Saarinen, R., (2015a), Photos (Photo Ref.)

A viable business opportunity is another major mean to generate a change, agriculture being the biggest potential market in Africa (World Bank, 2013). Now, this paper gives the voice to Majok Kariom, who discussed about a livelihood and business opportunities during the interview (the story 12):

'Even at a village level, using this energy (solar) system and lighting, and setting up a juice-factory and hiring employees, you can employ them locally from this village, and villagers can earn wages and salaries and they can live their way of life. Because there grow a lot of fruit trees, mangos, and nothing have been utilized yet, you can have a factory and you do not have to go for long distances to get your work and even there you have the same problems, there is no energy, you have nothing expect only in rainy seasons, and this rainy season is once a year and then you can cultivate, but this area is small and not commercial. But if we install a factory there, a juice-factory, then, if you have an energy in place, you have factories, they will work for 24 hours and people are working there, and their lives will change, and your agricultural projects will work for a whole year not only once a year, and you have education and your factory is commercial and that will change your life, your family's life and your friends', and village. So with this project (energy) we have roots in place, we have a factory, and we have schools, total change in people's lives' (Appendix IE TAMAA Interviews).

1.2 Objectives and research questions

Figure 1.3 demonstrates the relationships of research philosophy, the community to be researched, and co-generative learning in participatory actions. TAMAA Case is a multidisciplinary and cross-functional study, which follows a strategic goal-oriented approach and has defined the following vision, mission, aim, main research question and sub-questions as well as strategic steps.

TAMAA Vision: sustainable flourishing learning Village Community

TAMAA Mission: Creating wellbeing of African villagers within their community empowered by sustainable energy services, in a collaborative dialogue of participants involved as villagers, NGOs, companies, and researchers at diverse levels.

TAMAA Aim: To assess which are the building blocks and change levers for creating sustainable flourishing learning Village Community.

This study addresses the major research question — how to build sustainable flourishing learning Village Community, which is dived into the three more specific research questions as following:

1. How can African villagers' wellbeing be empowered by sustainable and new energy services?
2. Which customer needs of villagers can be met by providing sustainable energy services and how?
3. What are these new energy services, which can empower villagers?

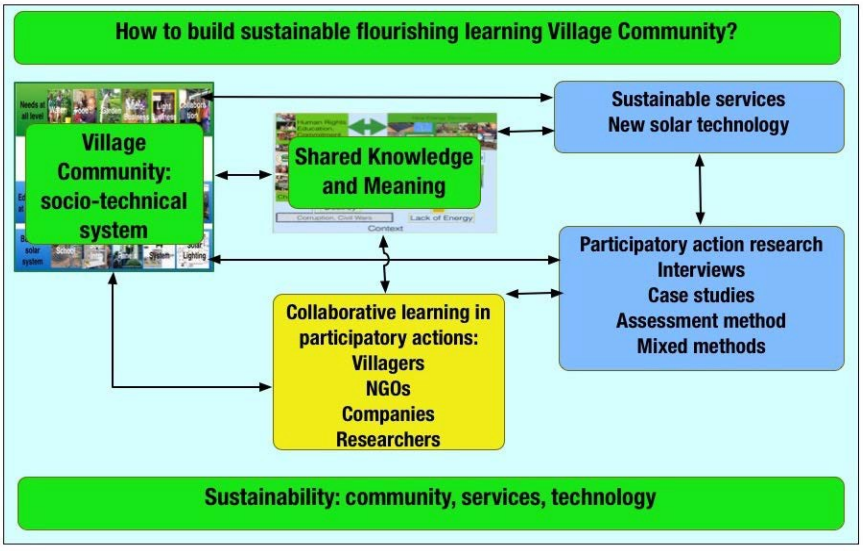


Figure 1.3. The relationships of the socio-technical system (Village Community), the collaborative learning of villagers, NGOs, companies, and researchers, the shared knowledge and meaning, the sustainable services and solar technology, and the methodologies and methods. Saarinen, R., (2015a).

In starting to answer the research questions, this TAMAA Case aims to meet the following strategic steps:

1. Review General Basic Customer Needs of rural people living in developing countries
2. Discover New Customer Needs and driving Change Levers
3. Identify New Sustainable Energy Services and Concepts
4. Discover Constraints and Obstacles

Figure 1.4 expresses the TAMAA research map. The research data discovered is grounded to general basic customer needs and reviewed in Chapter 2.1, data gathered during the years 2009-2014. Similarly, new energy technology data is reviewed and discussed in the licentiate thesis (Saarinen, R., 2015b). Case study analysis (Chapter 3.2) was applied for data mining, and this TAMAA Case applied assessment method (Chapter 3.3), mixed methods, and qualitative and quantitative research (Chapter 3.4).

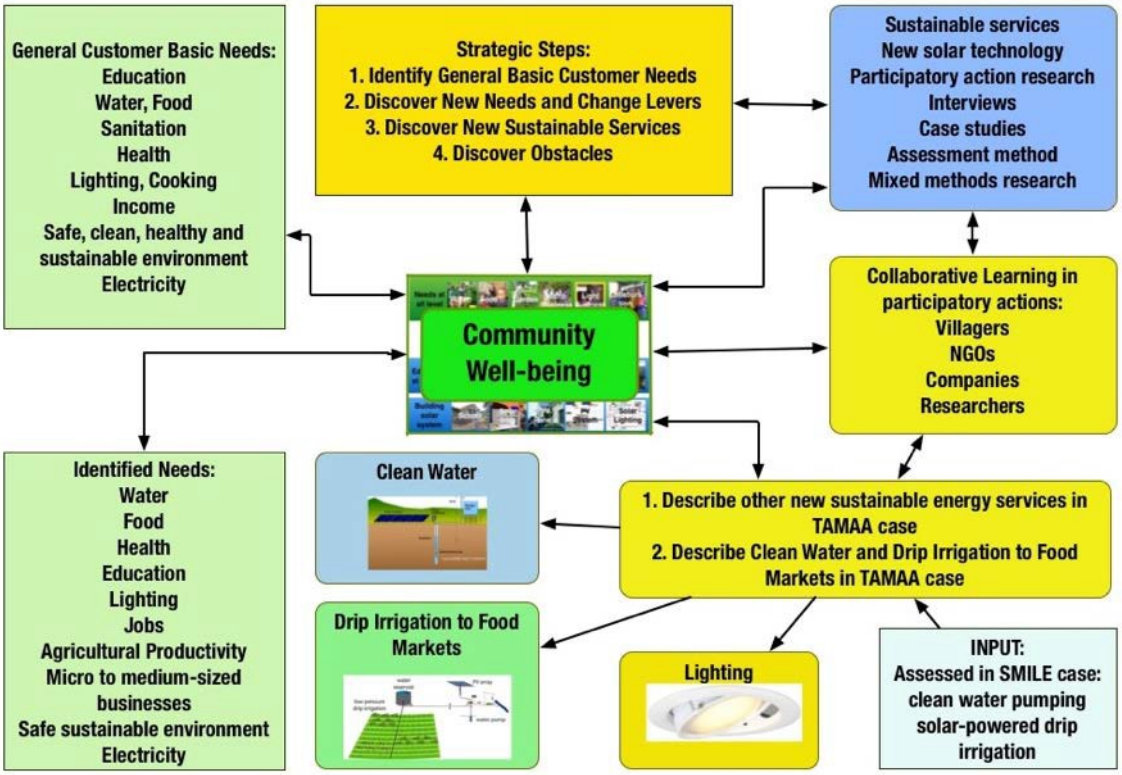


Figure 1.4. Research Map and environment for TAMAA Case, Saarinen, R., (2015a), Photos, (Photo Ref.)

2 Baseline review

2.1 General basic customer needs

2.1.1 Identified basic needs

Establishing the problem area, an overall picture of general basic needs in developing countries is illustrated in Figures 2.1 and 1. In this review, the references to TAMAA Appendices are found in this TAMAA Case report.

Figure 2.1. Problems to be solved, Saarinen, R., (2015a), Photos (Photo Ref.)

2.1.2 Education

Approximately 800 million adults (aged 15 years and over) are considered functionally illiterate, and still 123 million youth (aged 15 to 24) do not know how to read and write. It is also estimated that especially in developing countries 250 million children of primary school age lack basic reading, writing and numeracy skills. However, access to education has improved worldwide (approximately 60 million children of primary school age were out of school). But at the same time, we all have the universal right to education: Article 26 of the Universal Declaration of Human Rights. (CIA, 2014; UN Human Rights; UN MDG, 2013; UNESCO EFA, 2014; UNESCO, 2000). The education status in some African countries is illustrated in Figure 2.2 (UN Africa MDG, 2013, p.39) and Appendix A, which show positive progress, e.g., in Tanzania and Zambia, where primary school enrollments researched 90 % or more. On the other hand, in most African countries the differences are discovered in gender parity (the ratio of girls/boys) at secondary school level, where the enrollments of girls are smaller than in boys and these differences even grow after secondary school. (UN Africa MDG, 2013).

Because the increasing number of poor households are headed or maintained by women, a focus on poor women is therefore essential for poverty reduction. Similarly, investments on girls, which help them to complete good quality secondary education and to support their transition from education to work, will improve the livelihood opportunities of these girls. Meda Wagtole, a schoolgirl in Ethiopia (DFID, 2005, p.iii) stated: 'To be educated means... I will not only be able to help myself, but also my family, my country, my people.' The education of girls and women powerfully decreases diseases (see Appendix B) and helps to make communities and societies healthier, wealthier and safer. To eliminate malnutrition in the long term, education – especially education that empowers women – is vital. Many countries in Africa have school fares, and obligatory school uniforms, which are barriers to parents to send their children to school. Regarding girls' education, especially at secondary and tertiary level, deprivations, such as lost household work or paid labor, burden their parents' economy. These costs have a significant impact on whether and which children are educated. In Africa, school fee removal has led to a dramatic increase in enrollments, e.g., in Kenya. Training and education enable to promote women's opportunities for their own small businesses related to their everyday life. The role of women is essential in reducing the harmful indoor emissions due to traditional stoves and lights, and women need to be involved to design and solve problems regarding new safe and clean cooking and lighting solutions. (BMZ, 2012e; DFID, 2005; UNESCO EFA, 2014; Grown et al., 2005; Misana&Karlson, 2001).

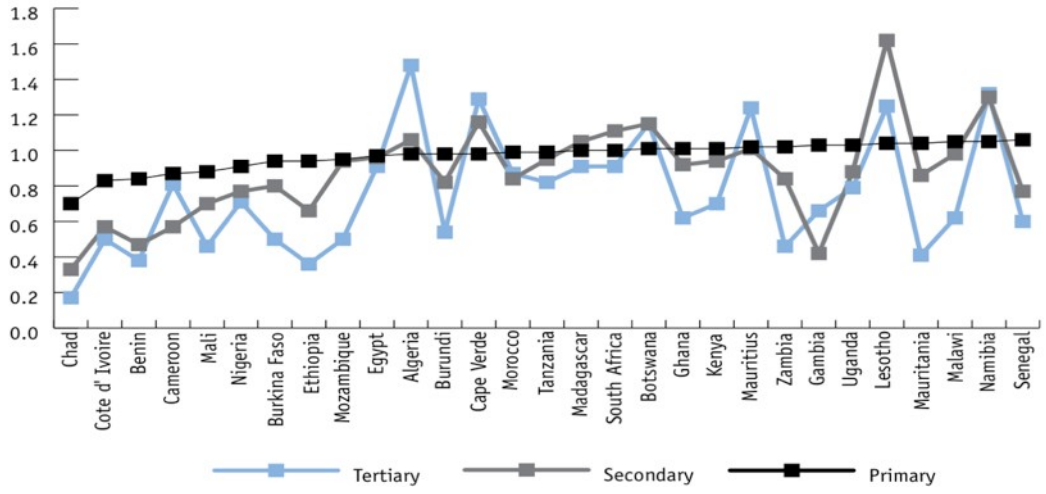


Figure 2.2. Education status in some African countries, primary school enrollments show good progress, but secondary and tertiary level educations still give big challenges regarding gender parity (ratio of girls/boys) in 2012. UN Africa MDG, (2013), p.39.

2.1.3 Water, food, and sanitation

By the end of 2011, globally 768 million people relied on unimproved drinking-water sources; although by some estimates, the number of people whose right to water is not satisfied could be as high as 3500 million (UN Water WWDR, 2014, p.2). In Sub-Saharan Africa, only 61% of rural population had clean water for drinking, but noteworthy, the 66% of the rural poorest 20% get their water from such unimproved sources as rivers in 2010 (see Figure 2.3, UN MDG, 2012, p.53).

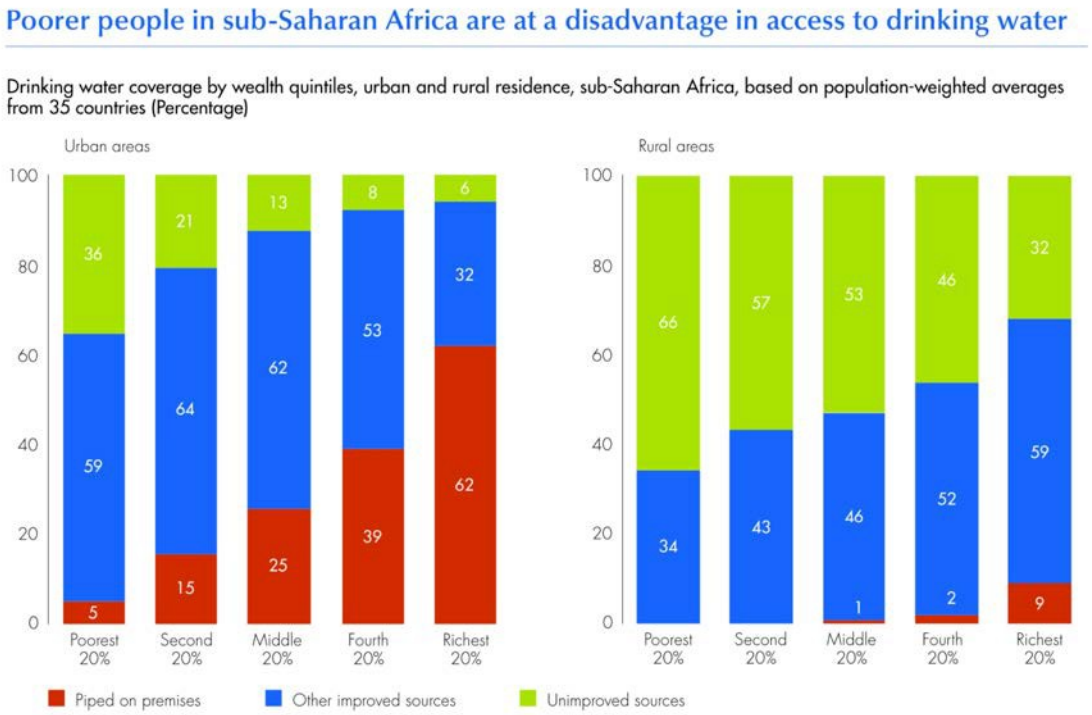


Figure 2.3. Drinking Water status in Sub-Saharan Africa. In rural areas, the 66% of the poorest 20% get their water from unimproved sources like rivers, UN MDG, (2012), p.53.

Moreover, 2500 million people lack access to clean sanitation, and as a consequence, globally 2 million people die and 4000 million get sick every year due to WASH related diseases (Figure 2.4, Prüss-Üstün et al., 2008, p.11), (WASH=Water, Sanitation, Hygiene). The clean water and sanitation status in rural areas worldwide is illustrated in Appendix F. Today agriculture is using more than 70% of water withdrawals but in the least development countries (LCDs, UNCTAD, 2011) even up to 90%, access to water being a constraint to produce food for hundreds of millions of people (Appendix E). Fresh water, on the other hand, is needed for drinking and might need long distances to fetch (Appendix D). (Prüss-Üstün et al., 2008; UN MDG, 2013; UN Water portal; UN Water WWDR, 2014; WHO&Unicef, 2013).

Related to prolific agriculture, there are globally approximately 1000 million hungry people, the majority in the least developing countries (LCDs), where the population living on less than $ 1.25 a day has increased from 18% in 1990 to 36% in 2007 (Appendix C; von Grebmer et al., 2013; UNCTAD, 2011, p.v). In regards to this issue, 50% of world's hungry people are smallholder farmers, 76% of the world's extreme poor people are rural, and over 60% of Africans depend directly on agriculture for their livelihoods. Moreover, the international prices of food are volatile, and high prices cause undernourishment and food crises, especially to those who spend 70-80% of their daily income on food and are food net importers. The MDGs (Millennium development goals) are described in references (UN MDG 2005, 2012, 2013). (Figure 2.5 and Figure 2.6; Clements, 2009; Deininger et. al., 2009; FAO et al., 2014; FAO, 2011; IAASTD, 2009; UN ESA, 2013; WFP, 2015; World Bank, 2013 GMR; World Bank, 2012)

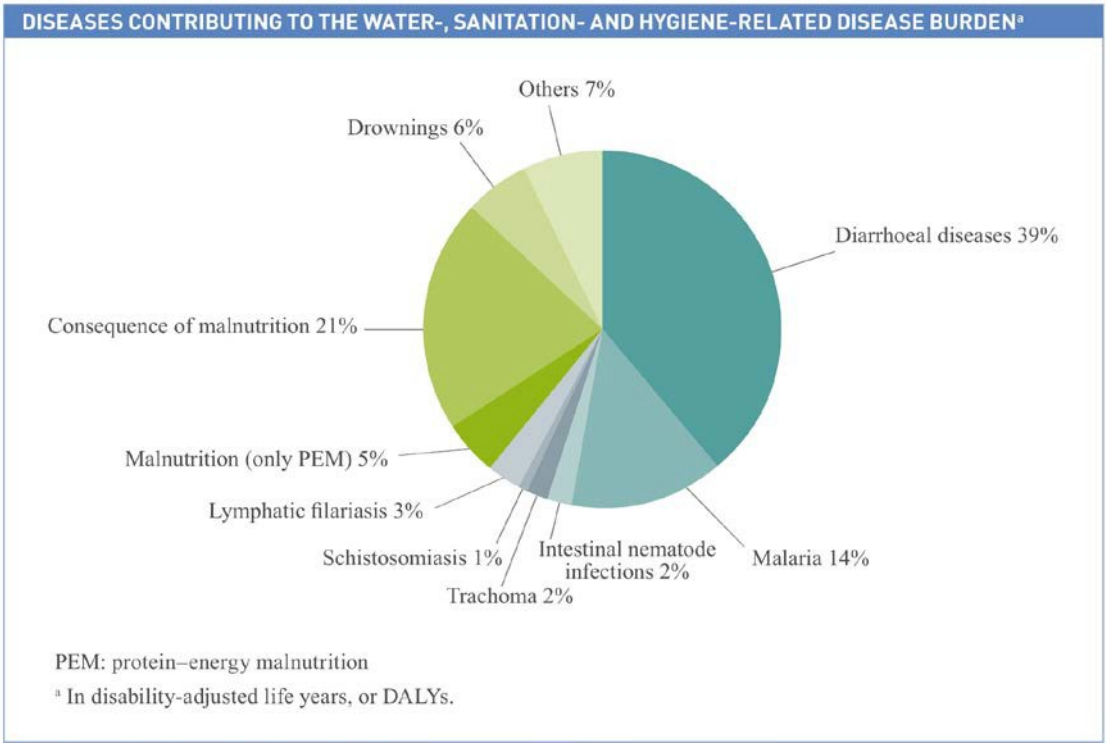


Figure 2.4. WASH (Water, Sanitation, Hygiene) related to deceases, Prüss-Üstün et al., (2008), p.11

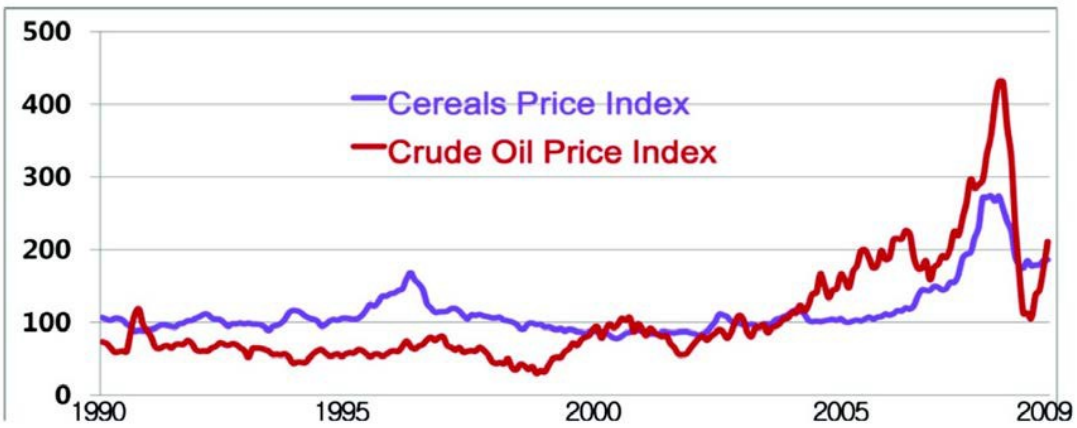


Figure 2.5. Comparative trends of crop commodity and oil price indices from 1990 to 2009 (with 2004 as baseline), FAO, (2011), p.iv

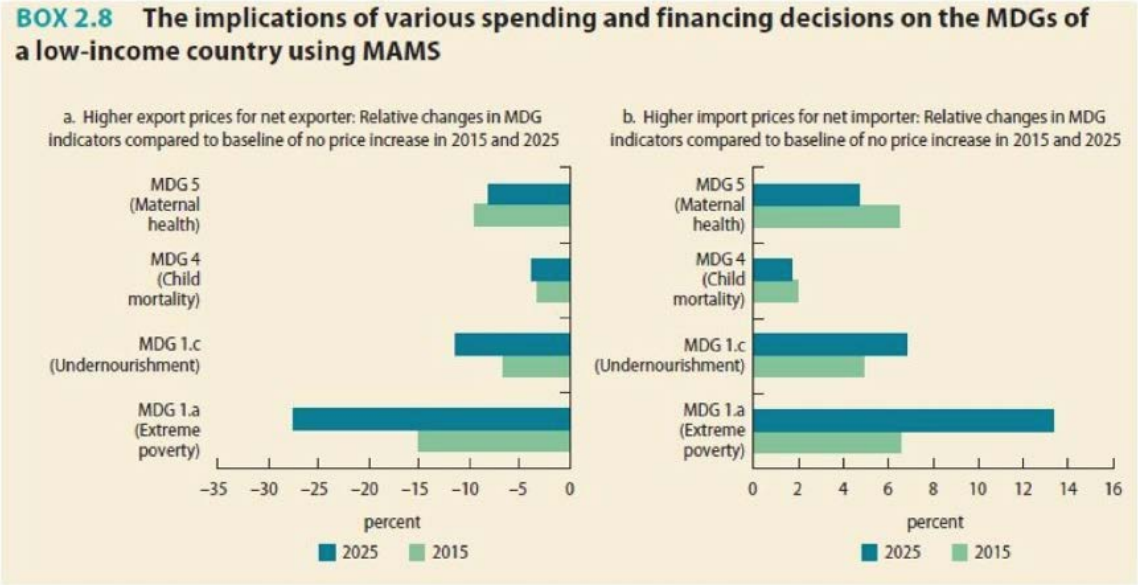


Figure 2.6. Net Food Importers versus Net Food Exporters, World Bank, (2012), p.83. MASH=World Bank's computer application Maquette for MDG simulations (MASH, 2013).

2.1.4 Health, lighting, and cooking

Even today, approximately 3000 million people cook and heat their homes using open fires and stoves and approximately 1300 million people lack electricity traditional kerosene lamps being most common (IEA Energy, 2014; UNDP 2013, p.11). In the most Sub-Saharan countries, the use of solid fuels is widespread (see Appendix G). Indoor smoke from biofuels, charcoal and such traditional fuel-based lighting as kerosene lamps consists of high levels of harmful combustion products, of which the small particle matters (PM) and direct black carbon (Appendix H) cause such diseases as lung cancer, pneumonia and other acute infections, indoor air pollution resulting in 3.5 million deaths every year (WHO, 2012). (WHO, 2011). The comparisons of particle matters for kerosene lamps and traditional cook stoves are shown in Figure 2.7 (Poppendieck et al., 2010). (Apple et al., 2010; Bhusal, 2009; IEA, 2013; Jacobson et al., 2013; Ludwig et al., 2002; Poppendieck et al., 2010; Smith, 2006; Smith, 2000; Torres-Duque et al., 2008; WHO Indoor, 2010; WHO PM, 2011).

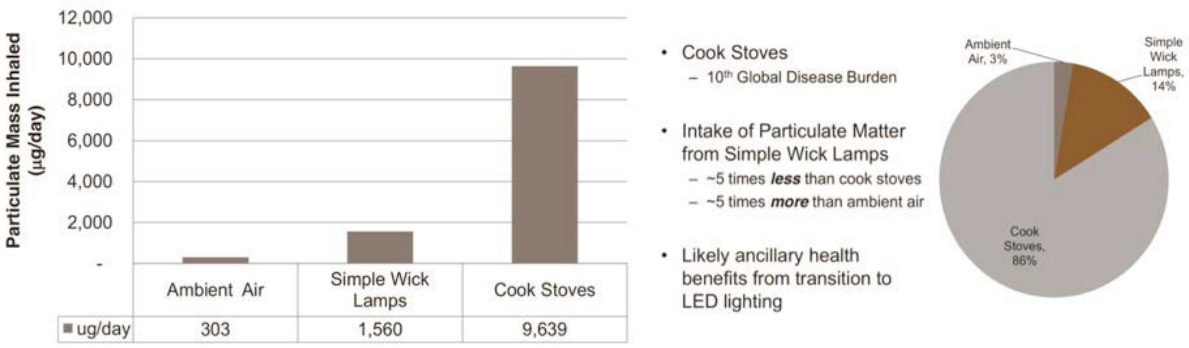


Figure 2.7. Particle Matters of kerosene lamps and traditional cook stoves, Poppendieck et al., (2010)

Undernourishment, indoor air pollution, unsafe contaminated water, these are all related, malnutrition being the top health risk both worldwide and in low income countries measured as DALYs (Appendix I). In low-income countries unsafe water, sanitation and hygiene are the second biggest risks, unsafe sex the third biggest risk and indoor smoke from solid fuels is the fifth biggest risk. The fourth largest risk is related to breast-feeding, and this problem area needs information and education, where the role of educated mother for healthy children is crucial (Appendix B). Noteworthy, approximately 1700 million people lack access to essential medicines and basic health services: 3300 million are at risk of malaria and approximately 1200 million are affected by neglected tropical diseases. (AGI BOP, 2012; Haupt & Krämer, 2012; WHO Malaria, 2013).

2.1.5 Income

Figure 2.8 (World Bank, 2013 GMR, p.60) shows global income as Gross Domestic Product (GDP) per capita in USD indicating low income in Sub-Saharan Africa expect for South Africa, Botswana and Gabon (World Bank, 2013 GMR). Still, 1200 million people live in extreme poverty (less than $1.25 a day), of whom 76% living in rural areas (UN MDG, 2013). In 2010, 48.5% of Sub-Saharan Africa's population lived on less than $1.25 a day meaning 413.8 million people, and this number has increased. (IEA, 2014; World Bank, 2013 GMR; 2014). Moreover, approximately 3000 million people worldwide live on less than $2.5 per day (Chen et al., 2008, p.41; UN Water WWDR, 2014, p.2).

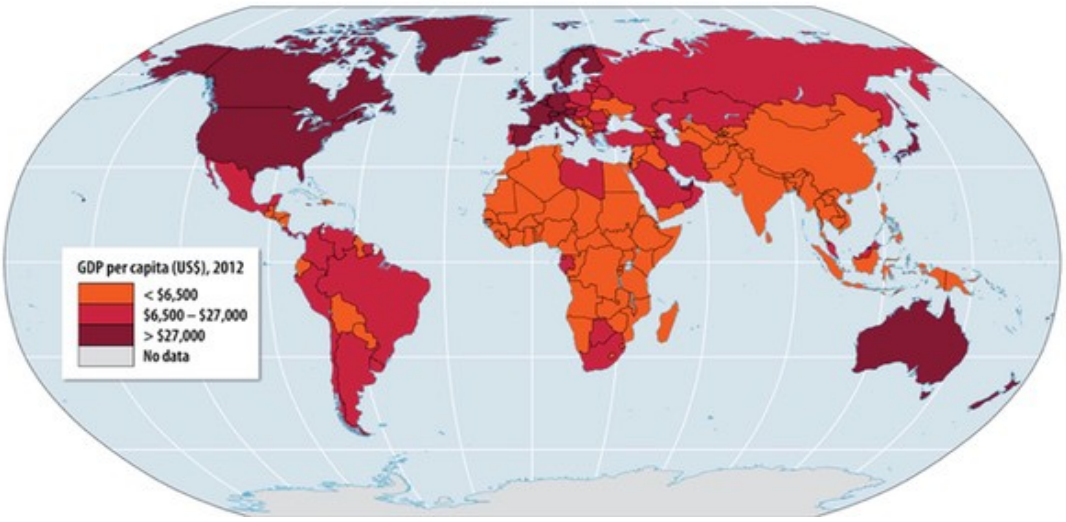
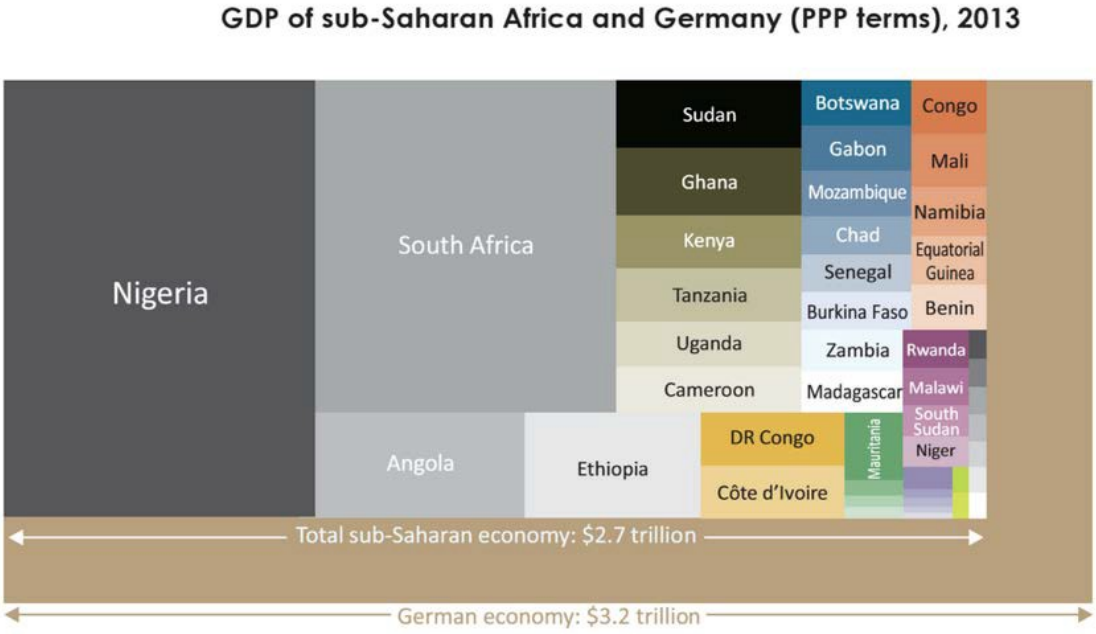


Figure 2.8. Global income as Gross Domestic Products (GDP) per capita in USD, World Bank, (2013 GMR) p.60

Figure 2.9 (AGI BOP, (2012), on the other hand, illustrates global income as a pyramid, where the earnings more than $20 000 per year form the upper income group comprising 1% of all people in the world, the middle income group earns $3 000 - 20 000 per year (33% of the world's population), and the bottom of the pyramid (BOP) earns less than €5 per day meaning 4000 million people in the world (AGI BOP, 2012).

Even more concrete picture 2.10 (IEA, 2014) points out how the whole Sub-Saharan Africa fits German economy ($3.2 trillion).

Figure 2.9. Our world as incomes groups, Source: AGI BOP, (2012)



Sources: IMF; IEA analysis.

Figure 2.10. Sub-Saharan economy versus German economy, IEA, (2014), p.22

2.1.6 Safe, clean, healthy and sustainable environment

Safe, clean, healthy and sustainable environment are suggested to Human Rights (UN Human Rights, 2014; UN HR Env., 2015) in a similar way than rights to clean water, nutritious food, health and other basic needs reviewed in this Chapter 2. Figure 2, Maslow's hierarchy of needs (in Executive summary), illustrates how sustainability surrounds all needs. Furthermore, for agricultural productivity healthy and sustainable environment is a vital condition. Deforestation, draughts and erosion are results in the combustion of solid fuels, on the other hand, climate change even exacerbates situation. As a result, these issues cause serious trouble in food security, access to clean drinking water and health of rural people. Furthermore, one third of

Africans now live in drought-prone areas, mainly in the Sahel, around the Horn of Africa and in southern Africa. It is time consuming to gather wood and straw and due to deforestation women and children have to go even further to get their fuel. Forests and woodlands occupy approximately 650 million ha or 21.8 % of the land area in Africa (UNEP, 2006; Appendix K). (Bizzarri, 2009; Clements, 2009; Corvalán et al., 2005; McCoy & Watts, 2014; Nellemann et al., 2009; Perlis, 2006; Srilata, 2011; UN Water WWDR3, 2009; UNCCD; World Bank Water, 2010).

Climate change is highly related to the agro-forest development and carbon sinks. A carbon sink is a natural or manmade reservoir that accumulates and stores (some chemical compounds containing carbon) for an indefinite period. Natural sinks are oceans and photosynthesis by plants and algae. Anthropogenic increases in the well-mixed greenhouse gases (WMGHGs) have substantially enhanced the greenhouse effect. The major components of these WMGHGs produce 80 % of this RF: carbon dioxide CO_2 (1.82; 1.63 to 2.01 W/m²), methane CH_4 (0.48 ± 0.05 W/m^2), nitrous oxide N_2O (0.17 ± 0.03 W/m^2), and halocarbons (total RF 0.360 W/m^2). (Appendix L). Moreover, black carbon is a strong climate warmer (Appendix H). Greenhouse gases and their reduction with new renewable energy services account to the sustainability of new energy services. (CCIAM, 2012; FAO, 2006; Funder et al., 2009; IPCC, 2013; Jacobson et al., 2013; Kellomäki et al., 2013; Trenberth, 2009; UNDP, 2011; UNEP 2006: Varis O., 2006).

Climate change contributes to the extreme appearances of heavy rains and draughts in Africa and erosion has caused substantially smaller crop yields resulting in serious hunger and malnutrition of people as have occurred in the fourth consecutive years in Uganda (Bizzari, 2009), and approximately 1000 million people are worldwide affected by land degradation. Drip irrigation in arid and semi-arid regions (see Appendix M) reduces water use, because this practice delivers water and fertilizers directly to the roots of plants, thereby improving soil moisture conditions. On the hand, irrigation leads to local cooling effect. Thus, solar-powered irrigation decreases CO_2 emissions, cools locally, increases plant covers and the impacts of photosynthesis, and mitigates desertification. Mitigating deforestation and sustainable forest management improve soil conditions, decrease erosion and alleviate climate change. (Burney et al., 2009; Corvalán et al., 2005; FAO, 1987; IPCC, 2013; Kimaro et al., 2007).

As identified above (Chapter 2.1.4) approximately 3000 million people cook and heat their homes using traditional fuel wood and other solid fuels (Appendix G), and in Sub-Saharan Africa approximately 730 million people rely on solid biomass for cooking (IEA 2014, p.34). As a result, in developing countries, about 730 million tons of biomass are burned each year, amounting to more than 1000 million tons of carbon dioxide (CO_2) emitted into the atmosphere (World Bank Cook, 2011, p.ix). Worldwide, due to deforestation, the net change in forest area was estimated for -5.2 million hectares per year in the period 2000–2010. This means forest losses with an area about the size of Costa Rica. (FAO Forest, 2011). Over half of this deforestation occurred in Sub-Saharan Africa: net changes in Southern Africa -1056 000 ha, West Africa -875 000 ha, East Africa -783 000 ha, and Central Africa -660 000 ha, amounting to 3.374 million ha in Sub-Saharan Africa (in 2010).

Sustainability of burning biomass is also much related to carbon sinks. Africa contributed 21 % of the global total of carbon stock in forest biomass, of which Central Africa owns the largest amount (Figure 2.11, Forest 2011, p.5) (FAO Forest, 2011). These forest losses no doubt have disturbed carbon sequestration in forest ecosystems and opportunities for climate change mitigation (Kellomäki et al., 2013).

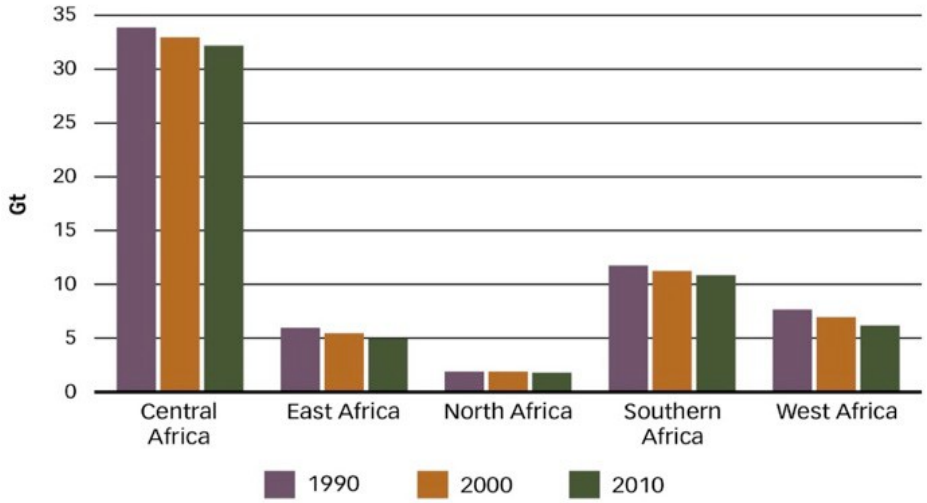


Figure 2.11. Carbon stock in forest biomass in Africa, 1990–2010 (Gt), Forest (2011), p.5

2.1.7 Electricity

Approximately 1300 million people worldwide lack access to electricity, and regarding Sub-Saharan Africa only 290 million out of 915 million people have access to electricity (IEA, 2014). Rural electrification rates have remained particularly low in Sub-Saharan Africa over the past 30 years at less than 10 %, while they reached 50 % percent for developing countries as a whole (Bernard, 2010), access to electricity in Sub-Saharan Africa in 2012 shown in Appendix N, the total number of people without access rising due to population growths. More than 75 per cent of the population living in the East- and Central Africa lacks access to electricity, such countries as South-Sudan, Tanzania, Ethiopia, Somalia, Kenya, Uganda, Central Africa, and Congo.

Moreover, in Sub-Saharan Africa nearly 80% of those lacking access to electricity live in rural areas (IEA, 2014). Even less than 10 % of Sub-Saharan rural households have access to electricity (World Bank AFREA, 2012). However, people in developing countries spend about EUR 28 000 million annually for poor quality energy supply, which causes high levels of such pollution as greenhouse gases and black carbon (EU se4all; Chapters 2.1.4, 2.1.6, Appendices G, H, L). In most countries in Sub-Saharan Africa, small diesel generators are presumably the default option for off-grid electrification resulting in an average carbon dioxide emission baseline 1.7 tCO_2/MWh (UNDP Sub-Saharan, 2013). Lack of electricity hinders villagers run their micro-small business and will prevent investors from bridging the financing gap of infrastructure (african monitor, 2012). Figure 2.12 (IEA Energy, 2014, p.543) shows how solar PV (Photovoltaic) with diesel generators has been estimated to provide both for mini-grid and off-grid power generation solutions in rural areas in Sub-Saharan in 2040 (IEA Energy, 2014).

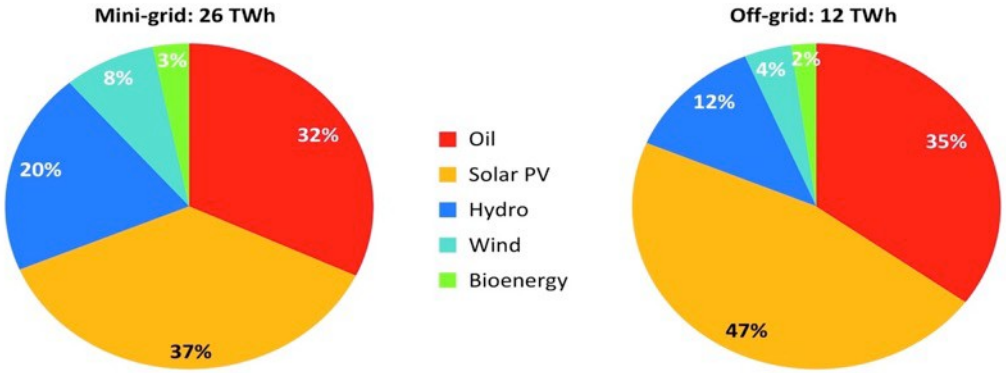


Figure 2.12. Technology mix for mini-grid and off-grid power generation in Sub-Saharan Africa in the New Policies Scenario in 2040, IEA Energy, (2014), p.543

Equal accesses to sustainable energy services as Human Rights (UNEP, 2009) contribute to human wellbeing (Oxfam, 2014). In fact, there has been some progress, as exemplar Kenyan rural electrification program started in 2003 and by June 2011 10% of public facilities were electrified (World Bank AFREA, 2012; Ayieko, 2011). In Tanzania, access to electricity increased from around 13% in 2008 to 24% in 2012, due to a reduction in connection fees (IEA, 2014). In Mozambique, approximately 40% of the population has access to electricity, either through the grid or mini/off-grid systems, from solar PV systems in rural areas (AllAfrica, 2014). However, Sub-Saharan Africa abundant solar resources (Appendix O) are the largest and most unused of the renewables in the world, the installed capacity around 280 MW in 2013 (IEA, 2014). The technical hydropower potential in Africa, the second largest of the renewables, is estimated for 283 GW (Figure 2.13, IEA, 2014, p.57), and is able to generate close to 1 200 TWh per year: 8% of the global technical potential (IEA, 2014).

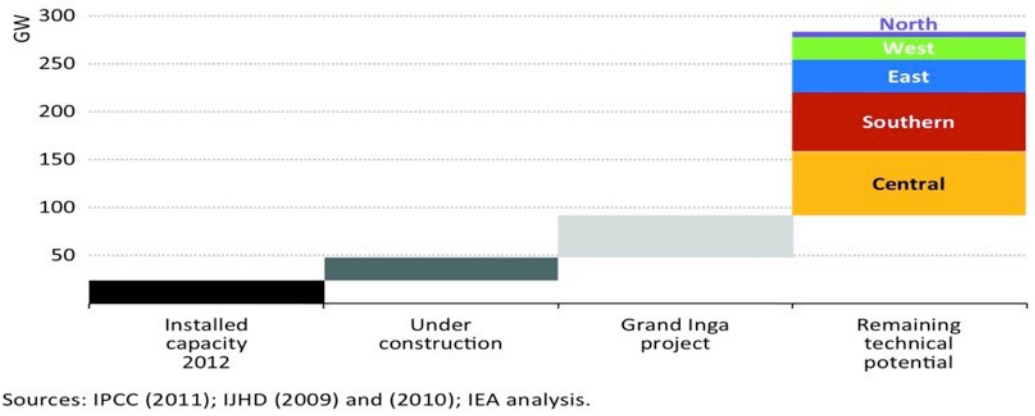


Figure 2.13. Existing hydropower capacity and potential in Africa, IEA, (2014), p.57

2.1.8 Life-cycle assessment and sustainability

As discussed previously, health and environment are strongly related to almost every sector of our society, and thus a more holistic perspective on health is needed to address the sustainability of economics, ecology, culture, and politics angles. (Corvalán et al., 1999; Corvalán et al., 2005; Oxfam, 2014; UNEP, 2009). Belz and Peattie introduce the concept of sustainability marketing, which seeks to take account of both social and environmental issues. Hence, their definition is the starting point for discussing the question of sustainability and sustainable development: 'Sustainability marketing is marketing that endures forEVER, in that it delivers solutions to our needs that are: ecologically oriented, viable, ethical, and relationship-based' (Belz & Peattie, 2009, p.18). In the first place, the sustainable development was defined by Brundtland 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (UN WCED, 1987, the article 49).

Life-cycle assessment (LCA) provides another view to sustainability. The definition of this LCA is, 'a concept and methodology to evaluate the environmental effects of a product or activity holistically, by analyzing the whole life cycle of a particular product, process, or activity' (Johnson U 2003). On the other hand, the concept, "cradle-to-grave", begins with 'the gathering of raw materials from the earth to create the product and ends at the point when all materials are returned to the earth' (EPA, 2001). (ISO 14040, 2006; ISO 14040, 2006). Sustainability assessment of a product (goods and services, Crawford, 1994 p.23; ISO 14040, 2006) contains three pillars: environmental, economic and social sustainability and the system boundaries of these three pillars should preferably be consistent. The system is described with a process diagram, which shows the unit processes and their inter-relationships, when assessing the environmental aspects and potential impacts throughout a product's life cycle (e.g., cradle-to-grave) from raw material acquisition through production, use, recycle, and disposal. (ISO 14040, 2006; ISO 14044, 2006; Klöpffer, 2008; Tähkämö, 2013).

The social aspect of sustainability was introduced in Chapter 2.1.6 by creating a relationship to Human Rights, however official social LCA is considered at its early stages (Klöpffer, 2008; Petersen N.N., 2013) despite of the valuable work of the UN in 'The Guidelines for Social Life Cycle Assessment of Products' (UNEP/SETAC, 2009; 2013). This TAMAA study draws attention to some key basic needs discussed above, health and income versus poverty, and brings forward one interesting study in social LCA. Bocoum, Macombe and Revéret (2015) anticipated impacts on health based on changes in income inequality in their study, which was considered a step forward towards social life cycle assessment utilizing the impact pathways method (here the Wilkinson pathway). This pathway allows the comparison of different change scenarios in the life cycle of a product or a service. Therefore, they applied the Wilkinson pathway as a comparative method for anticipating the change in the infant mortality rate caused by a change in income distribution in the population of a country. Figure 2.14 (Bocoum et al., 2015, p.407) shows the functional diagram of Wilkinson Pathway (Wilkinson et al, 2010), which brings the discussion to the methods how Bocoum, Macombe and Revéret re-examined, with the most up-to-date time series data, the

hypothesis that the increases in inequality have negative consequences to health. For estimating the impact of income on health and the relationship between income inequality and infant mortality, they used an empirical regression model based on the generalized method of moments (GMM). The sample of 46 countries covered the data from the time series 1960 to 2006 in member (29 countries) and non-member OECD countries.

Bocoum, Macombe and Revéret (2015) took advantage of the inequality indicator, the GINI Index (also named GINI coefficient, a standard economic measure of income inequality based on Lorenz curve). This indicator is found most frequently in international databases and is a measure of the degree of income concentration within a population (OECD, 2014; UNDP GINI/HDI, 2013; World Bank, GINI). Similarly, for the health indicator, they chose the infant mortality (mortality of children under 1 year old) due to the availability in international databases in most countries and because of the infant mortality included in the Millennium Development Goals (the Goal number 4). In this way, these international indicators provided the regular visibility and follow-up (UN MDG, 2013; 2012; 2010; 2005). The results of regression analysis based on the model GMM showed a relationship between a variation in income inequality and a variation in infant mortality. Thus, this relationship made it possible to anticipate the potential impacts of a change in income distribution (through the GINI coefficient) and a delayed change in infant mortality. In OECD countries, this delay, lag time, was on average 14 years, and 16 years for non-OECD member countries.

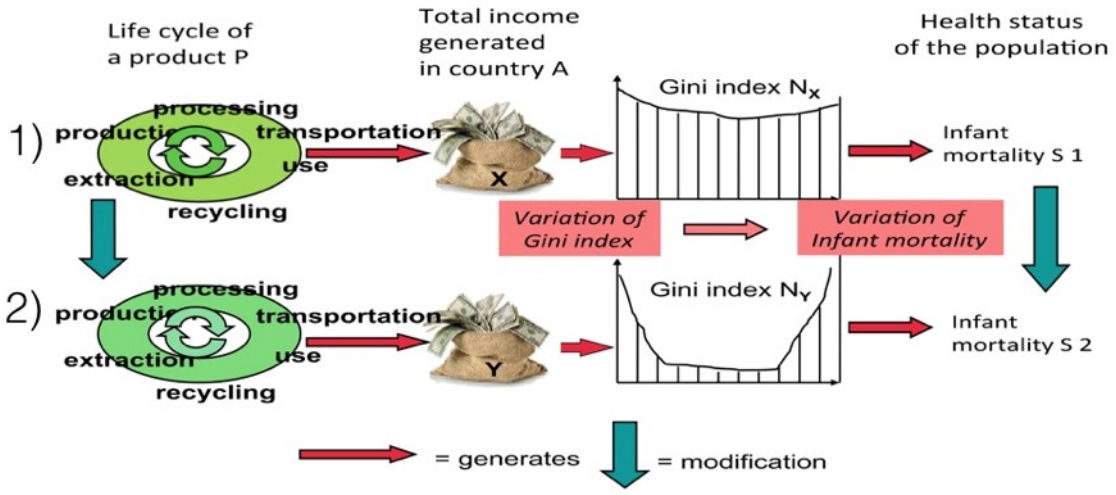


Figure 2.14. Functional diagram of the Wilkinson pathway, Bocoum et al., (2015), p.407

Having defined and confirmed the relationship between income inequality and infant mortality, these scholars demonstrated how to calculate the change in income distribution (in the GINI coefficient) resulted from a change in the life cycle of the product (expressed in variation in turnover). A case study in country C exemplified how imported wine is replaced with the wine production in country C, see the functional diagram in Figure 2.14. In country C, table wine is 1) imported entirely from abroad in the baseline situation (the upper process 1) in Figure 2.14) and 2) wine is produced

within the country after the change. The variations of infant mortality, because of this change in a life cycle, were calculated through the next steps. Bocoum, Macombe and Revéret analyzed a) the number of jobs created for the direct suppliers, b) the variation of income inequality represented by that of the GINI coefficient, and c) the link between the variation of the GINI coefficient and the variation of infant mortality within the population. The cropland was initially covered with natural grassland and sown pasture used to feed animals. Therefore, the grapevines were cultivated by intercropping with maize (Federer W.T., 1999), the area of 500 000 ha for each crop, and the quantity of produced wine replaced the same quantity that previously was imported (40 million hectoliters). The findings of this case provide valuable insights into the social LCA and the methods how it is possible to anticipate the impacts on health caused by an important change in the life cycle of a product. Because these findings help to understand potential social LCA processes, here are summarized for illustrative purposes, the steps a), b), and c), the exact case found in (Bocoum et al., 2015).

The stage a) calculated the overall production value by using the average price of a liter of table wine. The calculations utilized the input–output tables (IOT) of each country, and in this example case the data on the consumption of the food, beverage and tobacco production sector. Table 2 as a fictional IOT only highlights the economic changes occurring in the supply chain in country C (Table 2 in Bocoum et al., 2015). This example illustrated how to proceed through each phase. Following the steps described in (Bocoum et al., 2015), a demand for 200 000 additional full-time jobs in this sector was actualized, all other things being equal. The indirect (in the supply chain only) economic changes resulted in the creation of 107 853 new full-time jobs in the supply chain, so the changes in product life cycle in country C created 307 853 jobs distributed in the different activity sectors.

The stage b) utilized the calculation of the variation of the GINI coefficient, where the initial GINI coefficient (the upper process 1) in Figure 2.14) was 0.391 (see Table 3 in Bocoum et al., 2015). The detail calculations are expressed in Table 3. For calculating the final GINI (0.367), the data from columns 5 (variation in the number of wage earners) and 6 (average net monthly wage) in Table 2 were used. In this example case, the 307 853 new jobs created are filled by the same number of people who initially were unemployed. The results of the calculations lead to a significant drop in income inequality within the population, the change drop in the GINI coefficient representing a drop in income inequality of 6.1 %.

Finally, the stage c) linked the variation of the GINI coefficient and the variation of infant mortality within the population. As executed above, this link was calculated by using the results of regression based on the model GMM, which showed a relationship between a variation in income inequality and a variation in infant mortality. The results indicated that in OECD countries, a 1 % variation in the GINI coefficient leads to a variation of about 1 % in infant mortality at the end of 14 years, all other things being equal. For other countries, the results showed that a 1 % variation of the GINI coefficient leads to a 0.5 % variation in infant mortality at the end of 16 years.

The social LCA study utilizing the Wilkinson pathway (Figure 2.14) concentrated on a social change caused by the change in the LCA, when the import of the product was substituted for the production in country C. A system perspective will prevent sub-optimizations in LCA, when we analyze the potential impacts and describe the system with a process flow diagram throughout a product's life cycle (e.g., cradle-to-grave). Within a system, the sub-processes can be investigated and find out the best potential solutions. This kind of system perspective is exemplified in the LCA of a solar cell (the licentiate thesis, Saarinen, R., 2015b) in the pure silicon production phase, which is energy intensive and has health consequences. These health impacts lead to social impacts as discussed in this Chapter 2.1 and call for applying social LCA. The LCA study of solar cells drafted first the whole product process and its sub-process in order to learn the bottlenecks regarding energy and material consumptions, pollutions, emissions and wastes. This led to apply the potential of the most sustainable sub-process, exemplified in the pure silicon production as analyzed in Saarinen, R. (2015b, pp.36-46). This production phase is one of the most crucial processes in the solar cell supply chain and omitting this phase will cause serious weaknesses in the sustainability of solar power.

Even though there is much research needed for establishing social LCA, the developed tool, Wilkinson Pathway, is very promising for governments and big companies in helping them assess the global impacts of their activities on the entire population of a country and make decisions (e.g., sustainable purchasing) against these assessments. These purchasing behaviors and prosocial behavior related to happiness are discussed in the licentiate thesis (Saarinen, R., 2015b).

2.2 Market perspective

Why Africa? Africa is Opportunity. The bottom of pyramid income (BOP) group was defined in Chapter 1.5. These 4 000 million people are estimated to be a potential market sector of 5000 billion USD. Analysis of the data from household surveys in 110 countries showed that even though Africa has a slightly smaller BOP market, at $429 billion, it is by far Africa's dominant consumer market, with 71% of purchasing power and 486 million people equal to 95% of the surveyed population (Hammond et al., 2007). Globally this $5 trillion consumer market falls into categories BOP500 to BOP3000, BOP500 representing individuals living less than $500 a year and BOP3000 individuals between $2500 and $3000 as illustrated in Figure 2.15 (Hammond et al., 2007). The categories in BOP markets in Africa show a different pattern, BOP1000 being distinctly the largest market compared with other categories. Moreover, Figure 2.16 illuminates how markets of Food, Energy, Housing, Health, transportation, ICT, and Water are disruptive fields for new innovations in wellbeing and smart living environment, but where will Africa be located in this future? (Berman, 2013; Bowman, 2009; Hammond et al., 2007; World Bank, 2013).

The global food market share of approximately USD 3 000 billion represents the largest segment of 5 000 billion USD markets potential (Table 2.1; Figure 2.16, Hammond et al., 2007). According to future estimates in 2030 by World Bank (World Bank, 2013), Africa's total agriculture and agribusiness could create opportunities for an industry sector of 1 000 billion USD, which is half of Africa's total economy today (Leke et al., 2014).

Regarding potential Food markets development, Africa has most of uncultivated land in the world (Figure 2.17, Deininger et al. 2011, p.xxxiv), approximately 6 % of land is irrigated and in Sub-Saharan Africa 4% (You et al. 2010). (Berman, 2013; Hammond et al., 2007; Mukherji & Facon, 2009; Sasson, 2012; World Bank, 2013).

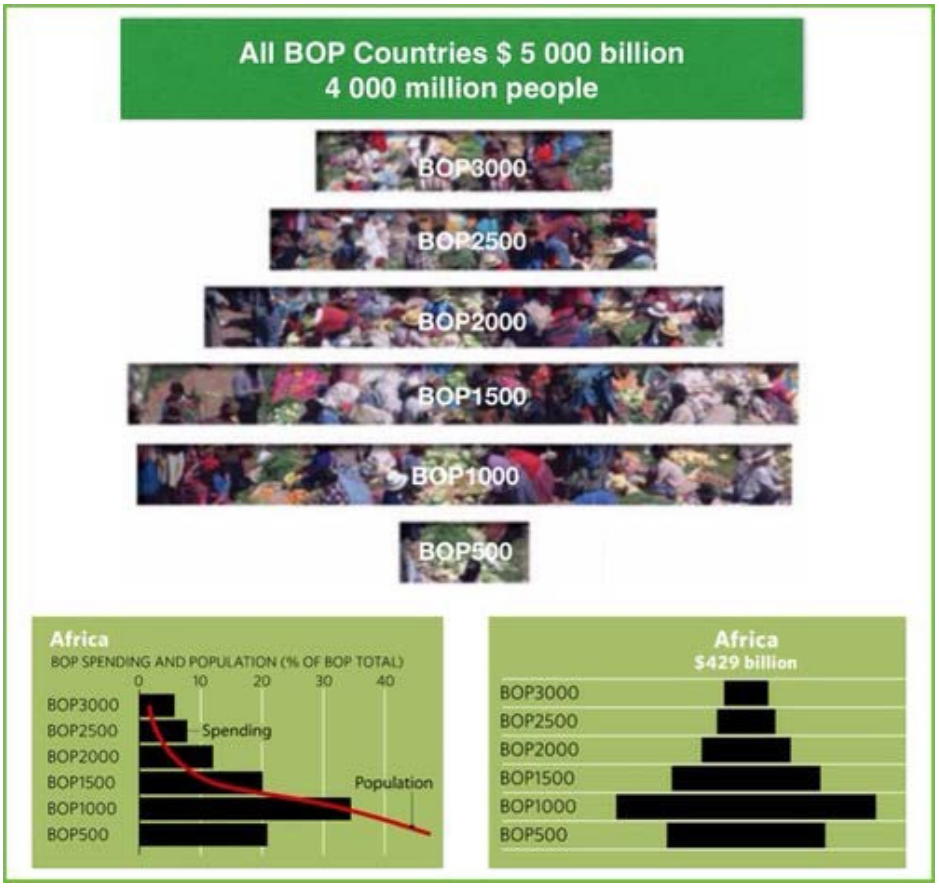


Figure 2.15. Categories in global BOP markets and in Africa, Hammond et al., (2007)

Table 2.1. Market opportunity by sectors in global BOP markets, Chevrollier, (2011), Hammond et al., (2007), Table Saarinen, R., (2015b)

Estimated BOP Market $5 trillion	
Market Sector	**Value in $1000 million**
Food	2 895
Energy	433
Housing	332
Transportation	179
Health	158
ICT	51
Water	20

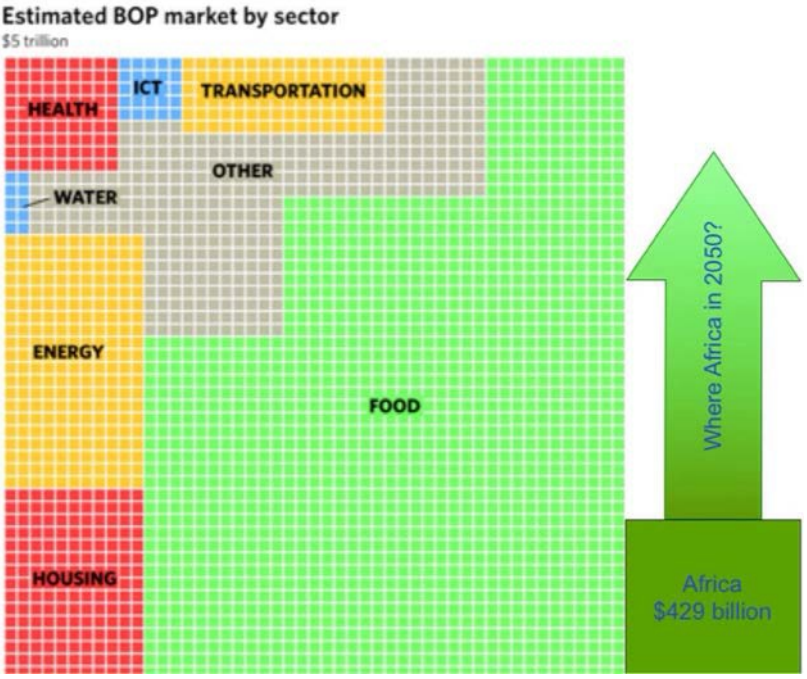


Figure 2.16. What will be Africa's place in BOP markets in 2050?, Hammond et al. (2007), modified Saarinen, R., (2015a

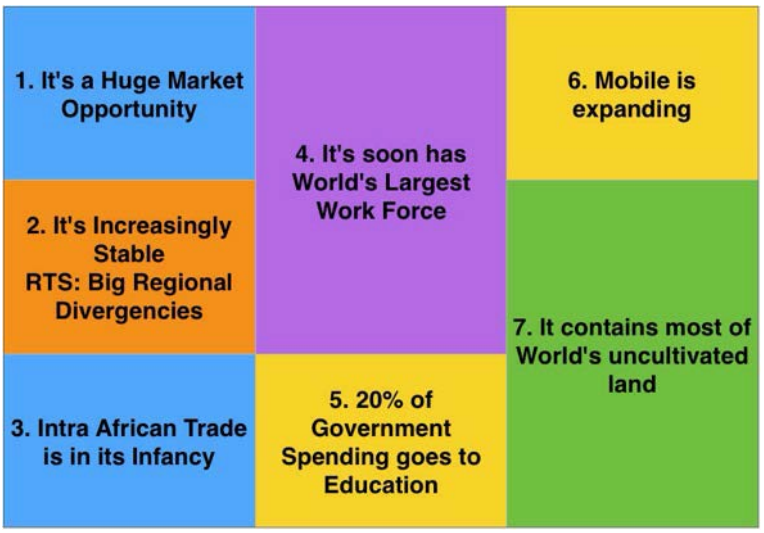


Figure 2.17. Why Africa, Source Berman (2013), modified Saarinen, R., (RTS), (2015a)

According to the latest IEA scenario, 950 million Africans will gain access to electricity by 2040, but 530 million people will remain without electricity in Sub-Saharan Africa (IEA, 2014, pp.13, 79). On the other hand, electricity is considered a basic need (Chapter 2.1.7). The largest potential in BOP markets in the energy sector exists in Sub-Saharan Africa: more than 620 million people in Sub-Saharan Africa remained without access to electricity in 2012 (IEA, 2014, pp.19, 30; Figure 2.18, IEA Energy, 2014, p.57. and Figure 2.19, IEA, 2014, p.123), Appendix N illustrating access to electricity in Africa. Thus, this IEA projection ties the research questions and the opportunity: What basic customer needs of rural people in Africa can be met by

providing sustainable energy services and how villagers' wellbeing is empowered by these services?

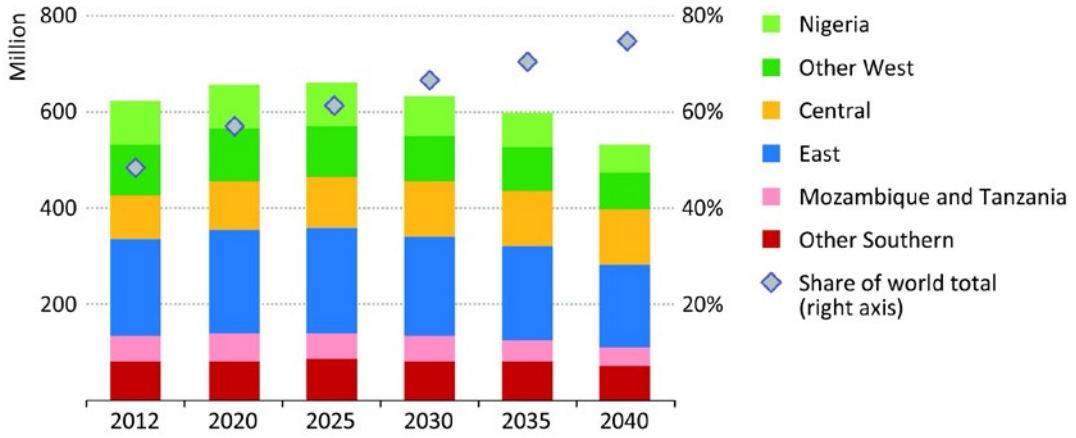


Figure 2.18. Population without access to electricity by sub-region in Sub-Saharan Africa in 2040, Source IEA Energy, (2014), p.57

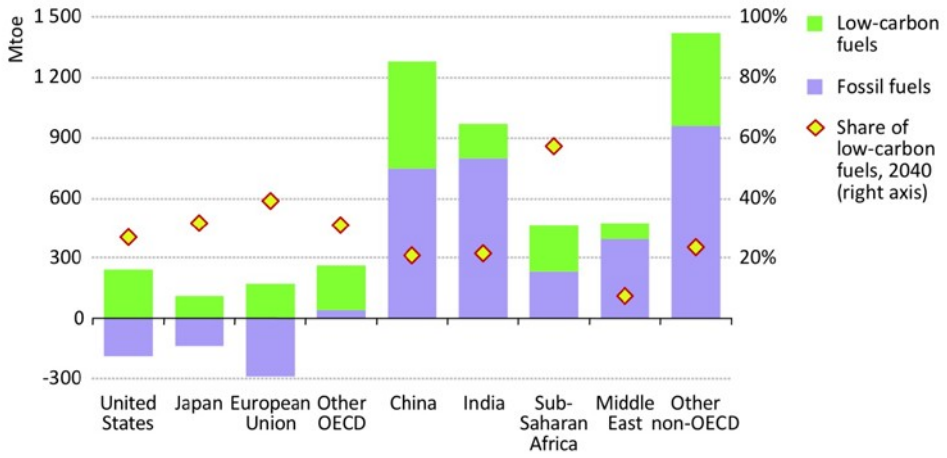


Figure 2.19. Primary energy demand growth by region and fuel type in the New Policies Scenario, 2012-2040, Source IEA (2014), p.123

3 Methodologies and methods

3.1 Face-to-face active interviews

3.1.1 Exploring in-depth knowledge

This TAMAA Case explored in-depth knowledge for the problem area defined in Chapters 1 and 2, and set the purpose on mining with interviews multidisciplinary participatory co-learning knowledge of African villagers within their community and how their wellbeing can be empowered by new sustainable energy services. The key interview question was 'what basic needs of rural people in Africa can be met by providing sustainable energy services and how?' This question was categorized into interview questions (Maxwell, 2009, p.230), and TAMAA Case creating individual, community and social interview questions as expressed in Table 3.1.

Table 3.1. Interview questions for the first interview round, Saarinen, R., (2015a)

N	Individual	Community	Social
1	What basic Needs of people do you think there are, people who are living in Africa? And do you think, there are differences between rural and urban areas?	How do you think nutritious Food and clean Cooking could be arranged in African countries?	How do you think new Energy Services can provide Security for people and what these new Energy Services could be ? Security meaning Health, Food, Water etc.. and costs of living?
2	In your opinion, what are the biggest obstacles and barriers for people for getting these basic Needs?	What about clean and fresh Water How do you think this is possible to arrange in Africa?	What about Access to these new Energy Services? How do you think this is possible to arrange? And What do you think is the biggest obstacles and barriers for getting new Energy Services?
3	What about new Energy Services? How they are connected to basic Needs? What do you think are the most important new Energy Services for people living in Africa?	How about Education, Training and Working environments? What do think is the connection to the energy and what kind of energy?	How about Healthy Environment for people? What is your opinion, what kind of new Energy Services can contribute this?
4	What do you think, what are obstacles and barriers for new Energy Services for people living in Africa?	How these new Energy Services could provide Livelihood opportunities and exporting possibilities? What kind of business models there could be?	What do think, what are the most important things to create and transfer new Technologies for people living in Africa? What are obstacles and barriers?
5	What do you think, what kind of possibilities there is for people to be a part of a community-based energy system, a larger ecosystem of energy services, for instance for villagers ?	How these Energy Services might decrease deceases and provide healthy environment?	What do you think, how these new Energy Services and basic needs like Food, Water, Health, Education can be a part of people's life? How all these Needs could be integrated and combined to new Energy Services ?
	What basic needs of rural people in Africa can be met by providing sustainable energy services and how?		

The selection of the interviewees (Table 3.2) was based on their mature, deep knowledge and experience of research aspects, which were able to reveal valuable data to research. The purposive sample was combined with quantitative reference interviews; instead of face-to-face interviews, the interview questions (Table 3.1) were sent by e-mail to the interviewees and the answers were received as written versions by e-mail (Appendix IA in TAMAA Interviews). The reference interviews were conducted with Brita Jern, Irja Aro-Heinilä, and George Pindua, and the interviewer was Ritva Saarinen (CV in Appendix IC).

Table 3.2. Purposive Sample, Saarinen, R., (2015a)

Interviewee position	Representative Organisation	Interviewee name	Experince
CTO, D.Sc.	NAPS Solar Systems Inc.	Mikko Juntunen	CERN, Nokia, medical imaging, solar systems, over 20 years
Controller	Swedish Lutheran Evangelical Association in Finland	Solveig Nylund	Africa clean water projects, solar pumping, 17 years
Scientist, D.Sc.	Aalto university	Pramod Bhusal	Nepal, Thailand, Vietnam, Philippines, Ethiopia, EU countries, several years
Director of International Co-operation, PhD	Finn Church Aid	Tomi Järvinen	Several years experience in development cooperation
Mission coordinating secretary	Evangelical Lutheran Church of Finland	Vuokko Alanne	Several mission and development aid coordinations for target developing countries, 28 years
Senior Economic Adviser, D.Sc. Econ., L.Sc. Social	Department for Development Policy Ministry of Foreign Affairs	Mika Vehnämäki	Several years for co-operation development with foreign countries
Senior consultant	GAIA Group	Paula Tommila	In development co-operation in Ministry of Foreign Affairs of Finland, sustainability consulting, several years.
International Learning Space Coordinator, M.Sc.	Finn Church Aid	Pasi Aaltonen	Constructions work, education concepts, school-concepts in developing countries
Mission coordinating secretary	Evangelical Lutheran Church of Finland	Helene Taal	Several mission and development aid coordinations 12 years, before as assistant in business environment
D.Sc., Scientist, Lecture	Aalto University	Paulo Pinho	Multinational experience, Lighting technology, Finnish and Portuguese nationality, born in Angola
Master thesis student in Business	Aalto University	Majok Kariom	at School of Business, Business management, from South-Sudan, worked in Kenya
Multicultural diacon	Evangelical Lutheran Church of Finland	Jyrki Myllärniemi	Church international work practices in deacon multicultural work, young people teams, over 30 years
M.Sc. Electrical	Evangelical Lutheran Church of Finland	Seppo Vehko	Several years experience in Ethiopia
D.Sc, energy professional	Fortum Oyj	Tapio Keränen	30-years, several positions
Rev, Dean reference interview	Evangelical Lutheran Church in Tanzania	Rev, Dean George Pindua	assistant to the Bishop of the Evangelical Lutheran Church in Tanzania, Morogoro
PhD, theology reference interview	Evangelical Lutheran Church of Finland	Irja Aro-Heinilä	Experience over 20 years in East-Africa
Mission Director reference interview	Swedish Lutheran Evangelical Association in Finland	Brita Jern	Several years experience in Kenya

Furthermore, the sampling was combined with a quantitative case study 'ABC Water Project' (SLEF ABC Water, 2012, Appendix IB). The research work by Pramod Bhusal (2009, 2007) served as a reference study (named Nepal Light Case in Figure 3.2 below) for lighting services. Each person of the focus group was interviewed individually face-to-face using active thematic in-depth open-ended interviews. The face-to-face interviews were recorded leaving thus time for the interviewees just to relax and feel as comfortable as possible while telling their stories what they think and

know and what they have experienced during their working life in developing countries or in a sending organization.

The design of interviews started from the research questions, the research strategy and objectives by applying a flexible, proactive and incremental development. The focus was to explore and find out experienced real-life views and the meaning of this particular phenomenon to the participant, who was a part of social units to be studied, and who had a personal commitment on the subjects, which covered several interview segments or even all segments. The approaches to collect qualitative data through open-ended interviews can be divided into three tactics as (Patton 1990, p.280):

1. Informal conversational interview
2. General interview guide approach
3. Standardized open-ended interview

This TAMAA Case applied mainly the standardized open-ended interview, which consists of a set of questions with the intention of taking each interviewee through the same questions for minimizing variations in the questions. 'This reduces the possibility of bias that comes from having different interviews for different people.' (Patton, 1990). On the other hand, based on previous experiences of the researcher, the semi-structured interview was applied when well-grounded (Robson 2002). A series of interviews, where participants' historical accounts are required in order to acquire how a particular phenomenon developed — change happened, provided a deeper understanding of the phenomena (Chapters 1 and 2). TAMAA Case explored and reviewed concepts developed in the SMILE case (Chapter 3.2) as well as brought out further issues to research in-depth. These interviews involved a greater expression of the interviewee's self than do other types of interviews and took an account of the interviewees' experiences, and not only their experiences but also as organizers of the meaning as they conveyed. In this way, these interviews enquired the practical knowledge and authentic insights into people's experiences. (Gubrium & Holstein, 2002). In-depth face-to-face interviews map problems relevant to the participants and build up trust between a researcher and participants. Thus, they form a good foundation for further co-generative actions, and makes the researcher an active instrument. (Langvik, 2004).

3.1.2 Sampling method

Sampling procedures in the social and behavioral sciences can be categorized into (Teddlie & You, 2007):

1. Probability sampling
2. Purposive sampling
3. Convenience sampling
4. Mixed methods sampling

This TAMAA Case utilized purposive sampling by selecting information-rich representatives from target organizations and gradually increased the selection that would yield the most valuable information, knowledge, ideas, experience, and insights

for the research in-depth and detail. Snowball sampling made the first contacts and the sample expanded to new contact persons until the representatives shown in Table 3.2. Purposeful sampling can be used to achieve representativeness or typicality of cases, individuals, groups, organizations, sites, or activities selected, ‘A small sample that has been systematically selected for typicality and relative homogeneity provides far more confidence that does a sample of the same size that incorporates substantial random or accident variations’ (Maxwell, 1996). TAMAA Case also exploited sequential sampling using representatives from the broad target group (category) and examined particular instances of the phenomenon in order to define and elaborate on the various manifestations of this problem area defined. ‘Purposive sampling leads to the greater depth of information from a smaller number of carefully selected cases, whereas probability sampling leads to the greater breadth of information from a larger number of units selected to be representative of the population’ (Teddlie & You, 2007). Purposive sampling has also referred to as a qualitative sampling. ‘Social experience and lived realities are multi-dimensional, and our understandings are impoverished and may be inadequate if we view these phenomena only along a single dimension’ (Mason, 2006). Yin (2009) concluded, ‘for some case studies, the construction of reality provides important insights into the case. The insights gain even further value if the interviewees are key persons in the organizations, communities, or small groups being studied, not just the average member of such groups.’ (Hardon et al. 2004; Holstein & Gubrium, 1994; Kuzel, 1999; Maxwell, 1996; Maxwell, 2009; Patton, 1990; Robson, 2002; Yin, 2009).

3.2 Case study research

The research through case studies focuses on in-depth analyses of one case or multiple cases, they can apply qualitative, quantitative and mixed methods research (Chapter 3.4), and usually case studies characterizes complexity and causality. The method is used to study phenomena in their real-life context. The case study aims to answer, a "how" or "why" question. The definition of case study research needs to be defined (Gerring, 2007), starting in the terms defined by Yin (2004, p.xiv), “ ’case’ to be ‘the real-life set of events from which data will be driven’" and “the ‘case study’ is the substance of your inquiry”. Yin suggests making the case study significant by embedding it in larger research literature. This TAMAA Case inquired through in-depth interviews knowledge and experiences of the professionals involved in co-operation work. Thus, the case study approach specially fit this TAMAA research work. As Patton (2007) put it, when a comprehend understanding is needed in ‘some special people, a particular problem, or unique situation in great depth, and where one can identify the cases rich in information - rich in the sense that a great deal can be learned from a few exemplars of the phenomenon in question.’ Similarly, Gerring (2007) highlights this in-depth knowledge of an individual example and the ways to acquire a better understanding of the whole by focusing on a key part. Byrne and Ragin (2009) continue by emphasizing this instance character of the case study, a particular situation or set of circumstances. This TAMAA Case utilized the sample of the representatives of non-governmental organizations (NGOs) and companies, as well as researchers at universities (Table 3.2), in order to bring the voice of the professionals worked within people in the developing countries and especially in Sub-Saharan Africa.

Case studies enable people to apply the lessons derived from one situation to other cases (Whyte 1991; Yin 2004). TAMAA Case utilized in-depth face-to-face interviews, reference interviews and cases as well as literature reviews to identify needs and concepts, which can empower villagers to build sustainable flourishing learning Village Community. TAMAA Case is depicted in Figure 3.2, which shows how the SMILE case (Figure 3.1) provided input to TAMAA face-to-face interviews for formulating some interview questions, which was reviewed and enlarged in this TAMAA Case. Then, the licentiate thesis demonstrated and created the Village Community concept in a solar-based socio-technical system. The participants provided feedback for the TAMAA case study report, (Saarinen, R., 2015a). The ABC Water project and Nepal Light case are discussed in Chapter 4.

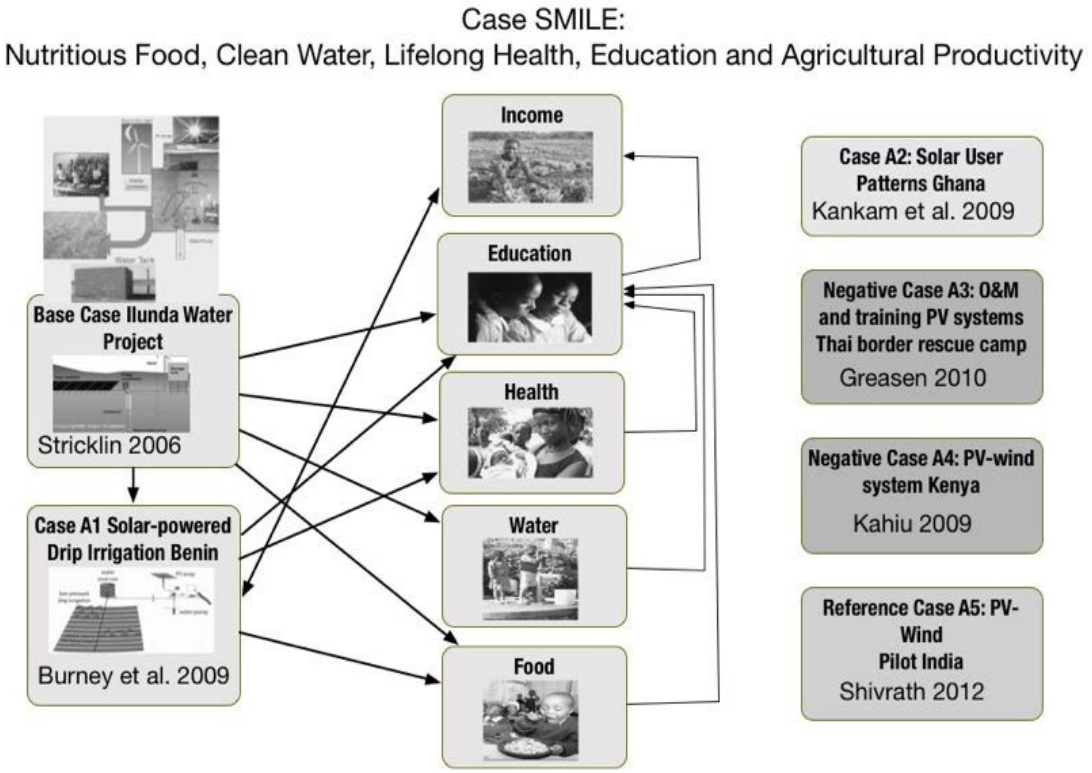


Figure 3.1. SMILE case: Base case Ilunda Water Project; A1 Solar-powered Drip irrigation; A2 Solar User Patterns Ghana; negative cases A3 O&M and Training PV systems Thai Border rescue camp, A4 PV-wind system Kenya; reference A5 PV-wind Pilot India., Saarinen, R., (2015b). Photos (Photo Ref.)

This TAMAA Case is a case study research and not a project work (Heikkilä, 2014; Simula, 2012), but applied participatory actions through active interviews. The licentiate thesis (Saarinen, R., 2015b) discusses this theory foundation in more details.

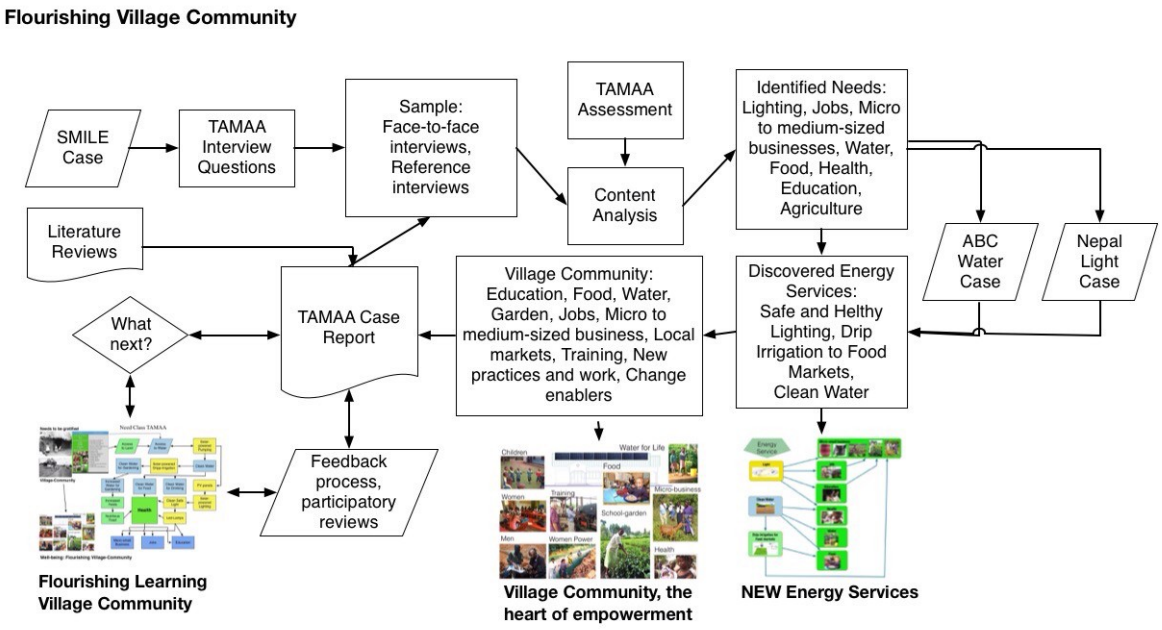


Figure 3.2. TAMAA Case identified Needs based on interviews and literature reviews and described New Energy Services although the licentiate thesis created and validated these services. This TAMAA Case described Village Community and the licentiate thesis widened, demonstrated and created Village Community in a solar-based socio-technical system. Saarinen, R., (2015a).

3.3 Assessment process and Village Community

The purpose of this TAMAA Case was to acquire shared knowledge and meaning of vehicles, which are capable of filling the gap between the status of general basic customer needs (Figures 1, 2, and 3 in Executive Summary) and the vision of sustainable flourishing Village Community. The scientific enquires involved different kinds of evaluations in a social reality domain, the purpose to make a change in the output, the output that meet the requirements and needs (see the exemplar of Needs and requirements in Table 4.7). The general basic customer needs (Chapter 2.1) — Food, Water, Health, Education, Income, and Safe, clean, healthy and sustainable environment, and Electricity, the research questions (Chapter 1.2), and the interview questions (Table 3.1) drove the review and assessment processes for new services. (Grönroos, 2002; IFAD Annex D; Maxwell, 1996; Robson, 2002; UNDP, 2007; Urban & Hauser, 1993).

Multiple qualitative methods (in Chapter 3.4) uncovered the needs of customers or end-users, and the target was to investigate how well a service or product meets the needs of users (Chapters 2.1 and 4.1). Antonides (1996, p.383) defines a need as ‘An excess or deficiency in something related to survival, such as air, food or water’, and the need for achievement ‘The need to accomplish something difficult, to master, manipulate or organize physical objects, human beings or ideas’. Here he refers to Maslow's hierarchy of needs (pp. 26-32), this hierarchy applied in Figure 2 (in Executive summary), which summarized basic customer needs in TAMAA Case. Similarly, the United Nations has defined the basic needs in The Universal Declaration of Human Rights (UN Human Rights, 2014), and in the Millennium Development Goals (UN MDG, 2005). Furthermore, when assessing and inquiring customer needs, we

keep focus on those values which these needs provide to customers as Grönroos (2002, p.55) emphasizes: 'Customer-perceived value follows from a successful and customer-oriented management of resources relative to customer sacrifice, not from a pre-produced bundle of feature'. The assessment in TAMAA Case applied the following six-steps criteria and in doing so, this assessment followed the steps which applicable (Belz & Peattie, 2009; Bergman 2007; Cooper, 2001; Grönroos 2002; Prahalad, 2010; Bhusal et al., 2007; Zahnd's studies e.g. in Bhusal, 2009; Zahn & Jennings, 2012; Zahnd et al., 2006):

1. Resource Assessment
2. Technology Assessment
3. Match Resources, Needs, Services and Technologies
4. Technology Selection and Technology Transfer
5. Quality of Service to customers

This TAMAA case addressed the question, which kind of socio-technical system (Whyte, 1991), learning community and partnership model might produce the wellbeing of rural villagers. In starting to describe a learning community, this case study introduces Isaacs (1999, p.9) and his ideas: '… a shared inquire, a way of thinking and reflecting together. It is not something you do *to* another person. It is something you do *with* people.' Isaacs (2002) continues that dialogue is like opening a space of learning together. Similarly, participatory action research emphasizes thinking and learning together, trying to make changes *with* others (Reason & Bradbury, 2008; Saarinen, R., 2015b). An organization, which can be called a learning community, has a shared vision, individual and collective learning practices, collective intelligence, a common language, and interdisciplinary teams and projects. Learning organizations encourage the growth of their people, foster democratic decision-making, enable positive deviance and create positive climate, create a new level of creativity and care among the community, where people can excel and learn. (Cameron, 2008; Gustavsen, 1992; Isaacs, 1999, 2002; Kemmis, 2008; Novick et al., 2002; Reason & Bradbury, 2008; Senge, 2006; Wenger, 2004).

When we try to change our beliefs and mental models, we are making these efforts in our social environments. Trying to change organizational behaviors (like in a community) is much more complex, because an organizational behavior is not only the sum of individual behaviors but the combination of interests between the goals of the organization, the goals of the subgroups (teams), and the personal goals of individuals. However, people can learn continually through their lifetime and learning of individuals, teams and organizations is the heart of our growth. We can increase our capacity to change, grow and thrive in an open, flexible, innovative and virtual organization, which provides visions, sources, and a fluid and even chaotic learning environment. In a sound learning environment, we can make mistakes and learn about our past mistakes. This ability to remember and to change is very important for organizational learning. We can simply think that learning is making contacts; we can be educated and educate each other.

Interactive real-life complex systems are holistic rather than reductionist, and they have such different layers (strata) as individual, group, community, institutional, or social levels. Real-life complex systems have feedback, it is possible in human social systems to go backwards and learn from experiences. The needs of human beings in complex systems might be obvious, but they are in many cases latent (hidden) and can be captured only in multiple methods. Furthermore, complex systems include non-linearity and chaos and you cannot solely describe them with linear-methods. (Aaltonen, 2007; Hyötyniemi, 2005; Oman, 2004; Saarinen E & Hämäläinen, 2004; Senge, 2006).

The village community system addressed ill-structured problems and multiple and conflicting criteria in the environment (Sasson, 2012; Vincke, 1992), where complex social groups participate at versatile levels to learn together what kind of sustainable new services and technologies are needed to empower rural villagers to achieve their wellbeing (Järvinen, 2007; Hammond et al., 2007; Novick et at., 2002). The co-operative development starts from the customers, the villagers within their communities, and proceeds so that both givers and receivers are in the same change process and both being beneficiaries, givers are individuals, faith-based organizations (FBOs), and social entrepreneurs (Cameron, 2008; Grönroos, 2000; Rudd et al., 2014; thisisFinland). Those who develop new technologies and services and market them belong to this socio-technical complex system as service providers (Beltz & Peattie, 2009; Bowman et al., 2009; Hyppänen, 2013; SIDA, 2008).

Participatory action research investigates the phenomena both from the theoretical and practical view in order to make the strength of collaboration of villagers, researchers, NGOs, universities, and companies. It is scientific and practical research for gathering information, exploring and experimenting complex socio-technical systems and communities. The aim is to make change to happen and take actions to meet the needs and requirements of customers (villagers) and communities in the context, which provides the ideal conditions for the desired output by involving participators to work together. Furthermore, it advantages from learning organization and socio-technical system thinking, ‘Systems Intelligence: Connecting Engineering Thinking with Human Sensitivity, ... on interactive participation in systems with feedback and subtle interrelations’ (Saarinen E. et al., 2004). (Reason et al., 2008; Whyte, 1991). The licentiate thesis analyzes and investigates participatory action research and learning organization theory in more details (Saarinen, R., 2015b).

3.4 Mixed methods research

Applying quantitative, qualitative methods and mixed methods, improves and complements the research with the most appropriate approaches to data gathering, analysis, interpretation, and presentation. This kind of research tries to answer one or more questions from different perspectives in order to seek new insights into existing knowledge or phenomena, for the purposes of breadth and depth of understanding and corroboration, data collection, analysis, and inference techniques. (Creswell & Plano, 2011; Creswell, 2010; Fakis et al. 2014; Johnson et al. 2007; Teddlie & Yu, 2007).

Qualitative research has a long tradition in business fields, where acquiring the needs of potential and current customers of products and services are crucial for business: a service or product should match customer needs. Designing and marketing new products and services has applied such methods as, field test, field work, focus group discussions, in-depth interviews, lead user analysis, observing people, analytic dialogue, analyses of 'documentary' societies and cultures, technology analyses, creative group methods, brainstorming, matched groups, narratives, discourse analyses, use-case stories, visual data, requirement management, conceptualization, and case studies, among others. The heart of all these methods is to capture early opinions and corrective actions for developing and creating services and products for users. (Belz & Peattie, 2009; Cooper, 2001; Easterbrook, 2007; Grönroos 2000; Hyppänen, 2013; Larman, 2002; Maxwell, 2009; Robson, 2002; Silverman, 2006, 2005; Urban & Hauser, 1993; Yin, 2009).

The social studies in the context of real-life complex systems have applied much the same methods as named above, the methods, which could provide qualitative data to understand social processes. A good design of qualitative research is addressed so that it would be effective in describing processes, understanding real-life phenomena, and the critical role of context where the phenomena existed. Maxwell has provided the research design model, which includes phases: goals, conceptual framework, research questions, methods, and validity (Maxwell, 2009, 1996). Robson has named the importance of a good design as flexible design (Robson, 2002). Yin, on the other hand, has illustrated how to make successful case studies (Yin, 2009).

3.5 Quality of Service

The quality of service is most of all measured by the statement: ‘does this service meet the needs and requirements of the customer?’, the customer being the heart of service creations (Beltz, 2009; Bergman, 2007; Grönroos, 2000). This TAMAA Case identified the needs by interviews (Chapters 3.1 and 4.1) and the general basic customer needs by literature reviews (Chapter 2), and furthermore applied case studies (Chapter 3.2) and mixed methods research (Chapter 3.4). The assessment method (Chapter 3.3) took advantages of the six-steps criteria, when evaluating the problem area and creating services to meet these needs; the service creation process and technology adaptation defined and created in the licentiate thesis (Saarinen, R., 2015b). The continuing improvements of quality of services are needed, and the service development (Figure 4.1) is an iterative and incremental process to fulfill the needs of customers.

4 Services in the TAMAA concept

4.1 Weighted Identified Needs

The research question was categorized into individual, community, and social interview questions (Table 3.1). Similarly, the written stories (Appendix IE) were categorized according to individual, community, and social perspectives. The notes of the recorded interviews were placed in Table 4.1 as raw data for analysis. In the first phase, data were grouped into the Need and Energy Service sub-tables, both groups including several items as the summary of the interviews, when every interviewee told freely and openly his or her experiences and insights into interview questions. During the interviews, each interviewee discussed the aspects in Need and Energy Service groups differently according to her or his experiences, thus first analysis started by counting how many times each interviewee weighted each aspects as for instance Food, Water, and Education in the Need group.

Table 4.1. Categorized preferences as raw data, Saarinen, R., (2015b). The dark grey color indicates either use of fossil fuels or environmental or health hazards, or a serious threat to social norms like corruption.

A) Need Set			
Need	Preferencies	Interviewee Amount of 14	Total Preferences
Food	1;3;5;1;3;4;1;6;7;8;3;2;11	13	55
Water	2;3;9;4;2;5;4;2;6;9;4;9;5	13	64
Health	1;2;1;1;3;2;4;5;4;2;6;5;11	13	47
Sanitation, Hygine	1;3;1;3;1;2;2;1;2;5;3	11	24
Education	1;3;3;2;5;9;10;4;8;15;10;10	12	80
Cooking	1;2;4;1;2;4;2;6;2;5;4;5;1	13	39
Light	1;2;8;1;3;3;6;3;3;3:2;1	12	36
Cooling	2;8;1;1;2;2;1	7	17
Indoor Air, environment	1;1;2;3;1;1;3;3;4;2;4;1;6	13	32
Security, Shelter	1;1;1;1;1;2;2;1;2;3;4;11	12	30
Work	2;1;5;8;3;6;1;1;3;7;3;9	12	49
Agricultural Productivity, Garden	2;3;3;1;1;1;2;5;7;4;4;6;9	13	48
Forest, Deforestation, droughts, pests	1;2;1;1;3;1	6	9
Livestock, farm animals	1;1;1;5;4;2;2;3	8	19
Micro/small business	1;1;1;6;1;1;2;4;3;8;8	11	36
Mutual benefits business, local	1;1;2;2;5;1;5;8;5;3;12	11	45
New Practices	1;3;1;3;3;11;14;2;12;10;11;15;4;16	14	106
Incomes, Money, Investments	1;3;7;9;1;2;4;4;8;6;13;13;5;25	14	101
Assets	1;1;8;2;1;3	6	16
Identity, ID, Tribes, minorities	1;4;3;4	4	12
Banking, Credits	1;1;4;2;1;1	6	9
Mobile phone, charging, Internet	1;1;2;3;2;7	6	16
Infrastructure, taxes	1;1;4;5;2;4;3;6;2;15	10	43
Corruption, Conflicts, Wars	1;1;2;1;4;3;2;1;3	9	18

B) Energy Service Set			
Energy Service	Preferencies	Interviewee Amount of 14	Total Preferences
Improved Stoves, Cooker, Heater	1;2;2;1;1;1;6;6;2;10;2;3	12	37
Pumping, wells, dams	3;1;5;2;1;3;1;2;1;5;6;2	12	32
Irrigation	1;1;1;1;1;3;4;3	8	15
Compost Toilet	1;1;1	3	3
Modern Lamps	1;3;1;1;1;5;1;2;2;2	10	19
Better Lighting	1;2;6;1;1;1;1;4;4;3;2;1;1	13	28
Electricity/ Energy	1;1;1;3;3;4;2;3;8;14;1;12	12	53
Cooling	2;8;1;1;1	6	13
Solar	1;2;4;4;1;1;1;1;5;8;5;18;2;3	14	56
Hydro	2;1;2;2;3;4	6	14
Wind	1;2;2;2	4	7
Machines	1;1;1;1	4	4
Small-scale system	2;3;2;1;3;3;2;3;3;6	10	28
Village system	1;1;2;1;1;2;2;4;16;4;7	11	41
Communal Sharing	1;2;1;1;2;2;2;7;2;3	10	23
Maintenance, Quality	1;1;1;1;1;3;5;1;5;1;6;3	12	29
Ownership	2;1;3;2;3	5	11
coal, straw, dung, fuel wood, waste	2;3;5;5;1;3;2;7;1;2;7	11	38
kerosene (lamps)	3;1;2;1	4	7
oil, gas turbines, diesel	2;4;1;2:3	5	12

The preferences of interviewees were placed in Table 4.1 according to the frequency the interviewee emphasized the aspect, and these preferences of each interviewee were separated by a semicolon. Table 4.1 shows two sets of actions, A) Need and B) Energy Service, and the sets A and B are asymmetric, in some items they are related to each other, whereas some items have no relationship (Vincke 1992, pp.5-7). For example, “Food” in the A) Need Set in Table 4.1, the left sub-table: 13 interviewees of total 14 interviewees referenced Food as a basic need and the third interviewee 5 times as is shown in the column Preferences, the eighth interviewee preferred Food 6 times, and the 13th interviewee preferred Food 11 times etcetera, total Preferences for Food amounted to 55. Taking an example of the right sub-table, “Solar” in the B) Energy Service Set: all the 14 interviewees preferred Solar, the third and fourth ones 4 times, and the 12th one 18 times, altogether 56 times.

Next, these analysis grouped needs to the five main broader need groups: a) Safe and Healthy Lighting, b) Clean Water, c) Education, d) Nutritious Food, and e) clean safe cooking. For the creation of services, each service was mapped with relevant items from A) Need set and B) Energy Service set in order to get an integrated service, which comprised all influential aspects. To start with, the preferences were placed in Table 4.2 to summarize how **a) Need Safe and Healthy Lighting** was comprised of direct and indirect needs. For the definition of Class, see Appendix 2 in the licentiate thesis (Saarinen R., 2015b) and Chapter 4.3.

Table 4.2. Need Class: Safe and Healthy Lighting, Saarinen, R. (2015a)

Need: Safe and Healthy Lighting 357 Preferences							
Direct Need	Light(ing)	Better Light	Modern Lamps				Total
Preferences	36	28	19				83
Indirect Need	Education	Health	Indoor Air	Security	Jobs	Business	Total
Preferences	80	47	32	30	49	36	274

Taking account Better Light with 28 preferences and Modern Lamps with 19 preferences from Energy Service set B), Lighting was preferred 83 times. All in all, Lighting was considered an important basic need, and in the interviews, it was preferred as a modern electricity light and especially solar-powered illumination in rural areas. Furthering, Safe and Healthy Lighting affects on Education, Health, Indoor Air, Security, Jobs, and Micro to medium-sized businesses, and this way Lighting amounted to the frequency of 357, service Lighting encompassing villagers' whole wellbeing. Chapter 4.3 analyzes Safe and Healthy Lighting as the new service.

Similarly, during the interviews **b) Clean Water** was preferred a crucial, basic need, which directly influences on such other basics needs as Food, Health, Sanitation & Hygiene, Pumping, wells and dams, Irrigation, and Hydropower, thus Clean Water had the frequency of 251 preferences (Table 4.3). Furthermore, Clean Water involves in Education, Cooking, Security, Jobs, Agricultural Productivity, and Micro to medium-sized businesses, altogether Clean Water amounted to

533 preferences. In conclusion, Clean Water was considered a cornerstone for all developments of rural areas in developing countries and this service is analyzed in Chapter 4.4.

Table 4.3. Need Class: Clean Water, Saarinen, R. (2015a)

Need: Clean Water 533 Preferences								
Direct Need	Food	Water	Health	Sanitation& Hygiene	Pumping, wells, dams	Irrigation	Hydro	Total
Preferences	55	64	47	24	32	15	14	251
Indirect Need	Education	Cooking	Security	Jobs	Agricultural Productivity	Business		Total
Preferences	80	39	30	49	48	36		282

Like Clean Water and Safe and Healthy Lighting, **c) Nutritious Food** was acknowledged a vital basic need, which directly touches Water, Health, Cooking, Agricultural productivity, Livestock, and Stoves and amounted to 309 preferences (Table 4.4). Considering those indirect correlations with Education, Security, Jobs, Irrigation, Pumping, Compost, and Micro to medium-sized businesses, Nutritious Food summed up to 544 preferences. Chapter 4.5 discusses Agricultural Productivity, which significantly contributes to Nutritious Food.

Table 4.4. Need Class: Nutritious Food, Saarinen, R. (2015a)

Need: Nutritious Food 554 Preferences								
Direct Need	Food	Water	Health	Cooking	Agricultural Productivity	Livestock	Stoves	Total
Preferences	55	64	47	39	48	19	37	309
Indirect Need	Education	Security	Jobs	Irrigation	Pumping, wells	Compost	Business	Total
Preferences	80	30	49	15	32	3	36	245

Turning now to the self-esteem need, **d) Education**, which can leverage people to self-actualization level (Figure 2, Maslow's hierarchy of needs). This need was highly preferred and amounted to 80 preferences. Considering the integrated value of Education with the help of Figure 4.2, the system concept map shows the direct connections to Food, Water, Health, Light, Agricultural Productivity, Jobs, and Micro to medium-sized businesses, the whole frequency of preferences resulting in amount of 415 (Table 4.5). Indirectly Education correlates with Modern Lamps, Better Lighting, and Electricity/Energy amounting to 100 preferences, altogether 515 preferences. Chapter 5.1 analyses Education and school food, which is related to **d) Nutritious Food**. Finally, interviewees preferred 76 times to cooking, improved stoves and cookers, but when the whole phenomena was accounted as Water, Food, Health, Indoor Air, Agricultural Productivity, Forest & deforestation, the frequency of preferences amounted to 331, which figure indicates how large individual, community

and social problem area e) clean safe cooking is as was suggested in Chapter 2.1. Chapter 5.1 analyses clean safe cooking.

Table 4.5. Need Class: Education, Saarinen, R. (2015a)

Need: Education 515 Preferences									
Direct Need	Education	Food	Water	Health	Light	Agricultural Productivity	Jobs	Business	Total
Preferences	80	55	64	47	36	48	49	36	415
Indirect Need	Modern Lamps	Better Lighting	Electricity /Energy						Total
Preferences	19	28	53						100

By listening again the recorded interviews, I categorized data into Needs and every Need into individual, community, social, and obstacles groups (shown in Table 4.6). Needs are now placed in the needs-of-pyramid hierarchy (see Figures 2, 2.9, and 2.15), Food and Water at the bottom and banking and Micro to medium-sized businesses at the top. Noteworthy, the interviews revealed a real-life set of businesses and Job opportunities as well as mutual partnership models.

Table 4.6. Individual, Community, Social, and Obstacle Need groups, Saarinen, R. (2015a)

Need	Individual	Community	Social	Obstacle
Banking	Bank account, ID, credits, assets	Banks	Banking system, IDs, ownerships	Poverty, social structure
Micro to medium-sized businesses	Improved stoves production Hand-made products Making Cheese	under street light micro business, charging kiosk, selling ice, Improved stove production, hand-made products, making cheese, selling school-garden's vegetables	Women Bank, start-up funding	Poverty, Lack of education, Subsidized fuel, old traditions, ownership model
Mutual partnership	equality, humble mind, local	service charges, not free of charge, local knowledge	Infra	No ownership of systems, goods
Jobs	Getting work	Village Gardens, improved practices, irrigation, selling surplus to markets	local work for migrant workers	lack of education, unemployment marginalization
Agriculture	Improved practices, education	Improved practices, irrigation, education, school-garden	Improved practices, education, land reform	Poverty, Lack of education, investments, financing
Electricity	Light, cooling, equipment	Solar, hydro Village Electrification	National Electricity grid and utility	Poverty, lack of investments, financing, policies at state level
Light	Solar Light	Solar Light, street lights	Indoor Air program	Poverty, costs, Subsidized diesel, Funding, Financing
Equality	Inviolable worth of each human: Gender, race, disabled	Inviolable worth of each human: Gender, race, disabled	Inviolable worth of each human: Gender, race, disabled	No awareness of Human Rights, no education, prejudices, harmful old traditions
Education	Children Solar Light	Solar Light School Food	Enrollment, school food, removal school fares	Poverty, illnesses, costs, old traditions
Health	**Indoor Air, Solar Light**	**Indoor Air, Solar Light Solar cooling**	**Indoor Air program**	**Poverty, costs, lack of education, old traditions**
Water	Solar-based Pumping	Solar-system, 5-10 people in group, access to water near to you	Access to Clean Water, clean water programs	Poverty, lack of education, old traditions, Subsidized diesel, Gas turbine Funding, Financing
Food	**Improved stove Solar cooker**	**Improved stove**	**Improved stove programs**	**Poverty, lack of education, old traditions, Financing**

4.2 Assessment

The identified Customer Needs (Table 4.7) — Food, Water, Health, Education, Lighting, Jobs, and Agricultural Productivity —are the input to the service creation process (Figure 4.1) created in the licentiate thesis (Saarinen, R., 2015b). This TAMAA report describes how Needs, Requirements, and Services are mapped to each other, Table 4.7 helping to codify Needs, Requirements, and Services. The requirements to services are applied from the needs (this is named the requirement management phase in Figure 4.1), and some requirements are the same for several needs, such as the requirement “2H Decrease in Malnutrition in Health Need”, which is the requirement to Food Need and Health Need, 2H means the second requirement in Health Need. The service categories include those requirements which Service can meet, exemplified by Service Clean Water, which includes requirements “1W Clean Water for Drinking”’, “1F Clean Water for Food”, “3W Clean Water for Agriculture”, and “3E Clean School Water”. Similarly, Service Nutritious Food has the requirement ”1F Clean Water for Food”, and “3W Clean Water for Agriculture”.

Table 4.7. Need, Requirement, and Service categories, Saarinen, R., (2015b)

Need	Requirement(s)	Service
Food 	1. Clean Water for Food 2. Nutritious Food 3. Food Security 2H. Decrease in Malnutrition	Service Nutritious Food: 1F Clean Water for Food 3W Clean Water for Agriculture 1A Improvements in Crop Yields 2A Improvements in Versatile Crops 4A Increased Food Security 2F Nutritious Food 2H Decrease in Malnutrition
Water 	1. Clean Water for Drinking 2. Access to Clean Water 3. Clean Water for Agriculture	Service Clean Water: 1W Clean Water for Drinking 1F Clean Water for Food 3W Clean Water for Agriculture 3E Clean School Water
Health 	1. Decrease in Water related Diseases 2. Decrease in Malnutrition 3. Healthy Indoor Air	1H Service Clean Water 2H Service Nutritious Food 3H Service Safe and Healthy Lighting
Education 	1. Healthy Pupils 2. Nutritious School Food 3. Clean School Water 4. Healthy Teachers	1H Service Clean Water 2H Service Nutritious Food 3H Service Safe and Healthy Lighting => 1E, 2E, 3E, 4E
Lighting  	1. Safe and Healthy Lighting 2. Healthy Indoor Air, same as 3H, 3J 3. Provides Security 4. Enables Learning and Education 5. Healthy Pupils, same as 1E 6. Healthy Teachers, same as 4E 7. Enables Jobs 8 Healthy Workers, same as 4J 9. Enables Micro to medium-sized businesses	Service Safe and Healthy Lighting: 1L Safe and Healthy Lighting 2L Healthy Indoor Air, same as 3H, 3J 3L Provides Security 4L Enables Learning and Education 5L Healthy Pupils, same as 1E 6L Healthy Teachers, same as 4E 7L Enables Jobs 8L Healthy Workers, same as 4J 9L Enables Micro to medium-sized businesses
Jobs 	1. Income 2. Livelihood 3. Healthy Indoor Air 4. Healthy Workers 5. Enables Food, Water, Health, Education, Banking	1H Service Clean Water 2H Service Nutritious Clean Food 3H Service Safe Healthy Lighting => 3J, 4J, 5J
Agricultural Productivity 	1. Improvements in Crop Yields 2. Improvements in Versatile Crops 3. Increased Water amount to Agriculture 4. Increased Food Security 5. Responses to High Food Prices 6. Access to Arable Land	Service: Drip Irrigation to Food Markets 1A Improvements in Crop Yields 2A Improvements in Versatile Crops 3A Increased Water amount to Agriculture 4A Increased Food Security 2F Nutritious Food 5A Responses to High Food Prices 2H Decrease in Malnutrition 1J Enables Income 2J Enables Livelihood 5J Enables Heath, Education, Banking

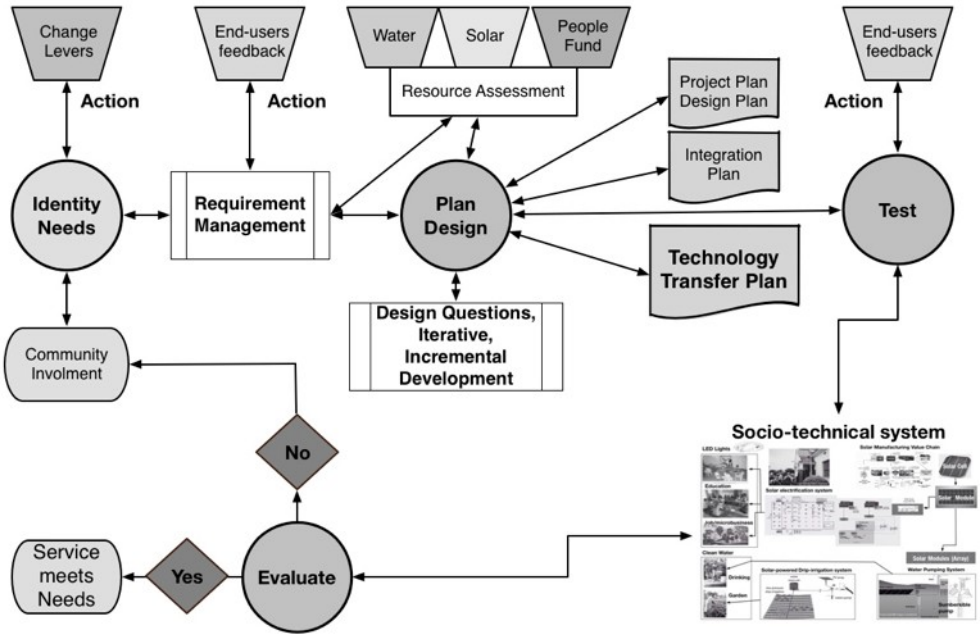


Figure 4.1. Service Creation Process: Service creation starts by identifying needs with the community and other actors (Table 4.7 and Chapter 2). The requirement management defines requirements with related needs for services and takes account of users' feedback, this is an iterative process. The design and development of services create required services, which meet requirements (Table 4.7). The evaluation assesses whether the created service matches with the needs, and if not the modification will start again and a new round of the creation. Saarinen, R., (2015b).

The assessment process in TAMAA Case (Chapter 3.3.) matched Needs (as Food, Water, Health, Education, Lighting, Agricultural Productivity, Jobs, and Micro to medium-sized businesses), with Resources (Solar, ground Water) and with Technologies (as PV Panels, submersible multi-voltage pumps, LED-lamps) to Energy Services (as Solar-powered Drip Irrigation, Solar-powered Pumping, and Solar-powered Illumination). Matching means that with these Resources, Technologies and Energy Services, it is possible to meet the Needs. The concept map of the socio-technical system (Kane & Trochim, 2007, 2009; Whyte 1991) is illustrated in Figure 4.2, which is built of:

- Solar-powered Drip Irrigation includes Solar-powered Pumping for Clean Water
- Solar-powered Pumping includes submersible pumps and PV panels
- PV panels use Solar Resources
- Submersible pumps use Ground Water Resources
- Need Agricultural Productivity includes Need Education and Energy Service: Solar-powered Drip Irrigation
- Need Education includes Needs: Water, Food, Health, and Lighting
- Need Health includes Needs: Water, Food, and Lighting
- Need Food includes Agricultural Productivity and Clean Water
- Need Water includes Energy Service: Clean Water with Solar-powered Pumping

- Need Lighting includes Energy Service: Lighting with Solar-powered Illumination and LED-lamps
- Need Jobs includes Needs: Education, Health, and Lighting
- Need Micro to medium-sized businesses includes Needs: Agricultural Productivity, Education, Jobs, and Lighting

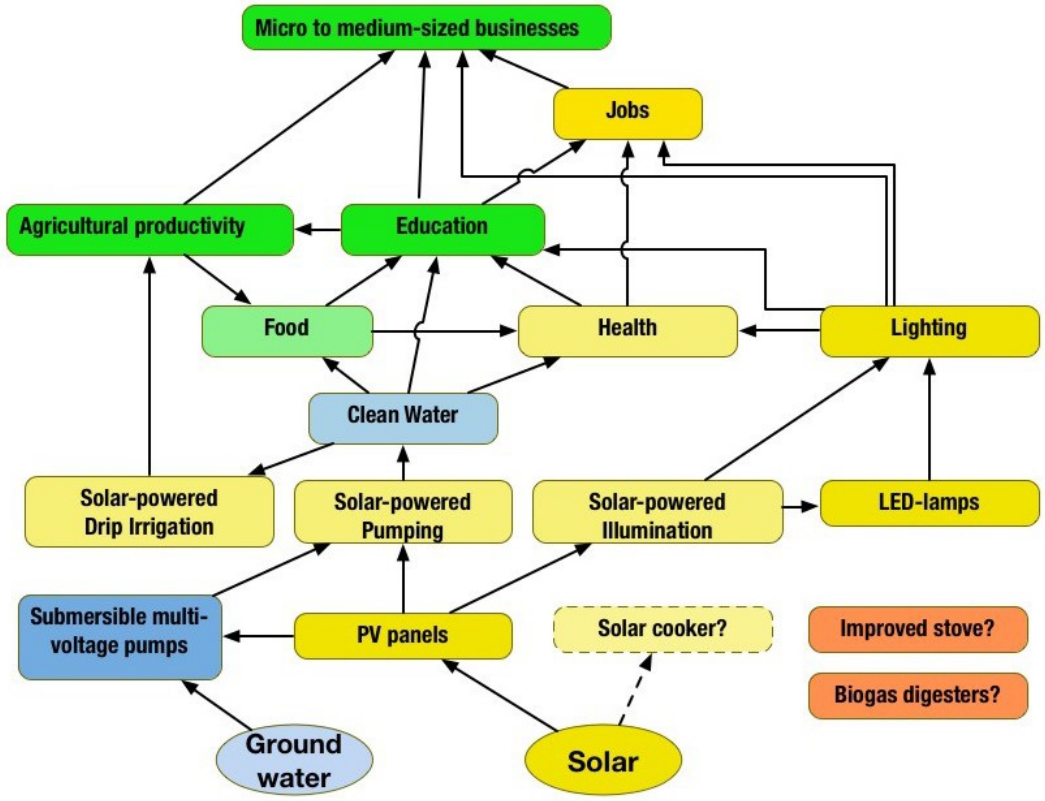


Figure 4.2. System concept map: Needs Food, Water, Health, Education, Lighting, Agricultural Productivity, Jobs, and Micro to medium-sized businesses with new Energy Services. Energy services: Solar-powered Pumping, Solar-powered Drip Irrigation, and Solar-powered Illumination with technologies. Technologies: submersible multi-voltage pumps, PV Panels, LED-lamps, and with resources: Solar and Water. Saarinen, R., (2015a).

4.3 Safe and Healthy Lighting Service

Seppo Vehko, one interviewee told: 'Energy services decrease deceases, Lighting is needed for children to do their homework, enough electricity lighting, better health and healthy eyes' (the story 11 in Appendix IE in TAMAA Interviews). The other one, George Pindua put it: 'If you want to have a very good performance, students need an extra time to review what they have studied at school, and it is possible to improve the performance of the students with Lighting' (Appendix IA in TAMAA Interviews). Solar- based Lighting is tightly integrated into Health, reducing the serious indoor air problems due to the use of traditional kerosene lamps, which are common in rural areas. Lighting makes Education, Jobs, and Micro to medium-sized businesses possible in the evening. The new Need Class of Lighting, which comprises the Needs — Lighting, Health, Security, Education, Jobs, and Micro to medium-sized

businesses — was described and this Lighting meets the related requirements as expressed in Table 4.8 (driven from Tables 4.2 and 4.7, and Figure 4.2). The definition of Class is 'a group of people, animals, or other things that can be considered or studies together because they are similar in some way' (Longman 1995; Appendix 2 in the licentiate thesis, Saarinen, R., 2015b).

Table 4.8. Need Class of Lighting, Saarinen, R., (2015a), Photos (Photo Ref.)

Need Class of Lighting	
Comprised Needs	**with Requirements**
Lighting **Health** **Security** **Education** **Jobs** **Micro to medium-sized businesses** 	Safe and Healthy Lighting Service: 1L Safe and Healthy Lighting 2L Healthy Indoor Air, same as 3H, 3J 3L Provides Security 4L Enables Learning and Education 5L Healthy Pupils, same as 1E 6L Healthy Teachers, same as 4E 7L Enables Jobs 8L Healthy Workers, same as 4J 9L Enables Micro to medium-sized businesses

The Service creation process starts with the phase "Identify Needs". Thus, this TAMAA Case reviewed General Basic Customer Needs (Chapter 2.1) and placed the results in Maslow's hierarchy of needs (Figure 2 in Executive Summary). For acquiring deeper understanding of needs, TAMAA Case conducted the in-depth interview study to inquire the needs of African villagers and their communities (Tables 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, and 4.8) and created this TAMAA report. The interview answers pointed out the importance of Lighting as a basic need "Light to People"; moreover Bhusal (2009) has researched solar-powered LED lighting in rural Nepalese villages and Tähkämö (2013) life cycle assessment of light sources. Bhusal reports (Figure 3.2, Nepal Light Case): 'The primary function of any home lighting system is to provide a safe visual environment for movement around the space, to make it possible to perform visual tasks, and to provide a comfortable and pleasant visual environment. On the other hand, the lighting system has to be cost-effective, efficient, non-polluting, and easy to clean and maintain'. As Seppo Vehko crystallized: 'Materials are needed in education, obligatory school-dress is an obstacle to a poor as well as school-fees, and

in urban area also school-trip might be long, doing homework difficult in very grounded homes and bad lighting, electricity light is needed' (the story 11). These TAMAA Case results can be modified to local needs as George Pindua replied in his feedback to the TAMAA Case report (Appendices IA and IF in TAMAA Interviews) (see Technology adaptation and learning new practices in Chapter 5.4).

The next phase, in the service creation process, was to analyze resources, and there are abundant solar resources in Africa (Appendix O in TAMAA Appendices), but the assessment of local conditions will confirm the status of the village or city. As Majok Kariom stated about Lighting: 'Today, in my country children sit under a tree, you put them in cold and in hot, they are in some places totally in the dark, but if you give them a place to sit and you manage to offer this energy, we have already invested in the next generation. If you provide this energy system, this will improve 100% the quality of education, and you see them manage to increase their knowledge and capacity, so our future is really in hands of education.' (the story 12 in Appendix IE).

The next phase, technology assessment and planning technology transfer (Chapters 3.3, 5.4, and Figure 4.1), follows in the assessment process, the interviewees emphasizing such issues as a) the applied technology should match with the local practical needs, b) education, training, public education and guidance, and knowledge transfer at all levels, c) applying best practices, visiting the places where successfully implemented, learning by doing, and villagers should be involved, d) the system integration and gradual development, with statements like "integrated into together", "all should go hand-in-hand", "small-scale step-by-step", e) the maintenance and operations of the installed systems, f) batteries and other spare parts, and g) finally summarizing by Paulo Pinho, one interviewee: 'perhaps not providing solutions but by sensitively discussing how local people can utilize new technologies, from the point of view their own culture and traditions, how co-operate, how to use these technologies, they have to find their own ways to use and deploy new technologies.' (TAMAA Interviews, the story 10 in Appendix IE).

The technology assessment for Lighting Service was not the focus of this TAMAA Case, but the licentiate thesis (Saarinen R., 2015b) created and analyzed the layered model of the community solar-powered system. Based on the thesis, the technology itself can be considered stable, as Brita Jern told her experiences: 'New energy services are splendid solutions for Africa, especially solar energy. Usually there is plenty of sun in the rural Africa, beside that solar energy is nowadays highly developed and the need for maintenance is almost nil. As far as I know, solar energy services are functioning for decades. At least for the basic need for water, the solar is an excellent solution.' (Appendix IA in TAMAA Interviews). The concept of Safe and Healthy Lighting is illuminated in Figure 4.3, which shows how Lighting, Health, Security, Education, Jobs, and Micro to medium-sized businesses are related to the solar-powered system and customer needs.

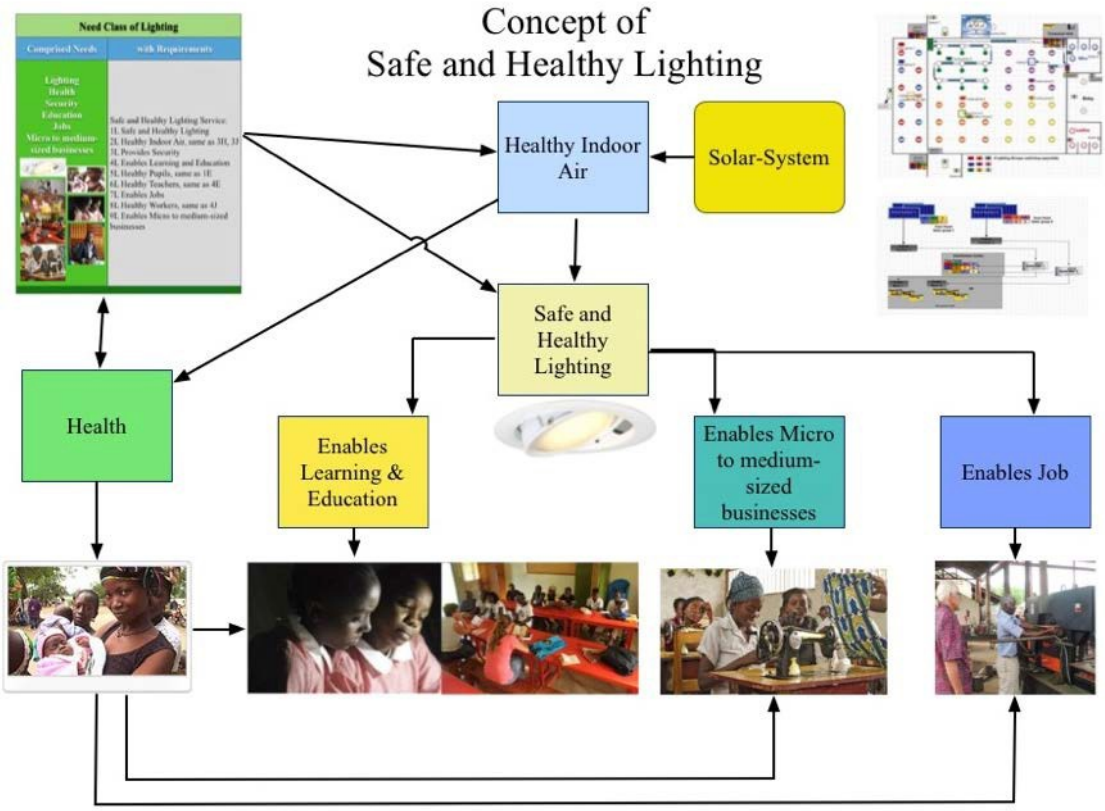


Figure 4.3. Concept of Safe and Healthy Lighting: Lighting, Health, Security, Education, Jobs, and Micro to medium-sized businesses, based on the solar-powered system, Saarinen, R., (2015a). Photos (Photo Ref.)

4.4 Clean Water Service

Clean Water was preferred a crucial basic need influencing on other basics needs as Table 4.3 and Figure 4.2 emphasize: Food, Health, Education, Agricultural Productivity, Lighting and Jobs are all related to Water either directly or through Health. Similarly, George Pindua (Appendix IA) crystallized: 'In villages, people use water from rivers which are not clean for human use. This may cause some diseases like diarrhea, typhoid and others associated with unclean water' (see Chapter 2.1.3). Clean water was preferred a cornerstone for all developments of rural areas in developing countries, as Jyrki Myllärniemi, one interviewee expressed: 'Clean Water covers security and future hope, healthcare related to clean water, and how to solve the drawbacks of the traditions in everyday practices like sanitation-needs in a river, so how to purify water and how to get clean water, how to get wells, toilets, compost-toilets, all these related to energy production, small-scale energy system' (the story 1 in Appendix IE). Clean Water was first assessed in SMILE Case (SMILE Base Case, Water: at the end of this TAMAA Case report), and this TAMAA Case modified Water further with the experiences of the ABC Water case and NAPS Solar Systems Inc. (SLEF ABC Water, 2012; NAPS Water, 2015) and applied Clean Water Service working without wind-turbines as shown in Figure 4.4; Solar-powered submersible pumps shown in Figure 4.5.

The real-life case, ABC Water project in Abongo Dhoga Community in Kenya, serves 1000 villagers at the total cost of 27 448,05 € by pumping clean water 200

l/min or 12 m³/hour, at the costs of 27,45€ per person, and provides affluent amount of good quality water. The ABC Water project was initiated by SLEF (SLEF ABC Water, 2012; Appendix IB in TAMAA Interviews) and it was taken over as a development co-operation project in Ministry for Foreign Affairs of Finland. Lake Diocese in Evangelical Lutheran Church in Kenya was a partner church and local Atemo Bible College.

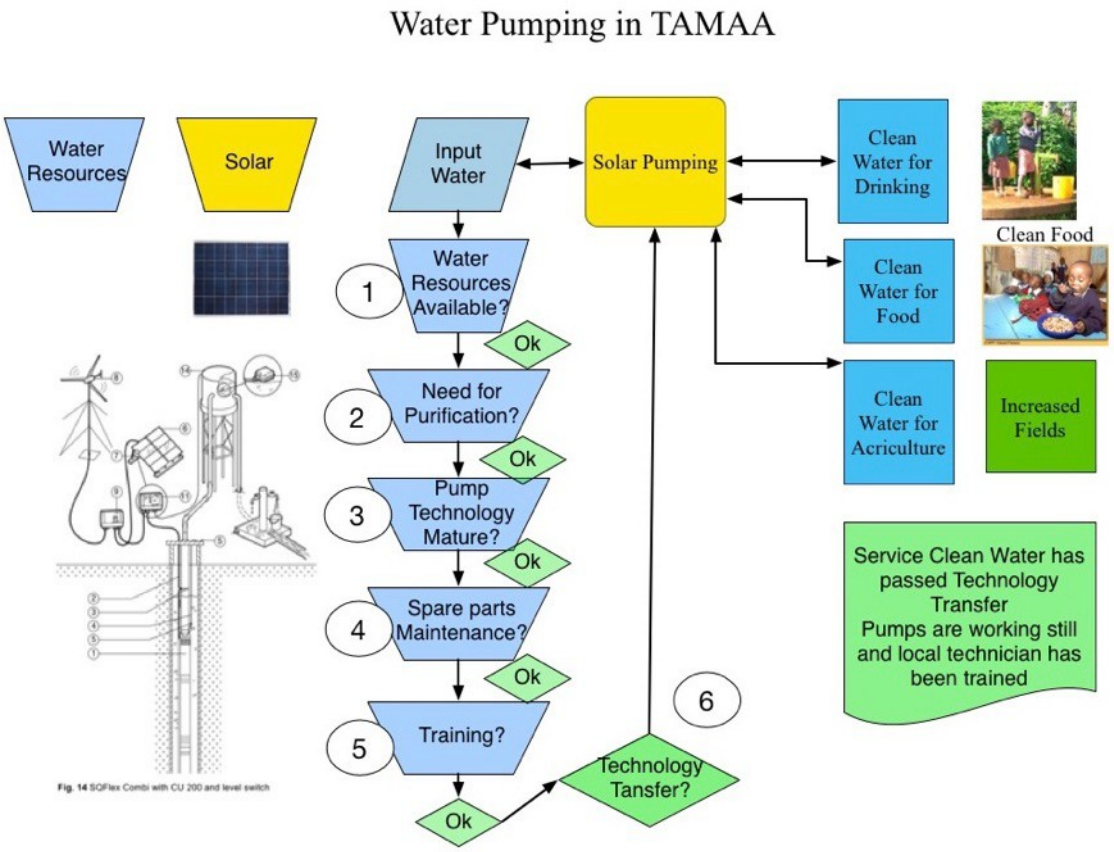


Figure 4.4. Flowchart for Water Pumping by solar power, Saarinen, R., (2015a). Photos (Photo Ref.)

Helene Taal (the story 14) told experiences of Senegalese water wells projects: ”bore wells and maintaining them, hygiene education, separating human and animal water places...unclear water for humans due to the old habits to use the same water places for humans, laundries, and animals, and animals are staying in this water place, and this causes a lot of deceases, everything begins from these foundations” (see Chapter 2.1.3). As Solveig Nylund, summarized (the Story 4 in Appendix IE):

"Clean water has enormous meaning for people in developing countries, it is the base for everything, but it takes much time to get water from long distances (see Appendix D), so you need to get a small-scale pumping system so that you have access to clean water near to you. For pumping water from groundwater wells solar-energy is absolutely great. Solar panels are relative expensive for poor people, therefore this is an obstacle to them to use sol-energy; this is valid for all energy you

need to get. For nutritious food, you need irrigation and access to a watering system, pumping water, and transfer water in some way. The latest ABC Water projects are not designed only for clean water but also for gardening. After rainfalls there exists water but afterwards come draughts, so then you need irrigation in some how, and wells are first for drinking then for irrigation, meaning that pumping should operate in a low-energy way (see Chapter 4.5) and saving water for irrigation, pumping water with solar-energy for gardening. Water near to you so that you have time for other activities and not just for survival and trying to get water and food fuel from long distances. Clean water without the need to cook it first. Clean water pumping provides small-business possibilities as well, solar-based watering, gardening, and you can sell surplus for markets, getting incomes, meaning livelihood, ideal condition for rural people. Clean water is the basic need for healthy people, sanitation, and better hygiene."

Paulo Pinho commented on water purification: ‘My research topic (Paulo Pinho, 2008) is related to use of LEDs, which may be applied in water purification systems, …a sustainable future, good water resources are needed, and they are not so equally distributed globally, in Africa water quality is an issue, how they can purify contaminated water, energy for this kind of purification is needed’ (the story 10).

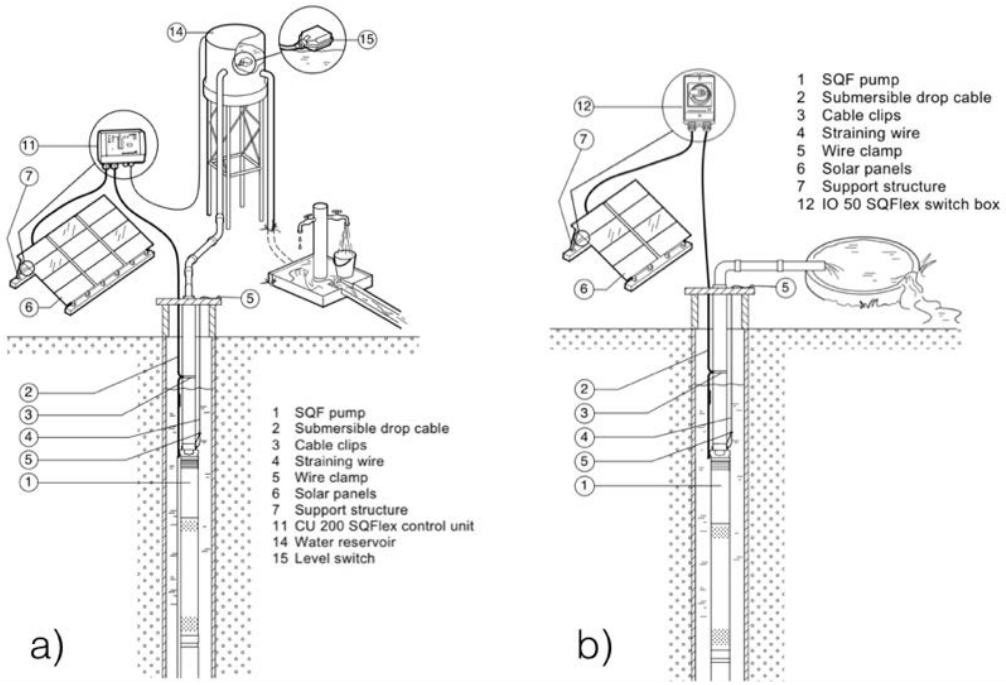


Figure 4.5. Submersible pumps powered by solar panels a) allows solar energy to be stored as water in a reservoir (14) at a higher elevation, b) the simplest pump system with a storage tank at ground level, Grundfos portal, (2014).

4.5 Service, Drip Irrigation to Food Markets

To start with Pramod Bhusal: ‘…if they own land, they can cultivate their own food like vegetables whatever and go to markets. It can be pretty complicated to consider all these things as fertilizers, cows, composts, and insects’ (the story 3 Appendix IE). Jyrki Myllärniemi told the story from the Zimbabwean village (the story 1)

, where a dam and garden system provided for the whole village work and income. As a result, villagers were no more forced to go as migrant workers to capital city or other countries. They learned through this dam project to organize and manage projects, budgets, funds and how to keep meetings, as well as the meaning of networking and they started many new projects. Furthermore, they understood their rights and ownership issues. Through banking system, they placed their income on bank accounts and gave to those who had no money for their children's school.

This Zimbabwean story is related to the SMILE case (in Figure 3.1), which case demonstrated how women-groups started to cultivate their vegetables garden plots since 2007 in Benin (Case A1, Burney et al., 2009). The gardens were drip-irrigated by solar-powered submersible pumps, each system jointly used by 30-35 women in an agricultural group. As a result, food security increased significantly. During the first year farming, women kept 18% of vegetables production to their households and sold the rest to local markets (NDF, 2014). In summary, Figures 4.6 and 4.7 demonstrate the solar-powered drip irrigation for gardening.

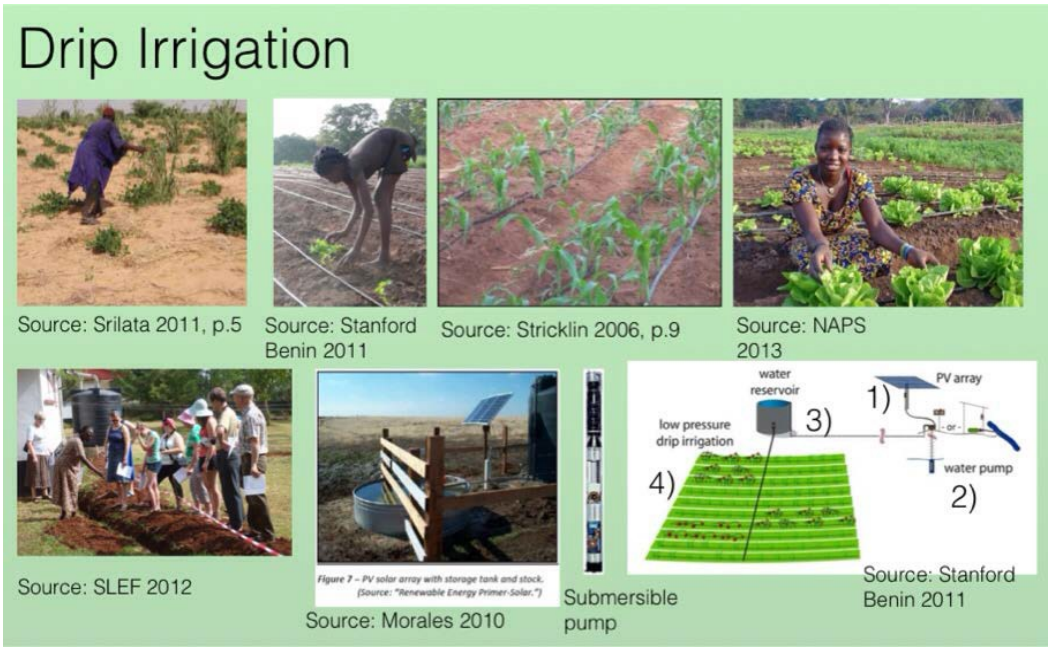


Figure 4.6. Principle schema of solar-powered drip irrigation, Saarinen, R., (2015a)

Regarding drip irrigation, Irja Aro-Heinilä, shared her experience: 'In Tanzania soil is fertile and good for cultivation, once you will get water. I have now understood that the bore well in Kimbilio can make it possible to get FOUR yields per year. One priest, who has studied at Morogoro university administration, business, and agriculture, showed his own field. Then, there I realized what opportunities Kimbilio will now have, when there exists enough water with the bore well. When training and education are possible for gardening, marketing, and drip irrigation, you can reap a good yield several times a year' (Appendix IA Irja, TAMAA Interviews).

The other successful case evaluated and assessed was the Ilunda Water project in Tanzania (Base case in Figure 3.1, SMILE Base Case, Water at the end of this TAMAA Case Report). In Gunga school premises, the hybrid system utilizes the drip irrigation for the school garden, and the solar-wind hybrid pumping for clean water for drinking and food preparations. The system has submersible pumps able to pump large amount of water for 24 hours per 7 days per week, the solar panels are located on the roof of the well house, and the chlorination system makes its own chlorine and injects the correct amount directly into the flow line from the pump. Similarly, Paula Tommila, one interviewee in TAMAA Case, referred to the projects where school food improved not only nutrition intake but enrollment of education as well (the story 6 Appendix IE, TAMAA Interviews). Brita Jern preferred Nutritious Food as well: “Health as a school subject would be the first thing to develop. From childhood they need to know that fruits are useful, and they need to know the importance of a balanced diet.” (Appendix IA Brita).

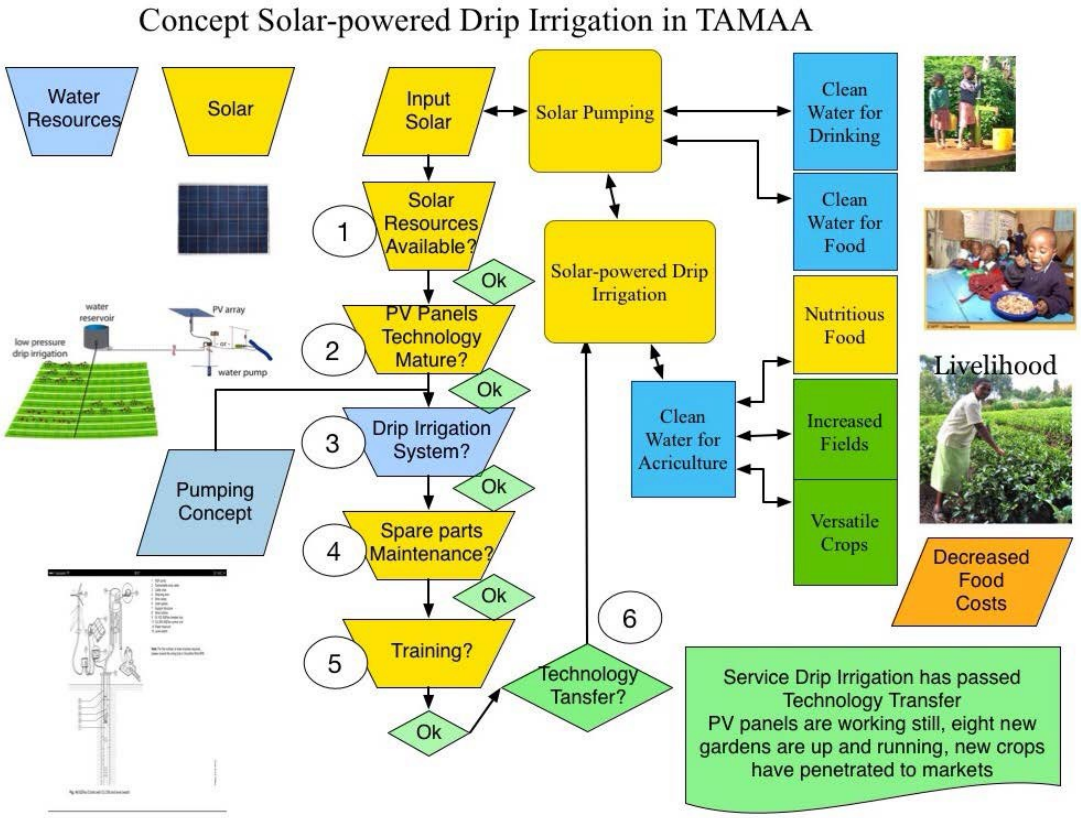


Figure 4.7. Solar-powered Drip Irrigation with Water Pumping, Saarinen, R., (2015a). Photos (Photo Ref.)

Drip irrigation in arid and semi-arid regions (Appendix M) reduces water use, because it delivers water and fertilizers directly to the roots of plants, thereby improving soil moisture conditions; in some studies, this has resulted in yield gains of up to 100%, water savings of up to 40 – 80% (Burney et al., 2009; Silungwe et al., 2010). The savings, compared with traditional irrigations, have been estimated to be 30 – 70% by Narayanamoorthy (2009), or 40 – 80% by Sivanappan (1994), over 50% by Maisiri (2005), even up to 90% by Tanji (2002). Drip irrigation is also suitable for lands of all

kinds, and improvements in yields co-operate with better utilization of fertilizers. Furthermore , irrigation leads to local cooling effect (IPCC, 2013), thus irrigation with renewables like solar decreases CO_2 emissions, cools locally, and increases plants (photosynthesis, land cover change, mitigates desertification) (Chapter 2.1.6; FAO, 2011; IPCC, 2013).

This Service “Drip Irrigation to Food Markets” (Figures 4.6 and 4.7) mitigates the consequences of high food prices, which cause malnutrition and food crises especially to those who are food net importers and spend 70-80% of their daily income on food. On the other hand, increased prices provide better incomes for those farmers who can sell their products to food markets (Figure 2.6). (Burney et al., 2013; Burney et al., 2009; FAO, 2011; Mukherji & Facon, 2009; Prato & Longo, 2012; SIDA, 2008; Stricklin, 2006; World Bank, 2012; 2013). Studies revealed (Chapter 2.2) that the food market (food and beverages) represents the largest BOP market potential and the largest share of household expenditures, and regarding Africa this is a vital market opportunity (the future estimates of USD 1 000 billion opportunity in 2030). As Seppo Vehko summarized: ‘Agriculture is very dependent on rains, and with irrigation you balance water needs, there are irrigation projects, and water for drinking bore-well projects**,** soil is very fertile (in Ethiopia)’ (the story 11 in Appendix IE in TAMAA Interviews).

Mika Vehnämäki put it clearly: ‘Most African farmers are women, especially as small-farmers, they are quite much responsible for what is cultivated and with which kind of practices, where to get seeds, how the farm is productive, where the production goes, to family or to markets, the role of women is very important. Of course water is related to food production, and how you irrigate, how much water goes lost, irrigation systems of different kinds starting from drip irrigation, which saves water compared to open dams.’ (the story 13).

4.6 Summary of services

This TAMAA Case evaluated how Needs, Resources, and Technologies matched with the energy services as illuminated in Figure 4 (in Executive Summary). These services are based on solar technology, thus they integrate Needs, Energy Services, and Technology to a socio-technical system with the rich ontology (Figure 4.2), which system is investigated in the licentiate thesis (Saarinen, R., 2015b). Tomi Järvinen concluded: “due to the combustion of traditional solid fuel (wood and charcoal) and its consequences (see Chapters 2.1.4, 2.1.6, and 2.1.7), a massive middle class growth in Africa will lead to energy crisis if not sustainably developed ”(the story 8).

5 Sustainable Flourishing Village Community

5.1 Education, Nutritious Food and Clean Cooking

Continuing Water and Agricultural Productivity themes, Mika Vehnämäki introduced: 'The primary target for Agriculture development and improvement is Food Security, how people can gratify their Human Rights, their rights to sufficient Food. Water, people have rights to Water, so with diverse co-operation programs we support this right to clean water. Right to access to energy will be fulfilled, energy availability to families, communities. In energy sector renewable energy sources are considered. These are very much integrated each other though Water availability or Agricultural improvements to Food security, but these are also related each other and they use energy.' (the story 13 in Appendix IE).

Pasi Aaltonen discussed largely a school-concept, with a school garden, kitchen and food, where the parents and their children can together cultivate vegetables and other horticulture products and get livelihood possibilities by selling surplus products to local markets. Further, this concept might integrate a better stove for clean cooking in the school-kitchen (the story 9). Paulo Pinho suggested (the story 10): 'There are greenhouses powered by solar for producing food in deserts, with artificial light we can increase nutritious of cultivated food. Can greenhouses be used in villages and with LED-lights to improve the quality of food? Produce food in a clean way locally and sell?'

By continuing the theme, nutritious school food, Paula Tommila told about the experiences in Ethiopia. She explained how nutritious school food helps learning and school attendance, because parents will send their children easier to school, if children can get food there, exemplified the UN WFP program (UN WFP portal), which provided soy-maize porridge for school children. This interviewee alluded to the notion of clean cooking: 'As an old habit school-children collected wood fuel for cooking in week-ends and brought to their school on Mondays and fuel wood lasted until Wednesday or Thursday when cooking with traditional stoves. By providing improved stoves fuel wood lasted all school days. A simple stove system will cost not much to the school, but with this investment you can get many new children to school. Effective stoves are needed and practical knowledge and training how to use them, otherwise you just leave the stove unused. The stove must fit in the local use where you need it.' (the story 6).

Turning now to a solar-powered cooking, Brita Jern told: 'The best thing would be to try to teach people to use solar cookers. The system is already there, but very few are using them. I think, it might be because people are quite suspicious towards new things. Another obstacle in rural areas is that people are not used to technical issues and they do not know how to maintain things, or even the importance of maintenance. A lot of even simple devices are not in use, because they have broken down. So using a simple solar cooker is a question of change in paradigms, which is not easily done.' (Appendix IA Brita in TAMAA Interviews). Solar-powered water heaters on the roofs are simple and useful (Seppo Vehko, the story 11), simple solar cookers are in use for cooking and water pasteurization, and various studies have been conducted with both

parabolic and box-type solar cookers (e.g. Badran et al., 2010; Folaranmi, 2010; Okafor, 2013; Sapkota et al., 2011).

Bringing up one interesting study (Suple et al., 2013), an indoor parabolic concentrating solar cooker, which you can operate from the kitchen. The solar cooking system was designed, fabricated and tested for its thermal performance and cooking abilities. The one design target was that the solar cooker is easy and comfortable to use, the other target that solar cooking is similar to conventional cooking. The tested cooker was able to cook various meals as rice (the cooking time 15 min), various types of dal's, khichdi, tea, and coffee. The results showed that water heating and food cooking in the parabolic solar cooker are faster compared with the box type solar cooker. Similarly, in this TAMAA study, the interviewees suggested the improved stove, which should be very simple to use at home (stories 6, and 9).

However, clean cooking is still a problem (Chapter 2.1.4), new solar cookers are not yet widely used in developing countries, nor are improved stoves or biogas digesters even though massively investigated and promoted (Bajgan & Shakya, 2005; Hervie, 2008; Misana & Karlson, 2000; Saarinen R., 2010; Slaski & Thurber, 2009; UNDP, 2013; Xiliang & Smith, 2005; Wang, 2009). As Solveig Nylund emphasized: 'In developing countries you use fuel wood or coal/charcoal for cooking. Coal/charcoal is the worst option for cooking or heating, due to indoor air problems, so coal is the waste of energy in a way. You can utilize solar-power, but it costs to obtain/get/utilize solar energy and solar PV panels, the problem is how to plan the project to utilize this solar-energy. People nowadays use those traditional ways, such as fuel food and coal, and these cause environmental effects like deforestation and they need an afforestation plan. If you want to improve people's health, you need a better solution so that people are not forced to sit in that smoke' (the story 4).

As discussed in Chapter 2.1.6, deforestation is a serious and increasing problem in Sub-Saharan Africa, and Pasi Aaltonen put it clearly: 'In Kongo deforestation is a fact, due to use of fuel wood in inefficient traditional stoves. Because there is not enough money for individuals to buy even enough food and other basic things, poor people are not interested in environmental issues and effectiveness (quality) of stoves. These stoves should be clearly cheaper in use than coal/charcoal stoves and easily available to acquire and for a mother to take in use, and even better if you can see that your neighbor is using a new stove and it is working. Africans are, at least in construction work, very conservative and do not begin to try new things, and improving practices is not common even though the old ones are not working properly. The change should be small and there should be significant benefits compared with old stoves. Even tough you have modern lights you still cook using traditional stoves' (the story 9).

Equal access to sustainable energy services is a human right (Chapters 2.1.6 and 2.1.7), and regarding clean cooking the empowerment of women is crucial (Carr & Hartl, 2010; Clough, 2012; Sheikh, 2014; World Bank Cook, 2011). Women are the users of new cooking devices and they with their children suffer from the health consequences of the indoor smoke (Chapter 2.1.4) as well as bear the burden

spending even hours per day to fetch fuel wood. Summarized with the words of Jyrki Myllärniemi: 'In India, one women in rural area told her story, she felt like being a prisoner at home, and she was only able to see her husband and children, her husband controlling her life. The energy project, where women constructed improved stoves, provided this woman a better life. In this energy project women were able to interact with each other and build up operative groups. With these improved stoves, which they by themselves designed and produced, they solved the practical problem and saved a lot of time due to more effective stoves. This stove project met women's human rights and basic rights for education, right to be treated in a human way, starting from practical things (the story 1)'.

5.2 Village Community

The face-to-face interviews revealed the most weighted needs of villagers, which were Clean Water, Nutritious Food, Lifelong Health, Education at all levels, Safe and Healthy Lighting and opportunities for villagers' earnings. Figure 5.1 demonstrates how to design flourishing learning Village Community from the building blocks, which are Safe and Healthy Lighting, Clean Water, Drip Irrigation to Food Markets and the socio-technical solar system. This interview study created the new Need Class of TAMAA, which comprises the Needs – Clean Water, Nutritious Food, Agricultural Productivity, Lighting, Health, Security, Education, Jobs, and Micro to medium-sized businesses – and which meets the related requirements as expressed in Table 5.1, (compare with Need Class of Lighting in Table 4.8 in Chapter 4.3).

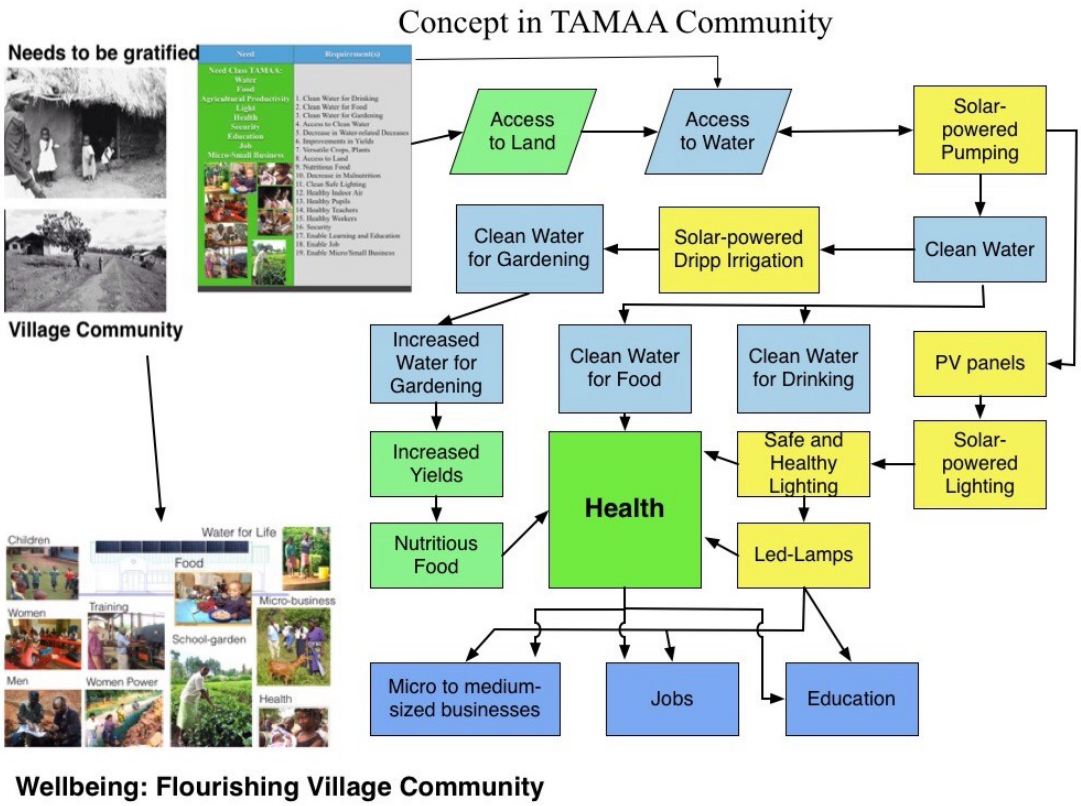
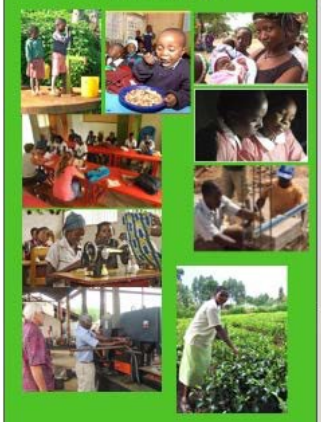


Figure 5.1 Flourishing learning Village Community, Saarinen, R., 2015a. Photos (Photo Ref.)

Table 5.1. Need Class of TAMAA, Saarinen, R., 2015a. Photos (Photo Ref.)

Need Class of TAMAA	
Comprised Needs	**Requirement(s)**
Water Food Agricultural Productivity Lighting Health Security Education Jobs Micro to medium-sized businesses 	1. Clean Water for Drinking 2. Clean Water for Food 3. Clean Water for Gardening 4. Access to Clean Water 5. Decrease in Water-related Deceases 6. Improvements in Yields 7. Versatile Crops, Plants 8. Access to Land 9. Nutritious Food 10. Decrease in Malnutrition 11. Safe and Healthy Lighting 12. Healthy Indoor Air 13. Healthy Pupils 14. Healthy Teachers 15. Healthy Workers 16. Security 17. Enables Learning and Education 18. Enables Jobs 19. Enables Micro to medium-sized businesses

Flourishing learning Village Community includes such elements as a school building/village house with solar panels, children at school and in kindergarten, women and men learning and training, women power in use for building a school or village house, cultivating in gardens for nutritious school food and selling a surplus to local markets, owning goats for micro-business, clean water and nutritious food for children and their mothers. The whole village can gather around the village house/school and learn to unlock their inner power and lift them to the highest level of Human Needs as shown in Figure 2. As Majok Kariom shared his experiences: 'Village Community based solar-energy system: a very good idea. Sometimes companies suffer a lot because they do not understand the culture in Africa. In our country, things are made based on a community, it is what a community thinks about not what I think about. If you see a guest is coming, the community welcomes the quest, who is not only his or her quest but the quest of whole community, our quest. If you think about your solar project, you need the whole community, this is a community-based service, you don't need to go to talk with everyone. Instead, you come to see a community leader and this community leader has a community group of people and you sit down and talk with this group and they talk with their people and then this solar system goes to every single house. When you go through community it is much easier in that way, I encourage this way especially in villages, in rural areas, which are based on communities. When you want to open a shop, you go to the community leader." (the story 12).

To sum-up, Mika Vehnämäki stated: ‘There are also Finnish operators, who would like to export these kind of mini-grid energy systems to developing countries, e.g., to Africa. Nowadays it is possible that a village of 100-200 persons can acquire a solar system and someone come and installs it. And, e.g., World Bank and other donors will invest these kind of systems and build them ready.’ (the story 13).

Figure 5.2. Village Community, the heart of empowering villagers, Saarinen, R., 2015a. Photos (Photo Ref.)

Creating a learning organization for making change happen in the context where customers, partners, and other stakeholders are located separately and where learning is encouraged by doing, is a challenge whenever we are talking about teams which have members without networking possibilities through Internet. This interview study TAMAA emphasized the dialectic view, the true collaboration within members in programs creating energy services to meet basic needs. One starting point could be the village house, where a communication center named 'Visual Meeting Place' (Figure 5.3) provides a collaboration portal for villagers to be a part of shared knowledge and flourishing village community. Education levels provide knowledge of versatile education opportunities and materials, which also villagers can upload to the portal. Similarly, members of this portal can get knowledge of technologies (here solar systems), gardening and agriculture, business opportunities, new practices, and collaboration of universities and institutes. Within flourishing learning community villagers can develop capabilities to achieve their full potential, be self-actualized, be full members of their community, they can even empower others (Figure 2 in Executive

Summary). (Berthold, 2012; Järvinen, 2007; Lehtonen, 2014; Novick et al., 2002). Although this is an illuminated opportunity (discussed in the licentiate thesis), the first step might be like Figure 5.4, which emphasizes the communication within villagers and collaboration between actors outside this village.

Figure 5.3. Visual Village Meeting Place, the heart of empowering villagers, Saarinen, R., 2015a. Photos (Photo Ref.)

Figure 5.4. Visual Village Meeting Place, a communication center, Saarinen, R., 2015a; Photo: Irja Aro-Heinilä, the drawing of the solar system NAPS

Now, this description of the socio-technical system follows the licentiate thesis (Saarinen, R., 2015b) and represents: The heart of this socio-technical system is the solar PV-LED system, and depending on whether the electricity needs are required for

a village-school, workshops, homes, a healthcare place or another community building, the solar system is scalable on demand (Figure 5.5). This system is based on photonics devices, which are light-emitted diodes (LEDs) and solar cells, and where the basic particle light is the photon. Light-emitted diodes (LEDs) convert electrical energy to optical energy while solar cells convert optical energy into electrical energy. The hard-core components are LED lights (lamps), photovoltaic panels (PVs) and submersible pumps. Solar-powered pumping provides services for clean drinking water and gardens with solar-powered drip irrigation. Solar electrification provides services for lighting, phones, computers, TVs, other communication devices, and refrigerators in schools and other buildings.

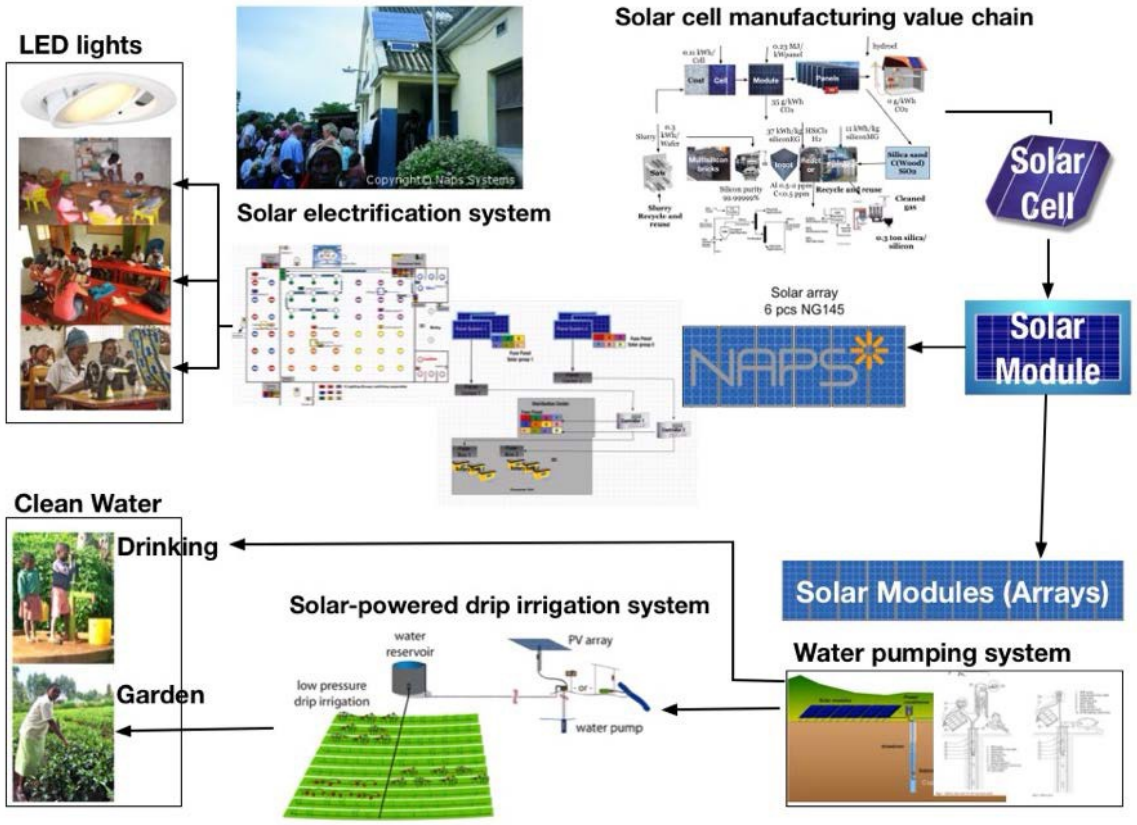


Figure 5.5. Layered community solar power system, Saarinen R., 2015a, Photos (Photo ref.)

5.3 Micro to medium-sized businesses

Mika Vehnämäki, an interviewee, expressed the core question: 'How it is possible to create local businesses for a community, including private sector development, micro-business, farmers, and agriculture?' (the story 13). Seppo Vehko, another one, answered: '...shops in Finland selling products from Africa like coffee ' (the story 11). Tapio Keränen, an interviewee emphasized that livelihood opportunities should start based on people's own-roots and their views (the story 2), exemplified in Indonesia, which produces large amounts of hand-made furniture, chairs, table etc., and for export

and to Europe, these are not energy-intensive to produce, why not in hand-made textile production, design products or furniture produced in Africa. To compare this story with Sweden and Finland, as an exemplar is the versatile textiles produced from Africa to Sweden (Watatu portal). Another exemplar, Finnish Mifuko shop sells African ecologically friendly products designed in Finland but made by African artisans. (Mifuko portal). Furthermore, you can already buy Kenyan extraordinary artwork Mijikenada design, on the Internet (Mijikenda portal).

Talking about this issue, Solveig Nylund, told: ‘You start at your home, and manage to have your basic needs met like water, food, education, opportunity for jobs, caring each other, you can develop and educate yourself further, come out from poverty, environmental livelihood and wellbeing and health, live in a human way. Macro perspective, you can work and produce something and transfer these products further and sell and get incomes. Standard of living, so that people are feeling well, but you do not have to be so rich. You feel good and can help other people’ (the story 4).

Turning now to some examples of solar-powered services suggested by Mikko Juntunen. First he illustrated, in a village, a village head might get enough money to put up a solar system for a charging place and for renting lamps for inhabitants, who might pay one € per night for the lamps. This price is less than they should pay for kerosene, in that way this system can pay back itself and is locally profitable even though the first starting investment is needed from somewhere. The interviewee continued with the second exemplar, somewhat middle class people might be able to start a charging kiosk for mobile phones, for instance a place for 100 sockets. He shared the third example from Victorian Lake area: a blocked ice shop for fishermen to chill their fish, instead of that they are burning charcoal or whatever energy might be possible. Last example he provided, a family owns the streetlight in the front of their shop and is motivated to take care of this light. Soon you can see that under this light there has arisen a micro-business opportunity, which is not connected to this shop, an economic unit (the story 5).

Majok Kariom continued the theme, food and business opportunities and envisaged: ‘But if you think about those, who have nothing, they need food which is not that clean, and if you do not have your fridge you need to buy food on a daily basis. A garden with irrigation is a source of money for whole a year, and you see many restaurants due to gardens, this is all I need for my restaurant. That will also change your mindset, people see that someone is cultivating and using irrigation, and they think that this will be due to me, I will do this, too’ (the story 12).

Regarding gardening and livelihood, through Rural Education Program (REP) women can learn to cultivate gardens like tea plants and agriculture products of other kind (SLEF REP, 2014). Relating to micro-businesses, Vuokko Alanne brought up that Women's Bank helps for starting your own micro-business (the story 7), and Seppo Vehko continued: ‘Incomes for the poor comes mainly only from your small field plot, from couple of chickens or baby lambs’ (the story 11). One key success factor is to start-up like in adult training and education supported by a small sum of investment for new livelihood (Women's Bank, 2014; SLEF MSB, 2014), which enables micro

businesses of diverse kinds. In summary, these results are expressed in Table 5.2, which provides an insight into the services, which already are functioning and some examples of services, which are needed and are realistic if only start money were available. The licentiate thesis discusses micro to medium-sized businesses and funding in more details.

Table 5.2. Business opportunities, Saarinen, R., 2015a. (Photo Ref.)

Business Field	Description	Service
Mijikenda Timber Artwork 	Our teams continue to scour East Africa for ever depleting sources of reclaimed & antique timber, which we salvage and return to our workshop on Diani Beach to be handcrafted into what must be some of the most intrinsically valuable furniture and interior items, being crafted today.	The Internet address: http://www.mijikenda.com/furniture/ The address: Diani Beach Road, PO Box 2 80400 Ukunda, Kenya, East Africa
Mifuko Handcrafts 	Work of hand and heart: Homeware, bags, jewelries. With the process of consensus we can produce better, ethically made and more exciting products together with talented African artisans.	The Internet address: http://www.mifuko.fi Retailers: http://www.mifuko.fi/content/retailers
Watatu: African textiles and mode 	De färgstarka varorna från Kenya, Tanzania och Uganda. Äkta kanga och kitenge från Tanzania	The Internet address: http:/www.watatu.se The address: Holsåkersvägen 15, 785 44 Dala Foda
Examples of solar-powered services 	1. Charging services for a) mobile phones b) renting charged lamps 2. A blocked ice shop for fishermen to chill their fish, e.g. Lake Victoria Fisheries 4. Micro businesses under the street light	Food Tank: Photo Sven Torfinn 'A Maasai pastoralist in Kenya utilizes his mobile phone to keep tabs on his herd'. http://foodtank.com/news/2015/01/five-ways-cell-phones-are-changing-agriculture-in-africa AFIPEK: Kenya Fish Processors and Exporters Association, Lake Victory Fisheries, http://www.afipek.org
Agricultural Products 	1. Versatile agricultural products 2. Ugandan healthy organic fruit: http://www.nogamu.org.ug/cope_members.php 3. Kenteco: Kenyan tea http://www.kenyateabags.com/about_tea_coffee.asp?c=11143	Service: Drip Irrigation to Food Markets 1. Improvements in Crop Yields 2. Improvements in Versatile Crops 3. Increased Water amount to Agriculture 4. Increased Food Security 5. Nutritious Food 6. Responses to High Food Prices 7. Decrease in Malnutrition 8. Enables Income 9. Enables Livelihood 10.Enables Heath, Education, Banking

5.4 Technology adaptation and learning new practices

As a starting point, George Pindua drew attention to a technology adaptation: 'First of all .., solar power is new technology to people who live in the countryside. If I am not wrong, it is about five or ten years since the technology introduced to us. Secondly in rural area, there were few people who roofed their house by iron-sheet, while the majority were roofing by glass...therefore, you can see about 20% use solar power while 80 % were not using solar power due to nature of their house...we should

provide education for them for the purpose of change their mind and build good houses. For the people who have already built good houses, they are able to own solar and pay the necessity costs while the poor people cannot afford to buy the panel and maintenance of the system once broken.' (Appendix IA).

The interviewees in this TAMAA Case preferred education and new practices at the frequency of 186 (Table 4.1), and including maintenance and quality, the frequency amounted to 215. Taken together, the interviewees considered technology adaptation and learning new practices a cornerstone for successful implementations of new services and technologies, some key issues placed in Table 5.3. In short, as Paulo Pinho stated: "Working together as equal partners" (the story 10).

Table 5.3 Some key issues in the adaptation of new technology, Saarinen R., 2015b

	Family/person	Community	Social
Mothers, women	Women accelerate change New practices save time for, e.g., micro-small business and school work	Women accelerate change New practices save time for i.e. micro-small business and school work	Women's rights to land and bank accounts Credits Education up-to the university level
Education at all levels	Literacy, preliminary, secondary, tertiary, mathematics, Apprenticeship contracts	Preliminary, secondary, tertiary schools, Apprenticeship contracts	Public education: preliminary, secondary Vocational school, high school University
Long term collaborative equal partnership	Respect, long term collaborative learning, participatory adaptation	Respect, long term collaborative learning, participatory adaptation	Infra
Training Maintenance Warranty Skills	New skills, technology, practices spare parts	New skills, technology, practices spare parts	Universities, trade and technical schools
Infra, shops, banking	Bank accounts	Shops, banks, electricity	Banking system, roads, railways, electricity networks
Visits, excursions	Best practices	Best practices	Best practices
Pilot projcts	Involvement	Involvement	Involvement

The assessment process (Chapters 3.3 and 4.2) explained technology selection, transfer and adaptation regarding new services and Figure 5.5 described the solar-powered socio-technical system in discussion. Next, taken from interviews some new aspects, which we have not yet covered, and the licentiate thesis, consequently, elaborates the technology adaptation and transfer in more details.

Jyrki Myllärniemi shared his experiences: ‘Mothers and women are accelerating effective change both in family and community. With new practices, women will get more time to be with their family, otherwise time must be spent on getting the energy like water and fuel wood, and this will have environmental consequences. This is not a moral issue for individuals, but energy issues should be arranged by state or other public organization. People are fetching fuel wood for their survival. The thing is, all changes are very slow, but with small steps by trainings and education, you might have possibility to change more and get larger changes. Old attitudes, traditions, and old basic structures are obstacles to the change.’ (the story 1).

Mikko Juntunen crystallized: ‘Gradually increasing social structures. The water brought to the well doesn't stay in there, as it's no use to try anything with anyone if that person himself or herself isn't willing to do it’. He continued: ‘But when going to places where you cannot read, the preliminary knowledge of how the new system works is quite challenging, it is necessary so that you can utilize the new system in a practical way and be able to maintain the system. If there is a village community, where you have several solar-powered systems, you already have structures, and there can be someone who can be specialized in that system and can have the income and livelihood of it.’ (the story 5).

Mika Vehnämäki summarized: ‘Capacity development, education, people have to learn new things so that they can solve their problems, working together, applying local resources with local methods, small-scale solution, which are suitable for local environment, scaling-up, modularity, local people have ownership to their solutions, adapting our western new technology to local needs’ (the story 13). Tapio Keränen brought forward the key aspect, the availability of spare parts: ‘And there exists a shop, where you can buy new batteries and charge them’ (the story 2). Pramod Bhusal emphasized the technology transfer: ‘..training, transfer your knowledge, visit to similar areas and learn how people do this and what are those best practices, run your pilot projects. Trained properly so that they can maintain their own system. How to integrate needs and technology: all things are related to one, quality of life. In summary, all system should be integrated, go hand-in-hand, not only one thing.’ (the story 3).

Helene Taal brought up the obstacles: ‘poverty, it is hard to get out of poverty, better infrastructures needed so that people can climb up...public education and guidance, also for against accidents, first for teachers, who then will teach others, enough suitable courses, education is expensive after preliminary and secondary school, getting new knowledge will cost’ (the story 11). Brita Jern continued: ‘Education, training and working needs good teachers and different types of school-materials, and in Kenya at least, an improved teaching of English as a different language.’ (Appendix IA Brita). Turning now to discuss obstacles.

5.5 Obstacles

Obstacles, why new energy services and basic needs were not met, were first covered in Table 4.6, and after several listening of interviews the obstacles were

arranged differently only at social and individual level in Table 5.4, because solely community level answers were few. To summarise as Irja Aro-Heinilä expressed: 'Most important is education at all levels: primary, secondary school, training for new socio-economics systems like these new technologies, professional schools, trade school, technical school, universities, and learning by doing. The other and even more important key to make change happen is human being's inner power, which we need to unlock, make people ready to help themselves and excel in their own capabilities and learn new things'. (Appendix IA Irja in TAMAA Appendices).

Table 5.4 Obstacles, Saarinen R., 2015b

Obstacle	Invidual	Social
Poverty	Yes	Yes
Lack of land reform	No right to land, no farming	In many countries no land reform, no landownership arranged
Lack of banking	No ID-card, no bank account	Banking system, ownerships, ID, need for a stable structure and laws
Lack of money, funding	Yes, need for start investment, one interviewee considered this social	Yes
Lack of jobs	Yes	Yes
Lack of knowledge and public education	Unliterary, school fares, lack of food, household activities, poverty	Lack of public education and qualified teachers, school fares, school books and material
Lack of training, also professional	No knowledge how to use new systems	Access to trade and technical schools
Women and girls do household activities	Women and girls need to be trained to use new services	Old traditions of women and girls, women need to be involved to new systems
Lack of sanitation, clean water, food	Diseases, education suffers	Diseases, healthcare and hospitals needed
Fuel food, straw etc. free in rural areas	Costs for improvement systems, e.g. Improved stoves	Costs as deforestation
Subsides for fossil fuels like petrol, diesel, kerosene	**Costs of new energy systems like solar**	Costs of greenhouse gases
Corruption, conflicts	**Yes**	**Yes**

Paula Tommila crystallized: 'Financing of solar systems is a big investment, but a basic lighting system with couple of lamps is quite inexpensive, however poor people can not afford even them' (the story 6 in Appendix IE). Solveig Nylund told: 'Obstacles and barriers are there, very much related to low education and lack of training how to use technical devices. I think it is possible to arrange courses on this topic and educate instructors. I think the girls and the women are the target. We need to teach them, they are the ones who are preparing food, fetching water, feeding children and so on. Try to teach the need for maintenance, try to show that the whole community is profiting from a system, thus avoiding thefts, planting a we-spirit, educating people who can maintain devices and supervisors who can do check-ups. Bringing knowledge to common people, not only to experts, is part of the solution to integrate new energy systems into the daily life of rural people in Africa. Obstacles and barriers to people to fulfill these

needs could be poor physical or mental health, poverty, large families, living in hard-ship areas and lack of education which often is related to poverty.' (the story 4).

The stories at social level:

'But the roots are in social structures, there is no tradition for banking systems and ownership (asserts), it is difficult for the society to be developed, because if you do not have any possibilities to develop and create your own work and your own income and asserts, there is no means to struggle' (Mikko Juntunen, the story 5). 'It is obvious if 300 people living in subsistence economy need to buy a system costing 10 000 $ for instance for a bore well, this is not possible' (Tomi Järvinen, the story 8). 'More effort to the beginning and go to the community and get involved and try to find out what villagers really want, what are practical things to do. Ask locals, what would be the best ways to do and get children to school.' (Pasi Aaltonen, the story 9).

Summary: 'open partnership in co-operation which is not based on money, the money can comes to the picture when the partnership has grown, there exists mutual trust and know-how' (Tomi Järvinen, the story 8). 'There are so many countries, so many cultures, and so many religions. It is sometimes very tricky to think about Africa as a whole, so many perspectives there. In many African countries, there are these tribal backgrounds, so these national policies have to take these into considerations.' (Paulo Pinho, the story 10).

'There must be land for agriculture, so that you can cultivate, the fundamental thing is how you own land' (Mika Vehnämäki, the story 13). At social level the land reform is lacking in many countries, which hinders people to own land and cultivate their land. 'Although solar energy as off-grid solutions is going to be the cheapest, the investment is needed first, on the other hand the people living in developing country can afford a diesel-generator, but this diesel-generator system will cost more than the solar system in those 20-years. Those boundary conditions are in somewhere in social and governmental structures, this applies also to solar-powered systems. If there exists no ownership, these new systems will be stolen or broken. In principle a co-operative ownership of a village solar system might be good, but there should be some kind of tradition how things are handled together, administrative unit is a family or larger family. In those poorest regions, there have first been a bloody fight for those limited resources, then the idea of getting more together might be too difficult thing to adopt.'(Mikko Juntunen, the story 5).

6 Lessons learnt and recommendations

This TAMAA Case assessed, which are the building blocks and change levers for creating sustainable flourishing learning Village Community, and how sustainable energy services are capable of creating wellbeing and empowering African villagers. This study took advantages of participatory involvement through the in-depth active face-to-face interviews and acquired shared meaning and knowledge in the needs of villagers and in the services to meet these needs. These interviews explored the insights, knowledge, experiences, and visions of people involved in development co-operation works for years — the representatives of villagers, NGOs, companies, and researchers — and invited them to seek solutions to the identified problems.

First, this TAMAA Case reviewed the General Basic Customer Needs of rural people living in developing countries. Then, the analysis of the face-to-face interviews revealed that the most weighted needs of villagers were Clean Water, Nutritious Food, Lifelong Health, Education at all levels, Safe and Healthy Lighting, Agricultural Productivity, Jobs, opportunities for Micro to medium-sized businesses and electricity, as well as clean cooking although this need not led to a new energy service in this study. Instead, the identified new sustainable energy services were Clean Water, Drip Irrigation to Food Markets as well as Safe and Healthy Lighting. The TAMAA concept (Figure 6) helps turning to summarize Clean Water, which is the most commonly researched and implemented service.

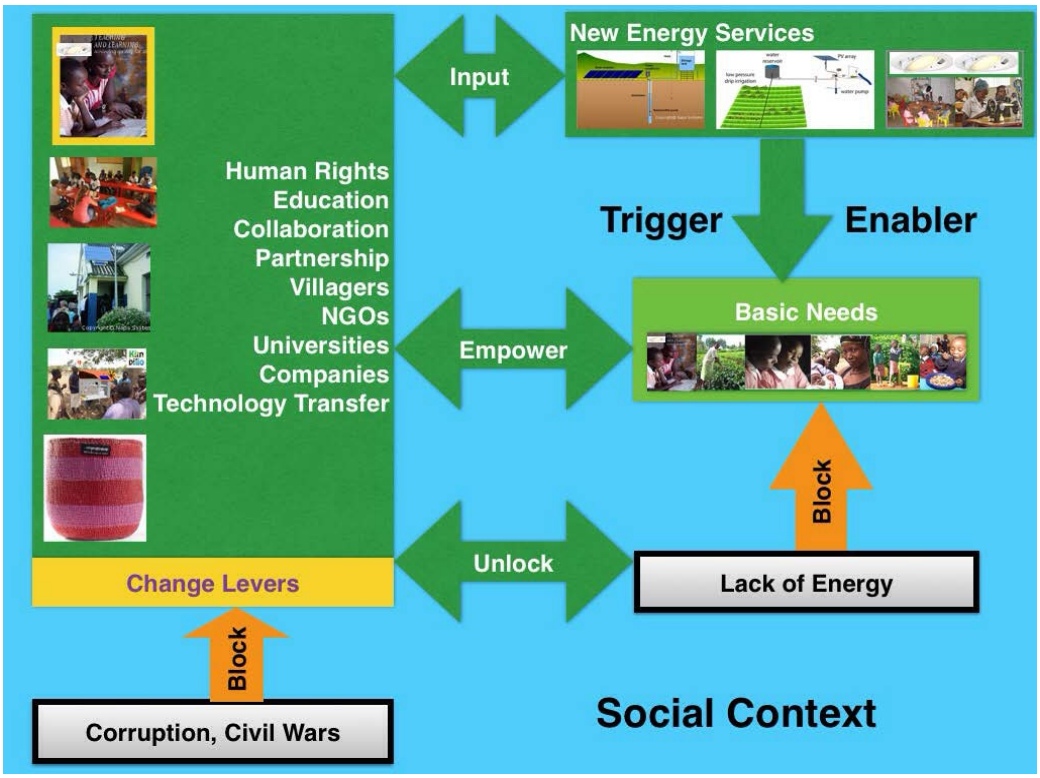


Figure 6. TAMAA Concept, Saarinen, R., (2015a), Photos (Photo ref.)

If the well provides good quality water, solar-powered pumping is a reliable way to get water without a need to cook it first. The Clean Water system was reviewed against the ABC water project of the solar-powered water system serving approximately 1000 villagers at the costs of 27,45€ per person (in 2012) (Chapter 4.4; SLEF ABC Water, 2012). Atemo Bible College (ABC) owns land and is responsible for working and the maintenance of the water system within Lake Diocese in Kenyan Evangelical Lutheran Church, the site Abongo Dhoga comprising among 800-1200 villagers and Rungu Primary School with over 400 pupils, who are getting now clean water. This Clean Water service is scalable and ready for the implementations, exemplified NAPS Solar Water Pumping Systems (NAPS Water, 2015). Clean water is also needed for agriculture and food preparations, and this brings up the second service, Drip Irrigation to Food Markets for discussion.

The primary target for agriculture development and improvements is Food Security, so that people can gratify their Human Rights (UN Human Rights, 2014), their rights to sufficient Food. Agricultural productivity by solar-powered drip irrigation has been a key success in improving malnutrition and crop harvest (Chapter 4.5), and indeed, Drip Irrigation to Food Markets with Clean Water enables a prolific agriculture with versatile crops and increased yields, thus creating opportunities for getting Nutritious Food. Equally important, this service generates micro to medium-sized businesses, and village-farmers can sell diverse products to local markets. The exemplified Benin solar-powered drip irrigation system has been successful (assessed by Stanford University) and has reached eight gardens by 2014 (NDF Benin, 2014), the solar technology provided by NAPS Solar Systems (NAPS, 2014). As the baseline review (Chapter 2.2) reported, food markets are the main potential sector in BOP markets, and estimations for the future indicate that Africa's total agriculture and agribusiness could create opportunities for an industry sector of 1 000 billion USD.

Moreover, irrigation leads to local cooling effect (IPCC, 2013), thus irrigation with the renewables like solar decreases CO_2 emissions, cools locally, and increases plants (photosynthesis, land cover change, mitigates desertification). This Service Drip Irrigation to Food Markets is elaborated and enlarged in the licentiate thesis focus on the potential food markets and the technology.

As Clean Water and Drip Irrigation to Food Markets, Lighting is tightly integrated into Health reducing the serious indoor air problems due to the use of traditional kerosene lamps, which are common in rural areas. Lighting makes Education, Jobs, and Micro to medium-sized businesses possible also in the evening. The service, Safe and Healthy Lighting (Chapter 4.3), is based on the LED lights and solar PV panels, which are considered stable technologies, and this service provides a safe and healthy environment for schools, hospitals, working environments in firms and other buildings, among others, as well as for public areas. Although the technology is stable, the availability of the system components might raise concerns in some Sub-Saharan areas, for example where to acquire LED-lamps. This turns the discussion to the new created TAMAA concept (Figure 6) and change levers, which are capable of enabling to bridge the gap (Figure 3) in building flourishing Village Community, where new sustainable services leverage the identified needs for the empowerment of villagers.

This TAMAA Case discovered Human Rights as a foundation for basic needs. As interviewees emphasized, Education at all levels provides opportunities to achieve villagers' full potential, self-actualization (Figure 2) level in Maslow's hierarchy of needs. Learning and working together, equal partnership and supporting others to become the beneficial community members, create we-sprit and a positive climate for wellbeing of Village Community. By establishing a collaborative learning environment within the village and between outside partners as NGOs, researchers, companies, and universities, encourages villagers and all parties to come together and work together for sustainable flourishing learning Village Community. When people learn together, they also get ownership to their knowledge and become an active part of their community. After all, the successful adaptation and implementation of the new energy service mean that the service meets the real needs of the user and is suitable and practical locally for the purpose it was created. Furthermore, villagers, NGOs, companies, and universities have collaboratively planned the technology adaptation.

Change levers with new sustainable services are capable of unlocking the obstacles when ever the funding is arranged. Those barriers were most of all poverty and it's consequences, such as no economics access to clean water, nutritious food, education, agricultural productivity, lighting and jobs. Lack of knowledge, public education and training including professional and languages, will deepen the gap to fill, as well as the old practices, such as that women and children are forced to spend hours for household activities due to ineffective ways to get water and fuel wood. For these small every day needs, micro-loans by SLEF and Women Bank were and are vehicles to come out of these old traditions, which hinder not only women and children but also men to come out of poverty. The discussion of these business and funding opportunities are broadened and deepened in the licentiate thesis to wider viable business opportunities.

Regarding clean cooking, further studies about solar cookers, improved stoves, and biogas digesters are needed. Solar resources as well as hydropower are considered renewable energies, but due to the LCA assessments of annual forest losses in Sub-Saharan Africa, the biomass electricity and combined heat and power (CHP) was not the focus in TAMAA Case. Instead, a new case is needed, exemplified waste management by gasification, which is capable of converting sustainably municipal wastes of all kinds as well as agricultural and forest residues to electricity. TAMAA Case had a focus on how to build a flourishing learning village community and the main resource was solar (the largest one in Africa). A pilot or pilots, which can implement these new energy services as concepts and broaden them to the exports in food markets, would be a next case or next cases.

Photo Ref.(erences)

Afipek (2015): Photo in page 57
Africa Renewal (2007): Photo in pages cover, 2, 3, 5, 8, 29, 38, 44, 47, 52, 53, 54, 62
Airam portal: Photo in pages cover, 2, 3, 5, 7, 38, 41, 43, 55, 62
Aro-Heinilä Irja: Photos in pages cover, 2, 3, 4, 5, 38, 43, 52, 53, 54, 62
Brenton et al. (p.22, cover page): Photo in pages 2, 41
daveveb & Squiffy: Photo in page 57
FELM (2014): Photo credit in pages cover, 2, 3, 5, 29, 38, 41, 43, 52, 53, 54, 62
Food Tank (2015): Photo credit in page 57
Grundfors portal: Photos in pages 44, 45, 47
Mifuko portal: Photos in pages cover, 3, 57, 62
Lighting Africa: Photos in pages cover, 3, 8, 29, 38, 41, 43, 52, 62
Ritva Saarinen: Photo in pages 2, 5, 54
Mijikenda (2015): Photo in page 57
NAPS: Photos in pages cover, 3, 7, 29, 41, 54, 55, 57, 62, NAPS (2013), Health (2015), Light (2015), School (2015, Water (2015)
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SLEF: Photos in pages cover, 2, 3, 5, 8, 29, 38, 41, 43, 44, 47, 51, 52, 53, 54, 55, 57, 62, SLEF (2015), (2015 Kenya), (2014 MSB), (2014 REP), (2014 UVS), (2014 Women)
Stanford Benin (2011): Photo in pages cover, 3, 7, 29, 47, 55, 62
UNESCO EFA (2014, cover page): Photos in pages cover, 2, 5, 62
UNFCCC (2014): Photo in page 57
Women's Bank: Photos in pages 2, 5, 8, 38, 41, 43, 52, 54, 55, 62, Women's Bank (2014), (2014 Congo), (2014 Uganda)

References

Aaltonen M. 2007. The Third Lens. Multi-ontology Sense-making and Strategic Decision-making. Helsinki University of Technology (Aalto University). ISBN. 978-0-7546-4798-0.

Afipek. 2015. Welcome to Kenya Fish Processors and Exporters Association website. Lake Victoria Fisheries. Available: [Cited 12.04.2015] http://www.afipek.org/#

Africa Renewal. 2007. Food keeps African children in school. Photo: WFP / Edward Parsons. Available: [Cited 12.06.2011] http://www.un.org/africarenewal/magazine/january-2007/food-keeps-african-children-school

AGI BOP. 2012. Doing Business At Emerging Markets: Guide For Inclusive Innovation. Aalto University BOP research group. Available: [Cited 13.05.2014] https://wiki.aalto.fi/display/BOP/Inclusive+business+models+in+low-income+contexts

Airam portal. SLIM 12 V LED Light. Available [Cited 23.03.2015] http://www.sahkonumerot.fi/4207368

Antonides G. 1996. Psychology in Economics and Business. Second, Revised Edition. Kluwer Academic Publishers. ISBN 0-7923-4107-4

Apple J., Vicente R., Yarberry A., Lohse N., Mills E., Jacobson A., Poppendieck E. 2010. Characterization of particulate matter size distributions and indoor concentrations from kerosene and diesel lamps. Indoor Air 2010 Vol. 20, pp.399-411. www.blackwellpublishing.com/ina. Singapore. DOI:10.1111/j.1600-0668.2010.00664.x

Ashok S. 2006. Optimised model for community-based hybrid energy system. Department of Electrical Engineering, National Institute of Technology, Calicut India. Vol. 32 (2007) pp.1151-1164. doi:10.1016/j.renene.2006.04.008. Elsevier Ltd..

Ayeko Z. 2011. Rural Electrification Program in Kenya. Lighting up Rural Kenya. AEI Practitioners Workshop Dakar Senegal November 2011. Available: [Cited 13.01.2015] http://siteresources.worldbank.org/EXTAFRREGTOPENERGY/Resources/717305-1327690230600/8397692-1327691237767/Rural_Electrification_in_Kenya_presentation_Final_11thNov2011.pdf in World Bank AEI Dakar Workshop http://siteresources.worldbank.org/EXTAFRREGTOPENERGY/Resources/717305-1327690230600/8397692-1327690360341/AEI_Dakar_Workshop_Proceedings_FINAL-for_Web1.pdf

Badran A.A., Yousef I.A, Joudeh N., K., Hamad R.A., Halawa H., Hassouneh H.K. 2010. Portable solar cooker and water heater. Energy Conversion and Management 51 (2010) pp.1605–1609. Elsevier Ltd. DOI:10.1016/j.enconman.2009.09.038

Bajgan S., Shakya I. 2005. The Nepal Biogas Support Program. A SUCCESSFUL MODEL OF PUBLIC PRIVATE PARTNERSHIP FOR RURAL HOUSEHOLD ENERGY SUPPLY. ISBN: 99946-32-31-0

Bekele G., Getnet T. (2012) Feasibility study of small Hydro/PV/Wind hybrid system for off-grid rural electrification in Ethiopia. Applied Energy, Vol.97, pp.5-15. Elsevier Ltd. doi:10.1016/j.apenergy.2011.11.059

Bekele E. (2009) Study into the Potential and Feasibility of a Stand-alone Solar-Wind Hybrid Electric Energy Supply System for Application in Ethiopia. Doctoral Thesis. Royal Institute of Technology, Department of Energy Technology, School of Industrial Engineering and Management, Stockholm. ISBN 978-91-7415-329-3.

Belz F-M., Peattie K. 2009. Sustainability Marketing. A Global Perspective. John Wiley & Sons. UK. ISBN 978-0-470-51922-6.

Bergman B., Klefsjö B. 2007. Kvalitet från behov till användning. Lund. Studentlitteratur. ISBN 978-91-44-04416-3

Bernal-Agustín J. L., Dufo-López R. 2009. Simulation and optimization of stand-alone hybrid renewable energy systems. Renewable and Sustainable Energy Reviews 13 (2009) 2111–2118. doi:10.1016/j.rser.2009.01.010.

Bernard T. 2010. Impact Analysis of Rural Electrification Projects in Sub-Saharan Africa. The World Bank Research Observer. Available: [Cited 13.02.2014] http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/12/02/000442464_20131202113517/Rendered/PDF/814320JRN0WBRe00Box379873B00PUBLIC0.pdf, DOI:10.1093/wbro/lkq008. 2012 in Research Observer Vol. 27 No. 1, http://elibrary.worldbank.org/doi/abs/10.1093/wbro/lkq008

Berman J. 2013. Vision Statement: Seven Reasons Why Africa's Time Is Now. Harvard Business Review, October 2013. Available: [Cited 7.10.2013] http://hbr.org/2013/10/seven-reasons-why-africas-time-is-now/ar/1

Berthold M.R. 2012. Bisocialite Knowledge. An Introduction to Concept, Algorithms, Tools, and Applications. ISBN: 978-3-642-31820-0 (Print), 978-3-642-31830-6 (Online).

Bhusal P. 2009. ENERGY-EFFICIENT ELECTRIC LIGHTING FOR BUILDING IN DEVELOPED AND DEVELOPING COUNTRIES. Helsinki University of Technology (Aalto University), Department of electronics, Lighting Unit. Espoo 2009. ISBN 978-951-22-9637-8.

Bizzarri M. 2009. Safe Access to Firewood and Alternative Energy in Uganda: An Appraisal Report. Team: Catherine Bellamy, WFP Rome, Erin Patrick, Women's Refugee Commission, Christa Roth, GTZ. 10-25 November 2009. Available: [Cited 13.03.2014] http://www.genderconsult.org/res/doc/SAFE_Uganda.pdf

BMZ. 2012e. Fighting Poverty More Effectively – Worldwide. Cross-Sectoral Strategy on Poverty Reduction. BMZ Strategy Paper 6 | 2012e. The German Federal Ministry of Economic Cooperation and Development (BMZ). Available: [14.10.2013, redirected 20.11.2015] https://www.bmz.de/en/publications/archiv/topics/poverty/Strategiepapier325_06_2012.pdf

Bocoum I., Macombe C., Revéret J-P. 2015. Anticipating impacts on health based on changes in income inequality caused by life cycles. International Journal of Life Cycle Assessment, Vol. 20, pp. 405-417. Springer-Verlag Berlin Heidelberg. DOI 10.1007/s11367-014-0835-x

Bowman M., Crews, C., Golden G. 2009. Engineering Solutions for the Base of the Pyramid. A report prepared for the Strategic Issues Committee Strategic Management Sector ASME June 30, 2009. AndSpace Consulting, Inc. team. Massachusetts. Available: [Cited 26.11.2011, redirected 21.06.2016] https://www.asme.org/getmedia/0a55060a-416e-4483-a471-41bac8202d44/IssueBriefs_2009_EngineeringSolutionsfortheBaseofthePyramid.aspx

Brenton P., Gamberoni E., Sear C. Women and Trade in Africa: Realizing the Potential. The World Bank. Photo: Arne Hoel for the World Bank. Available: Available:

[11.06.2014] http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/11/08/000442464_20131108144416/Rendered/PDF/825200WP0Women00Box379865B00PUBLIC0.pdf

Burney J.A, Naylor R.L., Postel S.L. 2013. The case for distributed irrigation as a development priority in sub-Saharan Africa. http://www.pnas.org/cgi/doi/10.1073/pnas.1203597110. Perspective. PNAS Early Edition. Proceedings of the National Academy of Science of the United States of America (PNAS).

Burney J., Woltering L., Burke M., Naylor R., Pasternak D. 2009. Solar-powered drip irrigation enhances food security in the Sudado-Shahel. Proceedings of the National Academy of Science of the United States of America (PNAS). PNAS February 2, 2010 Vol. 107 No. 5 pp.1848-1853. DOI: 10.1073/pnas.0909678107.

Cameron K. 2008. Positive Leadership, Strategies for extraordinary performance. Berret-Koehler Publishers, Inc. San Francisco. ISBN 978-1-57675-602-7

Carr M., Hartl M. 2010. Lightening the Load, Labour-saving technologies and practices for rural women. IFAD (International Fund for Agricultural Development) and Practical Action. ISBN 978 185339 689 2 (Practical Action Publishing) ISBN 978 92 9072 102 4 (IFAD)

CCIAM. 2012. Proceedings of the First Climate Change Impacts, Adaptation and Mitigation Programme Scientific Conference, Blue Pearl Hotel, Dar Es Salaam, Tanzania 2nd and 3rd January, 2012. Climate Change Impacts, Adaptation and Mitigation (CCIAM) in Tanzania July 2009 – June 2014. Available: [Cited 2.03.2013, redirected 20.11.2015] http://www.eldis.org/go/home&id=62643&type=Document#.Vk8pHnpXerU

Chen S., Ravallion M. 2008. World Bank Poverty. Poverty Reduction and Equity. The Developing World Is Poorer Than We Thought, But No Less Successful in the Fight against Poverty. Policy Research Working Paper 4703. The World Bank Development Research Group. August 2008. Available: [Cited 03.06.2011] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTPOVERTY/EXTPA/0,,contentMDK:22397595~pagePK:210058~piPK:210062~theSitePK:430367,00.html , http://documents.worldbank.org/curated/en/2008/08/11680409/developing-world-poorer-thought-no-less-successful-fight-against-poverty

Chevrollier N. 2011. Knowledge exploiting at the BoP in the ICT/Energy/Water sectors. Inclusive Innovation- Global experiences and technologies. Joint World Bank and Global Research Alliance Regional partnership workshop. 25 May 2011, Hanoi Vietnam. Available: [Cited 11.10.2014] http://siteresources.worldbank.org/INTVIETNAM/Resources/GRATNOVietnamWB.pdf

CIA. 2014. World Fact Book 2013-2014. Available: [Cited 12.01.2015] https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html

Clements R. 2009. The Economic Costs of Climate Change in Africa. Practical Action Consulting. Available: [Cited 13.09.2012] http://www.christianaid.org.uk/images/pacjaclimatereport.pdf

Clough L. 2012. London. The Improved Cook Stove Sector in East Africa: Experience from the Developing Energy Enterprise Programme (Deep). London. GVEP International. The European Union (EU) and the Dutch Ministry of Foreign Affairs (DGIS). Available: [Cited 12.03.2014] http://www.gvepinternational.org/sites/default/files/deep_cookstoves_report_lq_for_web.pdf

Cooper R.G. 2001. Winning at New Products. Accelerating the Process from Idea to Launch. Basic Books. Third Edition. New York. 425 p. ISBN-10: 0-7382-0463-3.

Corvalán C.F., Kjellström T., Smith K.R. 1999. Health, Environment and Sustainable Development. Identifying Links and Indicators to Promote Action. Epidemiology 1999;10:pp. 656-660. Epidemiology Resources Inc.

Corvalan C., Hales S., McMichael A. 2005. ECOSYSTEMS AND HUMAN WELL-BEING. Health Synthesis. A Report of the Millennium Ecosystem Assessment. World Health Organization (WHO). ISBN 92 4 156309 5.

Crawford C.M. 1994. New Product Management. Burr Ridge Illinois, Boston, Sydney. IRWIN, Inc. ISBN 0-256-12152-4

Creswell, J. W., Plano Clark, V. L. 2011. Designing and conducting mixed methods research. Los Angeles, CA: SAGE Publications, Inc. ISBN 978-1-4129-7517-9.

Creswell J.W. 2010. Mapping the developing landscape of mixed methods research. Chapter 2, in Tashakkori et al. (Eds.) Handbook of mixed methods in social and behavioral research. Thousand Oaks (California), London, New Delhi, Singapore. SAGE Publications, Inc. ISBN 978-1-4129-7266-6

daveveb & Squiffy Blog. Moshi to Mbeya: Two bad days on the bus. Photo 'Fruits'. Available: [Cited 12.04.2015] http://www.escapethecity.co.uk/moshi-to-mbeya-two-bad-days-on-the-bus/

DFID 2005. Girls' education: towards a better future for all. The Department for International Development (DFID). Crown London. ISBN: 1 86192 673 1.

Deininger K., Byerlee D., Lindsay J., Norton A., Selod H., Stickler M. 2011. RISING GLOBAL INTEREST IN FARMLAND. Can It Yield Sustainable and Equitable Benefits? World Bank. Washington DC. ISBN: 978-0-8213-8591-3, eISBN: 978-0-8213-8592-0.

Easterbrook S. 2007. Empirical Research Methods in Requirement Engineering. 15th IEEE International Requirements Engineering Conference, October 15-19th 2007, India, Habiat Center, New Delphi. Available: [Cited 16.06.2012] http://www.cs.toronto.edu/~sme/presentations/re07tutorial-vPrint.pdf

EFA. 2014. Teaching and Learning: achieving quality for all. Gender Summary. EFA Global Monitoring Report. United Nations Girls's Education Initiative (UNGEI). UNESCO. The Education for All (EFA) Global Monitoring Report is an independent annual publication. It is facilitated and supported by UNESCO. Available: [Cited 30.03.2014] http://unesdoc.unesco.org/images/0022/002266/226662e.pdf

ELC. 2014. Evangelical Lutheran Church of Finland. Evangelical Lutheran Parishes of Espoo. http://www.espoonseurakunnat.fi/english

EPA. 2001. U.S. Environmental Protection Agency and Science Applications International Corporation. LCAccess - LCA 101. 2001. Retrieved from http://www.epa.gov/ORD/NRMRL/lcaccess/lca101.htm.

EU Se4all. Empowering Development. Delivering results in the Decade of Sustainable Energy for All. Available: [Cited 13.09.2014] https://webgate.ec.europa.eu/multisite/devco/sites/devco/files/energy-booklet-relu_en.pdf, site EU development and cooperation http://ec.europa.eu/europeaid/

Fakis A., Hilliam R., Stoneley H., Townend M. 2014. Quantitative Analysis of Qualitative Information From Interviews: A Systematic Literature Review. Journal of Mixed Methods Research. 2014. Vol. 8, pp.139-161.

FAO, IFAD and WFP. 2014. The State of Food Insecurity in the World 2014. Strengthening the enabling environment for food security and nutrition. Rome, FAO. E-ISBN 978-92-5-108543-1 (PDF)

FAO. 2011. ENERGY-SMART FOOD FOR PEOPLE AND CLIMATE. Issue Paper. FAO. Rome. Available: [11.08.2014] http://www.fao.org/docrep/014/i2454e/i2454e00.pdf

FAO Forest. 2011. State of the World's Forests 2011. Rome. Food and Agriculture Organization of the United Nations (FAO). ISBN 978-92-5-106750-5.

FAO. 2006. Unasylva 224. An International Journal of Forest and Forest Industry. Vol. 57, 2006/2. ISSN 0041-6436

FAO. 1987. THE PROBLEM OF AGRICULTURE IN THE SEMI-ARID REGIONS in Water and Soil Conversations in Semi-arid Areas. FAO Corporate Document Repository. FAO Natural Resource Management and Environment Department. Available: [Cited 09.03.2014] http://www.fao.org/docrep/t0321e/t0321e-08.htm

Federer W.T. 1999. Statistical Design and Analysis for Intercropping Experiments. Volume II: Tree or more crops. New York. Springer. ISBN 0-387-98533-6

FELM. 2014. The Finnish Evangelical Lutheran Mission. Photo credit: *'Healthy Women, Healthy Children'*. Available: [Cited 12.03.2014] http://www.suomenlahetysseura.fi/ls_en/

Finn Church Aid. 2014. Development co-operation. Available: [Cited 10.04.2014] http://www.kirkonulkomaanapu.fi/en/home/?id=1824

Finn Church Aid. Africa. 2014. Development co-operation work in Africa. Available: [Cited 10.04.2014] http://www.kirkonulkomaanapu.fi/en/work/africa/?id=3052

Folaramni J. 2013. Performance Evaluation of a Double-Glazed Box-Type Solar Oven with Reflector. Hindawi Publishing Corporation. Journal of Renewable Energy, Volume 2013, Article ID 184352, 8 pages http://dx.doi.org/10.1155/2013/184352

Food Tank. 2015. Five Ways Cell Phones are Changing Agriculture in Africa, Photo Credit: Sven Torfinn *'A Maasai pastoralist in Kenya utilizes his mobile phone to keep tabs on his herd'*. Available: [Cited 12.05.2015] http://foodtank.com/news/2015/01/five-ways-cell-phones-are-changing-agriculture-in-africa

Frankl V.E. 2010. The Feeling of Meaninglessness. A Challenge to Psychotherapy and Philosophy. Edited & With an Introduction Alexander Battyány. Marguerite University Press. eISBN 9780874627695.

Frey B.S. 2008. Happiness. A Revolution in Economics. CES, the Center of Economics Studies of University of Munich. MIT Press. Cambridge, Massachusetts. London, England. Massachusetts Institute of Technology. ISBN 978-0-262-06277-0.

Funder M., Fjalland J., Ravnborg H.M., Egelyng H. 2009. Low Carbon Development and poverty alleviation. Options for development Cooperation in energy, agriculture and forestry. DIIS report 2009:20. Copenhagen. ISBN: 978-87-7605-333-8

Gerring J. 2007. Case Study Research. Principles and Practices. Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo. Cambridge University Press. ISBN-13 978-0-521-67656-4.

Greasen C. (2010) "Energy is a Human Right. Renewable Energy on the Thai-Burma Border. Energy and Development Workshop. Monteray Institute of International Studies (MIIS). Irvine Auditorium, McCone Hall, 7 May 2010. Monteray the US. Available: [Cited 07.06.2010 redirected 20.11.2015] http://www.bget.org/blog/?start=18, http://documents.mx/documents/chris-greacen-energy-is-a-human-right-renewable-energy-on-the-thaiburma-border-energy-and-development-workshop-monterey-institute-of-international.html

von Grebmer K., Hedey D., Olofinbiyi T., Wiesmann D., Fritschel H., Yin S., Foley C., von Oppeln C., Iseli B., Béné C., Haddad L. 2013. Global Hunger Index 2013. THE CHALLENGE OF HUNGER: BUILDING RESILIENCE TO ACHIEVE FOOD AND NUTRITION SECURITY. International Food Policy Research Institute (IFPRI), concern worldwide, Welthungerhilfe, Institute of Development Studies. Bonn, Washington D.C., Dublin. ISBN 978-0-89629-951-1. DOI: http://dx.doi.org/10.2499/9780896299511.

Grown C., Gupta G.R., Kes A. 2005. UN Millennium Project 2005. Taking Action: Achieving Gender Equality and Empowering Women. Task Force on Education and Gender Equality. The United Nations Development Programme (UNDP). Earthscan London Sterling, VA. ISBN: 1-84407-222-3 paperback.

Grundfos portal. 2014. Renewable-energy based water supply systems, SQFLEX Product Guide. Grundfos. Available: [Cited 10.09.2014] http://advancepower.net/pdf/SQFlexProductGuide.pdf

Grönroos C. 2000. Service Management and Marketing. John Wiley & Sons Ltd. West Sussex England. ISBN 0-471-72034-8.

Gubrium J.F., Holstein J.A. 2001. Handbook of Interview Research. Context & Methods. Sage Publications. ISBN 0-7619-1951-1

Gustavsen B. 1992. Dialogue and Development. Social science for social action: towards organisational renewal. Volume 1. Van Gorcum & Comp. b.v. Assen Netherlands.

Halme. M. 2014. Corporate Environmental and Social Responsibility Research at Aalto University.Halme, telephone 14.05.2015, mail https://wiki.aalto.fi/display/CESRR/Corporate+Environmental+and+Social+Responsibility+Research;jsessionid=3683DF5A067DA0DD957BCDEC0004D1EB

Hammond A.L., Kramer W.J., Katz R.S., Tran J.T., Walker C. 2007. The Next 4 Billion, Market size and business strategy at the base of the pyramid. World Resources Institute, International Finance Corporation. iSBN 1-56973-625-1 (soft cover)

Hardon A., Hodgin C., Fresle D. 2004. How to investigate the use of medicines by consumers. Amsterdam. World Health Organization (WHO), University of Amsterdam, Royal Tropical Institute (KIT). Available: [Cited 12.12.2014] http://apps.who.int/medicinedocs/pdf/s6169e/s6169e.pdf

Haupt S., Krämer A. 2012. Bringing Medicines to Low-income Markets. A guide to creating inclusive business models for pharmaceutical companies. BMZ, Federal Ministry for Economic Cooperation and Development. GIZ (The Deutsche Gesellschaft für Internationale Zusammenarbeit). Developed and authored by endeva. Available:

[Cited 15.05.2014] http://www.medicines-for-bop.net/fileadmin/user_upload/publications/Study_BringingMedicinesToLIM_Final.pdf

Heikkilä V.T. 2014. Case studies on release planning in agile development organizations. Aalto University publication series DOCTORAL DISSERTATIONS 6/2015. Aalto University, School of Science, Department of Computer Science and Engineering Software Process Research Group. ISBN 978-952-60-6046-0 (pdf)

Hervie E.M. 2008. Application of Renewable Energy in Fuelling Sustainable Development in Africa, African Alumni Workshop Accra/Kumasi May 2008. Ghana. Africa. Sustainable Energy Systems and Management (SESAM) in University of Flensburg in Germany. Available [Cited 4.2.2010] http://www.iim.uni-flensburg.de/sesam/front_content.php?idart=4559

Holstein J.A., Gubrium J.F. 1995. The Active Interview. Qualitative Research Methods Series 37. Sage Publications. ISBN 0-8039-5894-3.

Hyppänen O. 2013. Decision Makers' Use of Intuition at the Front End of Innovation. Aalto University School of Science Department of Industrial Engineering and Management. Doctoral Dissertations 30/2013. Aalto University Publication Series. ISBN 978-952-60-5030-0 (pdf)

Hyötyniemi H. 2005. Complex systems: Science at the Edge of Chaos. Collected Papers of the Spring 2003 Postgraduate Seminar. Report 145. Helsinki University of Technology (Aalto University). ISBN 951-22-7507-4.

IAASTD. 2009. Agriculture at a cross-roads. Volume V. Sub-Saharan Africa. IAASTD (International Assessment of Agricultural Knowledge, Science and Technology for Development). ISBN 978-1-59726-541-6 (pbk. : alk. paper)

IEA portal. 2014. International Energy Agency (IEA). Topic Energy Poverty. Available: [Cited 20.10.2014] http://www.iea.org/topics/energypoverty/

IEA Energy. 2014. World Energy Outlook 2014. International Energy Agency (IEA), OECD. Paris. IEA Publications. ISBN: 978 92 64 20804 9

IEA. 2014. Africa Energy Outlook. A Focus on Energy Prospects in sub-Sharan Africa. World Energy Outlook Special Report. Paris. OECD/IEA. Available: [Cited 15.10.2014] http://www.iea.org/publications/freepublications/publication/WEO2014_AfricaEnergyOutlook.pdf

IEA. 2013. World Energy Outlook. International Energy Agency. Available: [Cited 02.02.2014] http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/

IEA. 2011. ENERGY FOR ALL, Financing access for the poor, Special early excerpt of the World Energy Outlook 2011, First presented at the Energy For All Conference in Oslo, Norway in October 2011. IEA (International Energy Agency). Available in [Cited 04.09.2014] http://www.worldenergyoutlook.org/resources/energydevelopment/energyforallfinancingaccessforthepoor/

IFAD Annex D. Methods for monitoring and evaluation. Managing for impact of rural development. Annex D in IFAD Guide for Project M&D. IFAD (The International Fund for Agricultural Development). Available: [Cited 10.10.2013] http://www.ifad.org/evaluation/guide/annexd/ and the document http://www.ifad.org/evaluation/guide/annexd/Annex_D-3DEF.pdf; the whole guide Available: [10.10.2013] http://www.ifad.org/evaluation/guide/index.htm

IPCC. 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp, DOI:10.1017/CBO9781107415324

Isaacs W. N. 2002. CREATING A SHARED FIELD OF MEANING: AN ACTION THEORY OF DIALOGUE. Chapter 9 pp.203-241, in the Transformative Power of Dialogue, Volume 12. Elsevier Science Ltd. ISBN: 0-7623-0904-0

Isaacs W.N. 1999. Dialogue and the art of thinking together. New York, London, Toronto, Sydney, Auckland. A Currency book published by Doubley. Roundom House, Inc. ISBN 0-385-47999-9.

ISO 26000. 2008. ISO and social responsibility. ISO. ISBN 978-92-67-10471-3

ISO 14044. 2006. Environmental management — Life cycle assessment — Requirements and guidelines. SFS.

ISO 14040. 2006. Environmental management - Life cycle assessment - Principles and framework. SFS.

Jacobson A., Bond T.C., Lam N.L., Hultman L. 2013. Black Carbon and Kerosene Lighting: An Opportunity for Rapid Action on Climate Change and Clean Energy for Development. Global Views, Policy Paper 2013-03. The Brookings Institution. Massachusetts Ave., NW, Washington DC. Available: [Cited 12.02.2014] http://www.brookings.edu/~/media/research/files/papers/2013/04/climate%20change%20clean%20energy%20development%20hultman/04_climate_change_clean_energy_development_hultman.pdf

Johnson R.B., Onwuegbuzie A.J., Turner L.A. 2007. Toward a definition of mixed methods research. Journal of Mixed Methods Research 2007 Vol. 1 (2), pp.112-133. DOI: 10.1177/1558689806298224.

Johnson U. 2003. Fundamentals of LCA. In LCA/LCM Conference Seattle Center Northwest Rooms - Lopez Room, Seattle, Washington, September 22, 2003. ACLCA (The American Center for Life Cycle Assessment, UNEP, EPA (US Environment Protection Agency). Available: [Cited 23.09.2013] http://www.lcacenter.org/InLCA-LCM03/Fundamentals-presentation.pps

Järvinen T. 2007. Empowerment, A Challenge of Non-Governmental Organizations in Development Cooperation Partnerships. ACADEMIC DISSERTATION University of Tampere Department of Education Finland. Acta Electronica Universitatis Tamperensis 638 ISBN 978-951-44-7022-6 (pdf)

Kahiu N. 2009. Small Scale Wind Energy for Developing Countries. International Workshop. Nairobi Kenya. September 14-16, 2009, Nairobi, Kenya. Royal Minestry of Foreign Affairs of Denmark and Jomo Kenyatta University of Agriculture and Technology Nairobi Kenya. Njeri Waruingi Kahiu, Institute of Energy and Environmental Technology, Jomo Kenyatta University Kenya. Available: [Cited 18.05.2010, relinked 20.11.2015] http://www.vindenergi.dtu.dk/english/-/media/Institutter/Vindenergi/Research/Terminated%20projects/Development%20of%20wind%20energy%20technologies%20in%20Nepal/Workshop%202009/lemi_ken.ashx?la=da

Kane M., Trochim W.M. 2009. Concept Mapping for Applied Social Research. Chapter 14, in Bickman et al. (Eds.) Sage Handbook of Applied Social Research Methods. ISBN 978-1-4129-5031-2.

Kane M., Trochim, W.M.K. (2007). Concept Mapping for Planning and Evaluation. Thousand Oaks, CA. Sage Publication. ISBN 978-1-4129-4027-6

Kellomäki S., Kilpeläinen A., Alam A. 2013. Forest BioEnergy Production, Management, Carbon Sequestration and Adaptation. Springer. New York, Heidelberg, Dordrecht, London. ISBN 978-1-4614-8390-8. DOI 10.1007/978-1-4614-8391-5.

Kemmis S. 2008. Critical Theory and Participatory Action Research. Chapter 8, in Reason et al. 2008 (Eds.) The SAGE Handbook of Action Research. Participatory Inquiry and Practice. Sage Publication Ltd/Inc. London. Thousands Oaks. New Delhi. Singapore. ISBN 978-1-4129-2029.

Keränen T. 2010. Change in Organization - Emerging Situations, Characters and Praxis. Aalto University School of Science and Technology. Department of Industrial Engineering and Management. Doctoral Dissertation Series 2010/12. Espoo. ISBN 978-952-248-111-5

Kimaro A.A., Timmer V.R., Mugasha A.G., Gamshama S.A.H. Kimaro D.A. 2007. Nutrient use efficiency and biomass production of tree species for rotational woodlot systems in semi-arid Morogoro, Tanzania. Agroforest Syst. Springer Science+Business Media B.V. 2007. DOI 10.1007/s10457-007-9061-x.

Klöpffer W. 2008. Life cycle sustainability assessment of products. International Journal of Life Cycle Assessment, vol. 13, no. 2, pp. 89-95.

Kuzel, A.J. 1999. Sampling in qualitative inquiry. In BF Crabtrree and WL Miller (Eds.) Doing Qualitative Research (second edition). Thousand Oaks, CA: Sage Publlications (pp. 33-45)

Langvik T.Å. 2004. Innovation and regional development. Østfold Research Foundation. Available: [Cited 25.09.2014] http://ostfoldforskning.no/uploads/dokumenter/publikasjoner/90.pdf in http://ostfoldforskning.no/home.aspx

Lehtonen M.J. 2014. Visual knowing and visualizing knowledge in knowledge-intensive organizations. Aalto University School of Business Department of Management Studies FLUID research group. Doctoral Dissertations 43/2014. Aalto University Publication Series.

Leke A., Lund S., Manyika J., Ramaswamy S. 2014. Lions go global: Deepening Africa's ties to the United States. McKinsey&Company. Available: [Cited 18.12.2014] http://www.mckinsey.com/~/media/McKinsey/dotcom/Insights/Globalization/Lions%20go%20global%20Deepening%20Africas%20ties%20to%20the%20United%20States/MGI_Lions_go_global-Deepening_Africas_ties_to_the_US.ashx

Lighting Africa. Solar Lighting for the Base of the Pyramid- Overview of an Emerging Market- . Photo: Jamie Seno, Kenyan schoolgirls using a solar tasks lamps. Available: [Cited 13.03.2015] https://www.lightingafrica.org/wp-content/uploads/bsk-pdf-manager/Solar%20Lighting%20for%20the%20BOP-%20overview%20of%20an%20emerging%20mkt.pdf

London T., Anupindi R. 2011. Using the base-of-the-pyramid perspective to catalyze interdependence-based collaborations. Proceedings of the National Academy of Science of the United States of America (PNAS). PNAS Early Edition. www.pnas.org/cgi/doi/10.1073/pnas.1013626108

Lorentz portal. (2015) Solar Water Pumping Applications. Available: [20.11.2015] http://www.lorentz.de/en/home/?campaign=adwords&gclid=CJLq38zuockCFcZuGwodLzAJ2A

Lozano R. 2015. A Holistic Perspective on Corporate Sustainability Drivers. Corporate Social and Environmental Management, Vol. 22 (2015) Issue 1, pp.32-44. DOI: 10.1002/csr.1325. The enhanced article (HTML), Available: [Cited 12.01.2015] http://onlinelibrary.wiley.com.libproxy.aalto.fi/enhanced/doi/10.1002/csr.1325

Ludwig J., Marufu L.T., Huber B., Andreae M.O., Helas G. 2002. Domestic Combustion of Biomass Fuels in Developing Countries: A Major Source of Atmospheric Pollutants. Journal of Atmospheric Chemistry Vol. 44(2003) p.23-27. Kluwer Academic Publishers.

Maisiri N., Senzanje A., Rockstrom J., Towlow S.j. 2005. On farm evaluation of the effect of low cost drip irrigation on water and crop productivity compared to conventional surface irrigation system. Physics and Chemistry of the Earth 30 (2005) 783–791. Elsevier Ltd. DOI:10.1016/j.pce.2005.08.021.

MASH. 2013. Development Policy Analysis with MASH, World Bank's computer application Maquette for MDG simulations, Available: [Cited 13.01.2013] http://www.worldbank.org/mams

Maslow A.H. 2000. The Maslow Business Reader. Edited by Stephens D.C. John Wiley & Sons, Inc. ISBN 0-471-36008-2.

Mason J. 2006. Mixing Methods in quality driven way. Qualitative Research 2006 6:9. Sage Publications. DOI: 10.1177/1468794106058866

Maxwell J.A. 2009. Designing a Qualitative Study. The Chapter 7, in the book, Sage Handbook of Applied Social Research Methods/ ed. Bickman L, Rog D.J. 2009. ISBN 978-1-4129-5031-2.

Maxwell J.A. 1996. Qualitative Research Design. An Interactive Approach. Applied Social research Methods Series Volume 41. Thousand Oaks, London, New Delhi. SAGE Puplication. ISBN 0-8039-7329-2.

McCoy D., Watts N. 2014. CLIMATE CHANGE: HEALTH IMPACTS AND OPPORTUNITIES. A SUMMARY AND DISCUSSION OF THE IPCC WORKING GROUP 2 REPORT. The Global Climate & Health Alliance. Available: [Cited 12.06.2014] http://www.medact.org/wp-content/uploads/2014/04/medact_climatescience_Briefing2_Web.pdf

Mifuko portal. Mifuko shop, African products design in Finland, artisans made in Kenya or other African country. Available: [Cited 12.03.2015] http://www.mifuko.fi

Mijikenda portal. 2015. Mijikena design, EXTRAORDINARY ARTWORK CREATED IN EAST AFRICA. Photography by Mike Atkelslky. Available: [Cited 12.01.2015] http://www.mijikenda.com

Misana S., Karlson G. 2001. Generating Opportunities. Case Studies on Energy and Women. United Nations Development Programme (UNEP) Sustainable Energy. New York. ISBN 92-1-126124-4.

Morales T.D. 2010. Design of Small Photovoltaic (PV) Solar-Powered Water Pump System. Technical Note No. 28, Portland Oregon, United States Department of

Agriculture (USDA). Available: [Cited 18.10.2014]
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_046471.pdf

Morra L.G., Friedlander A.C. Case Study Evaluations. World Bank OED (Operations Evaluation Department). Available: [Cited 10.09.2013]
http://ieg.worldbankgroup.org/Data/reports/oed_wp1.pdf

Mukherji A., Facon T. 2009. Revitalizing Asia's Irrigation: To sustainably meet tomorrow's food needs. International Water Management Institute (IWMI), Food and Agriculture Organization (FAO) and Asia Pasific Water Forum. Funded by Asia Development Bank (ADB). ISBN 978-92-9090-709-1. Available: [Cited 05.05.2010]
http://www.fao.org/nr/water/docs/Revitalizing_Asias_Irrigation.pdf

Muralikrishna M., Lakshminarayana V. (2008) HYBRID (SOLAR AND WIND) ENERGY SYSTEMS FOR RURAL ELECTRIFICATION. ARPN Journal of Engineering and AppliedSciences. VOL. 3, NO. 5, OCTOBER 2008. ISSN 1819-6608.

NAPS. 2014. NAPS Solar Systems. Available: [Cited 12.01.2015]
http://www.napssystems.com/wordpress/

NAPS. 2013. NAPS Solar Systems. Available: [Cited 09.04.2015]
http://www.napssystems.com/wordpress/about-us/naps-systems-ltd/, Photo: *'A woman and her garden, Solar Electricity Systems'* NAPS Brochure 2013, (NAPS Water, 2015)

NAPS Health. 2015. Solar power for Mozambique health facilities. Available: [Cited 11.01.2015] http://www.napssystems.com/wordpress/about-us/references/mozambique-health-facilities/

NAPS Light. 2015. NAPS Northern Light. Available: [Cited 14.02.2015]
http://www.napssystems.com/wordpress/products/outdoor-lighting/

NAPS School. 2015. Available: [Cited 11.01.2015]
http://www.napssystems.com/wordpress/for-humanitarian-aid/schools-offices-and-shelters/

NAPS SHS. 2015. NAPS Solar Home Systems. Available: [Cited 3.12.2015]
http://www.napssystems.com/wordpress/for-humanitarian-aid

NAPS Water. 2015. Solar-powered water pumping for drinking, animal care and irrigation. Available: [Cited 20.10.2014] http://www.napssystems.com/wordpress/for-humanitarian-aid/water-pumps/, and NAPS Solar Pumping System
http://www.napssystems.com/wordpress/products/solar-pumping-systems/

Narayanamoorthy A. 2009. POTENTIAL FOR DRIP AND SPRINKLER IRRIGATION IN INDIA. Available: [Cited 14.10.2011]
http://nrlp.iwmi.org/PDocs/DReports/Phase_01/12.%20Water%20Savings%20Technologies%20-%20Narayanmoorthy.pdf

NDF. 2014. BENIN: SOLAR GARDENS. Nordic Development Fund (NDF). Available: [Cited 24.04.2014] http://www.ndf.fi/projects/benin

Nellemann C., MacDevette M., Manders T., Eickhout B., Svihus B., Prins A.G., Kalterborn B.P. 2009. The Environmental Food Crisis. The environment's role in averting future food crisis. A UNEP Rapid Response Assessment. United Nations Environment Program. Grid-Arendal. ISBN 978-82-7701-054-0.

Nogamu portal. 2014. National Organic Agricultural Movement of Uganda. Available: [Cited 30.04.2014] http://www.nogamu.org/index.php?page=nog_home

Novick B., Cress J.S., Elias M.J. 2002. Building Learning Communities with Character. How to integrate Academic, Social, and Emotional Learning. ASCD, Association for Supervision and Curriculum Development. eISBN 9781416602620

OECD. (2014) INCOME INEQUALITY UPDATE. Rising inequality: youth and poor fall further behind. Insights from the OECD Income Distribution Database, June 2014 . Available: [Cited 12.01.2015] http://www.oecd.org/els/soc/OECD2014-Income-Inequality-Update.pdf

Okafor B.E. 2013. Performance Evaluation of a Parabolic Solar Cooker. International Journal of Engineering and Technology Volume 3 No. 10, October 2013. ISSN 2049-344

Oman I. 2004. MULTI-CRITERIA DECISION AID AS AN APPROACH FOR SUSTAINABLE DEVELOPMENT ANALYSIS AND IMPLEMENTATION. Dissertation zur Erlangung des akademischen Grades einer Doktorin der Sozial- und Wirtschaftswissenschaften an der Karl-Franzens Universität Graz. Graz. Available: [Cited 12.3.2014] http://seri.at/wp-content/uploads/2010/05/Omann_2004_SustainableDevelopment-and-MCDA_PhD.pdf

Ouma C.A. 2011. Hybrid Energy System for Off – Grid Rural Electrification (Case study Kenya). MSC WIND POWER PROJECT MANAGEMENT, GOTLAND UNIVERSITY. Department of Wind Energy Gotland University. 30.5.2011. Available: [New Cited 12.10.2013; Cited 18.10.2011] http://www.computationalrenewables.com/bahriuzunoglu/publications/Clint_Arthur.pdf

Oxfam. 2014. Even It Up. Time to End Extreme Inequality. Oxford. Oxfam GB for Oxfam International. ISBN 978-1-78077-721-4

Oxford Dictionaries online. Available: [Cited 12.03.2014] http://www.oxforddictionaries.com/definition/english/human-being?q=human+being

Patton M.Q. 1990. Qualitative Evaluations and Research Methods. Beverly Hills, CA: Sage Publication, Inc. ISBN O-8039-3779-2

Paulo Pinho. 2008. USAGE AND CONTROL OF SOLID-STATE LIGHTING FOR PLANT GROWTH. Dissertation. Report 49. Helsinki University of Technology Faculty of Electronics, Communication and Automation Department of Electronics, Lighting Unit. Espoo 2008. ISBN 978-951-22-9502-9 (pdf)

Perlis A. 2006. Forest and Human Health. Unasylva 224 Vol. 57 2006/2. FAO. ISSN 0041-6436.

Petersen E.E. 2013. Tracking down Social Impacts of Products with Social Life Cycle Assessment. Doctoral Thesis in Planning and Decision Analysis with specialisation in Environmental Strategic Analysis. Environmental Strategies Research, Department of Sustainable development, Environmental science and Engineering School of Architecture and the Built Environment. KTH Royal Institute of Technology. TRITA-FMS-PHD 2013:01, ISBN 978-91-7501-976-5

Poppendieck D., Apple J., Vicente R., Yarberry A., Loshe N., Tracy J. 2010. Exposure to Particulate Matter from Kerosene Lamps. Lighting Africa Conference 2010, 2nd International Business and Trade Fair in Nairobi Kenya.

Prahalad C.K. 2010. The Fortune at the Bottom of the Pyramid. Pearson Education, Inc. ISBN-13 978-0-13-700927-5

Prato B., Longo R. 2012. Empowerment of poor rural people through initiatives in agriculture and natural resource management. Promoting pro-poor growth - the role of empowerment. OECD. Available: [Cited 4.10.2013]
http://www.oecd.org/dac/povertyreduction/50157503.pdf

Prüss-Üstün A., Boss R., Gore F., Bartram J. 2008. Safe Water, Better Health. Costs, benefits and sustainability of interventions to protect and promote health. WHO (World Health Organization). Geneva. ISBN 978 92 4 159643 5.

Reason P., Bradbury H. 2008. The SAGE Handbook of Action Research. Participatory Inquiry and Practice. Sage Publication 2008. London. Thousands Oaks. New Delhi. Singapore. ISBN 978-1-4129-2029.

Robson C. 2002. Real World Research. A Resource for Social Scientists and Practitioner Researchers. Blackwell Publishing. Second Edition. ISBN 0-631-21304-X (hardcover), ISBN 0-631-21305-8(paperback).

Rudd M., Aaker J., Norton M.I. 2014. Getting the Most out of Giving: Concretely Framing a Prosocial Goal Maximizes Happiness *. Research Paper No. 2145. Research Paper Series. Graduate School of Stanford Business. Available: [Cited 15.05.2014]
http://ssrn.com/abstract=2424103

Saarinen E., Hämäläinen R.P. 2004. Systems Intelligence: Connecting Engineering Thinking with Human Sensitivity, in: RAIMO P. HÄMÄLÄINEN AND ESA SAARINEN (EDS.). 2004. Systems Intelligence – Discovering a Hidden Competence in Human Action and Organizational Life, Helsinki University of Technology: Systems Analysis Laboratory Research Reports, A88, October 2004. ISBN 951-22-7168-0

Saarinen R. 2015b. Wellbeing of African villagers within their community empowered by new sustainable energy services. Licentiate thesis. The School of Electrical Engineering, Aalto University. Available 16.06.2015 http://urn.fi/URN:NBN:fi:aalto-201506163190

Saarinen R. 2014u. CASE SMILE: Nutritious Food, Clean Water, Health, Education and Agricultural Productivity. Espoo. Department of Energy Technology. School of Science and Technology. Aalto University. Unpublished.

Saarinen R. 1997. Networked Multimedia Applications of the Internet When and how will these new applications be deployed?. Helsinki University of Technology, Telecommunications Software and Multimedia Laboratory. (Current Aalto University). Available: [Cited 15.05.2014] http://www.cse.tkk.fi/fi/opinnot/T-110.5190/1997/netwmula.htm. The paper version Adapting Internet-based Training (IBT) and Virtual Reality (VR) to the Project for the Learning Course of Mobile Phones Systems. Helsinki University of Technology Telecommunication Software and Multimedia Laboratory. 17.03.1997.

SAGCOT. (2013) Southern Agricultural Growth Corridor of Tanzania (SAGCOT) Strategic Regional Environmental and Social Assessment. Government of Tanzania. This report was prepared by Environmental Resources Management Limited (ERM) under contract Bank of Tanzania on behalf of the Government of Tanzania: RFP Number: Pa/082/hq/S/Sagt/pmu/7; ERM Project Number: 0159588
Cover graphic: indicative map of SAGCOT prepared by SAGCOT Centre Ltd.

Sapkota S.K., Tamrakar S.R. 2011. Presentation on Current Status of Nepal's Solar Projects and Other RE Programs. Solar 2011 Conference, May 15-21, 2011, Raleigh, North Carolina, USA. Available: [Cited 2.03.2013] http://www.sari-energy.org/PageFiles/What_We_Do/activities/SOLAR_2011/Presentations/SOLAR_Nepal.pdf

Sasson A. 2012. Food security for Africa: an urgent global challenge. Agriculture & Food Security 2012 1:2. Doi:10.1186/2048-7010-1-2, http://www.agricultureandfoodsecurity.com/content/1/1/2.

Senge P.M. 2006. The Fifth Discipline. The Art & Practice of the Learning Organization. Doubleday, Random House Inc. ISBN 978-0-385-51725-6. The first edition in 1990.

Sheikh R.I. 2014. ENERGY AND WOMEN'S ECONOMIC EMPOWERMENT: RETHINKING THE BENEFITS OF IMPROVED COOKSTOVE USE IN RURAL INDIA. A Thesis submitted to the Faculty of the Graduate School of Arts and Sciences of Georgetown University in partial fulfillment of the requirements for the degree of Master of Public Policy in Public Policy. Washington D.C. Available: [Cited 20.10.2014] https://repository.library.georgetown.edu/bitstream/handle/10822/709861/Sheikh_georgetown_0076M_12533.pdf?sequence=1

Shivrath Y., Narayana P.B., Thirumalasetty S., Narsaiah E.L. 2012. Design & Integration of Wind-Solar Hybrid Energy System for Drip Irrigation Pumping Application. International Journal of Modern Engineering Research (IJMER). Vol.2, Issue.4, July-Aug 2012 pp-2947-2950. ISSN: 2249-6645.

SIDA. 2008. Organic Exports – A Way to a Better Life? Export Promotion of Organic Products from Africa by Epopa and SIDA for Agro Eco BV and Grolink AB. ISBN: 978-91-633-3233-3.

Silungwe F.R., Mahoo H.F., Kashaigili J.J. 2010. Evaluation of water productivity for maize under drip irrigation. Research Application Summary. Second RUFORUM Biennial Meeting 20 - 24 September 2010, Entebbe, Uganda. Available: [Cited 18.09.2011, redirected 20.11.2015] http://mak.ac.ug/documents/RUFORUM/Silungwe.pdf

Silverman D. 2006. Interpreting Qualitative Data. Methods for Analyzing Talk, Text and Interaction. Third Edition. SAGE Publications. ISBN13 978-1-4129-2244-9

Silverman D. 2005. Doing Qualitative Research. Second Edition. SAGE Publications. ISBN 1978-1-4129-0196-3

Simula H. 2012. Management of Commercialization. Case Studies of Industrial, Business-to-Business Product Innovations. Aalto University publication series DOCTORAL DISSERTATIONS 122/2012. Aalto University, School of Science, Department of Industrial Engineering and Management BIT Research Centre. ISBN 978-952-60-4792-8 (pdf)

Sivanappan R.K. 1994. Prospects of micro-irrigation in India. Irrigation and Drainage Systems 8: 49-58, 1994. Kluwer Academic Publishers. Printed in the Netherlands.

Slaski X., Thurber M. 2009. Cookstoves and Obstacles to Technology Adaptation By The Poor. Research Note. Working Paper #89. October 2009. Program on Energy and Sustainable Development (PESD). Available: [Cited 20.08.2011] http://iis-db.stanford.edu/pubs/22678/WP_89,_Slaski_Thurber,_Tech_adoption_framework_for_poor,_16Oct09.pdf

SLEF. 2014. The Swedish Lutheran Evangelical Association in Finland. Available: [03.04.2014] http://www.slef.fi/om-slef/in-english

SLEF ABC Water. 2012. ABC Water supply project. Available: [Cited 18.03.2014] http://www.slef.fi/utlandet/utvecklingssamarbete/vattenprojekt/abc-vattenforsorjning

SLEF Kenya. 2015. East Kenya. Available: [Cited 12.02.2015] http://www.slef.fi/utlandet/kenya-vastra-kenya

SLEF MSB. 2014. SLEF Micro-small business, start-up investment support. Available: [Cited 18.03.2014] http://www.slef.fi/utlandet/kenya-vastra-kenya/smaforetag

SLEF REP. 2014. Development Co-operation work, REP (Rural Education Program) Available: [Cited 18.03.2014] http://www.slef.fi/utlandet/utvecklingssamarbete/utbildningsprogram/bilder-av-rep-studerande

SLEF UVS. 2014. Development Co-operation work, Utvecklingssamarbete. Available: [Cited 10.12.2014] http://www.slef.fi/utlandet/utvecklingssamarbete

SLEF Women. (2014) Development Co-operation work among women, Arbete bland kvinnor. Available: [Cited 18.12.2014] http://www.slef.fi/utlandet/kenya-vastra-kenya/arbete-bland-kvinnor

SLEF Nyagowa. (2015) Nyagowa Water supply project for the community of 5000 people, two schools (800 students), and health clinic (7000 patients per year), the solar-powered system. Available: [Cited 09.01.2015] http://www.slef.fi/utlandet/utvecklingssamarbete/nytt-vattenforsorjningssystem-till-nyagowa-kenya

Smith K.R. 2006. Health impacts of household fuelwood use in developing countries. Forest and Human Health. Forestry Department. FAO Corporate Document Repository. Food and Agriculture Organization in the UN (FAO). Available: [Cited 17.05.2011] http://www.fao.org/docrep/009/a0789e/a0789e09.html in the paper Perlis A. 2006.

Smith K.R. 2000. National Burden of Disease in India from Indoor Air Pollution. Proceedings of the National Academy of Sciences PNAS November 21, 2000, Vol. 97 No. 24 pp.13286-13293.

Srilata K. 2011. Adapting to Climate Change. UNDP-GEF initiatives financed by the least developed countries fund, special climate change fund and strategic priority on adaptation. Global Environment Facility (GEF), United Nations Development Programme (UNEP). New York. Available: [Cited 13.09.2012, redirected 20.11.2015] http://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/climate-change/adapting-to-climate-change/UNDP_Adaptation_Annual_Report_2010.pdf

Stanford Benin 2011. Kalalé Solar Electrification Project. Available: [Cited 17.10.2011] http://www.stanford.edu/group/solarbenin/gallery/index.html, home page for the project http://web.stanford.edu/group/solarbenin/results.html, the project profile http://www.stanford.edu/group/solarbenin/references/Benin-Project-Profile.pdf , Photo: *'A woman and her garden, Solar Electricity Systems'* NAPS Brochure, (NAPS Water, 2015)

Stricklin A.D. 2006. Ilunda Ward, Tanzania Water Project. Outreach Africa. Pumping with Solar Power. Water and Wind LLC. Available: [Cited 12.04.2010] http://www.outreachprogram.org/wp-content/uploads/2011/05/waterreport-2006-10.pdf, redirected [20.11.2015] to SMILE Case Clean Water in this TAMAA Case study report (at the end of this document)

Suple Y.R., Tombre S.B. 2013. Performance Evaluation of Parabolic Solar Disc for Indoor Cooking. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684 Volume 4, Issue 6 (Jan. - Feb. 2013), pp. 42-47.

Tanji K.K., Kielen N.C. 2002. Agricultural drainage water management in arid and semi-arid areas. FAO Drainage and Irrigation paper 61. FAO. ISBN 92-5-104839-8.

Teddlie C., Yu W. 2007. Mixed Methods Sampling, A Typology With Examples. Journal of Mixed Methods Research, Vol. 1 No. 1 January 2007 pp.77-100. Sage Publications. DOI:10.1177/2345678906292430.

thisisFinland. Social entrepreneurship rising in Finland. this is Finland. Copyright The Ministry for Foreign Affairs of Finland. Available: [Cited 18.12.2014] http://finland.fi/Public/default.aspx?contentid=298710&nodeid=37602&culture=en-US

Torres-Duque C., Maldonado D., Pérez-Padilla R., Ezzati M., Viegi G.. 2008. Biomass Fuels and Respiratory Diseases. A Review of the Evidence. Forum of International Respiratory Societies Report. Task Force on Health Effects of Biomass Exposure by

Torres-Duque C., Maldonado D., Pérez-Padilla R., Ezzati M., Viegi G on behalf of the Forum of International Respiratory Societies (FIRS) Task Force on Health Effects of Biomass Exposure. Proc Am Thorac Soc Vol.5 (2008) p.577-590. DOI: 10.1513/pats.200707-100RP.

Trenberth K. E. 2005. The Impact of Climate Change and Variability on Heavy Precipitation, Floods, and Droughts. National Center for Atmospheric Research, Boulder, CO, USA. Encyclopedia of Hydrological Sciences. Edited by M G Anderson. John Wiley & Sons, Ltd. Available: [Cited 10.03.2014] http://acacia.ucar.edu/staff/trenbert/books/EHShsa211.pdf

TriplePundit. 2015. People, planet, profit. Corporate Social Responsibility Pdf Library. Available: [Cited 12.01.2015] http://www.triplepundit.com/corporate-social-responsibility-pdf/

Tähkämö L. 2013. Life cycle assessment of light sources – Case studies and review of the analyses. Aalto University School of Electrical Engineering Department of Electronics Lighting Unit. Aalto University Publication Series Doctoral Dissertation 111/2013

UN Africa MDG. 2013. Assessing Progress in Africa toward the Millennium Development Goals. MDG Report 2013. Food security in Africa: Issues, challenges and lessons. The UN, UNESCO, African Union, African Development Bank Group, UNDP. Available: [Cited 03.03.2014, redirected 20.11.2015] http://www.undp.org/content/dam/undp/library/MDG/english/MDG%20Regional%20Reports/Africa/MDG%20Report2013_ENG_Fin_12June.pdf

UN ESA. 2013. World Economic and Social Survey 2013, Sustainable Development Challenges, E/2013/50/Rev. 1 ST/ESA/344. UN New York 2013. eISBN 978-92-1-056082-5

UN HR Env. 2015. Human Rights and Environment. The United Nations (UN). Available: [Cited 11.02.2015] http://www.ohchr.org/EN/Issues/Environment/IEEnvironment/Pages/IEenvironmentIndex.aspx

UN Human Rights. 2014. Human Rights Portal, The United Nations (UN). Available: [Cited 11.05.2011, redirected 20.11.2015] http://www.un.org/en/sections/what-we-do/protect-human-rights/index.html , The Universal Declaration of Human Rights, Available: [11.05.2011, redirected 20.11.2015] http://www.un.org/en/universal-declaration-human-rights/index.html

UN MDG. 2013. United Nations' millennium Developments Goals Report 2013. United Nations. New York. Available: [Cited 10.10.2014] http://www.un.org/millenniumgoals/pdf/report-2013/mdg-report-2013-english.pdf

UN MDG Goal 2. 2013. We can end poverty. Millennium Development Goals and Beyond 2015. The United Nations. Goal 2. Available: [Cited 12.04.2014] http://www.un.org/millenniumgoals/education.shtml

UN MDG. 2012. United Nations' millennium Developments Goals Report 2012. United Nations. New York. Available: [Cited 26.10.2012] http://www.undp.org/content/dam/undp/library/MDG/english/The_MDG_Report_2012.pdf

UN MDG. 2005. Achieving the Millennium Development Goals. A GEF (Global Environment Facility) Progress Report. GEF, September 2005. ISBN 1-884122-49-3.

UN Water portal. International Decade for Action 'Water for Life Available' 2005-2015. [Cited 13.06.2014] http://www.un.org/waterforlifedecade/food_security.shtml

UN Water WWDR. 2014. Water and Energy. The United Nations World Water Development Report 2014. Volume 1. The United Nations World Water Assessment Programme. Paris. UNESCO. ISBN 978-92-3-104259-1, ePub ISBN 978-92-3-904259-3.

UN Water WWDR3. 2009. Water in a Changing World. The United Nations World Water Development Report 3. World Water Assessment Programme. UNESCO Publishing. eartscan. ISBN: 978-9-23104-095-5

UN WCED. 1987. Our Common Future. United Nations, World Commission on Environment and Development (WCED). Available: [Cited 28.08.2012] http://conspect.nl/pdf/Our_Common_Future- Brundtland_Report_1987.pdf

UN WFP portal. 2014. World Food Program. Available: [Cited 12.06.2014] http://www.wfp.org

UNCCD. Water scarcity and desertification. UNCCD (The United Nations Convention to Combat Desertification) thematic fact sheet series No. 2. Available: [Cited 14.06.2014] http://www.unccd.int/Lists/SiteDocumentLibrary/Publications/Desertificationandwater.pdf

UNCTAD. 2011. The Least Developed Countries Report. 2011. The Potential Role of South-South Cooperation for Inclusive and Stainable Development. United Nations Conference on Trade and Development (UNCTAD). New York and Geneva. ISBN 978-92-1-112835-2.

UNDP Sub-Sharan. 2013. Standardized Baseline Assessment for Rural Off-Grid-Electrification in Sub-Saharan Africa. A standardization tool to streamline and simplify the CDM project cycle. United Nations Development Programme (UNDP). Available: [Cited 13.03.2014] http://www.er.undp.org/content/dam/eritrea/docs/Environment/Standardized%20Baseline%20Assessment%20for%20Rural%20Off-Grid%20Electrification%20in%20Sub%20Saharan%20Africa_Nov2013.pdf

UNDP. 2013. Achieving Sustainable Energy for All in the Asia-Pacific. United Nations Development Programme (UNDP). Asia-Pacific Regional Centre. ISBN: 978-974-680-357-1.

UNDP. 2011. ADAPTING TO CLIMATE CHANGE. UNDP-GEF Iniatives Financed by the Least Developed Countries Fund, Special Climate Change Fund and Strategic Priority on Adaptation. UNDP (The United Nations Development Programme). New York. Available: [Cited 12.03.2013] http://www.undp.org/content/undp/en/home/librarypage/environment-energy/climate_change/adaptation/adapting-to-climate-change.html

UNDP. 2007. Capacity Assessment Methodology. Capacity Development Group Bureau for Development Policy May 2007. United Nations Development Programme (UNDP). Available [Cited 15.10.2013] http://europeandcis.undp.org/uploads/public/File/Capacity_Development_Regional_Training/UNDP_Capacity_Assessment_Users_Guide_MAY_2007.pdf

UNDP GINI/HDI. 2013. Income Gini coefficient. Available: [Cited 11.01.2015] http://hdr.undp.org/en/content/income-gini-coefficient

UNEP/SETAC. 2013. THE METHODOLOGICAL SHEETS FOR SUBCATEGORIES IN SOCIAL LIFE CYCLE ASSESSMENT (S-LCA). Pre-Publication Version. Milan. UNEP DTIE Sustainable Consumption and Production Branch. Available: [Cited 22.01.2015] http://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA_methodological_sheets_11.11.13.pdf

UNEP/SETAC. 2009. Guidelines for Social Life Cycle Assessment of Products. Social and socio-economic LCA guidelines complementing environmental LCA and Life Cycle Costing, contributing to the full assessment of goods and services within the context of sustainable development. Milan. UNEP DTIE Sustainable Consumption and Production Branch. ISBN: 978-92-807-3021-0

UNEP. 2006. Africa Environment Outlook 2, Our Environment, Our Wealth. United Nations Environment Programme (UNEP). ISBN 92-807-2691-9.

UNESCO EFA Goals. UNESCO Goals for EFA (Education for All), Available: [Cited 12.03.2014, redirected 20.11.2015] http://www.unesco.org/new/en/education/themes/leading-the-international-agenda/education-for-all/efa-goals/

UNESCO EFA. 2014. Teaching and Learning: achieving quality for all. Gender Summary. EFA Global Monitoring Report. United Nations Girls's Education Initiative (UNGEI). UNESCO. The Education for All (EFA) Global Monitoring Report is an independent annual publication. It is facilitated and supported by UNESCO. http://unesdoc.unesco.org/images/0022/002266/226662e.pdf

UNESCO EFA Global. 2014. Teaching and Learning: achieving quality for all. EFA Global Monitoring Report. The Education for All (EFA) Global Monitoring Report is an independent annual publication. It is facilitated and supported by UNESCO. ISBN 978-92-3-104255-3.

UNESCO Education. 2013. TECHNOLOGY, BROADBAND AND EDUCATION, ADVANCING THE EDUCATION FOR ALL AGENDA, A Report by the Broadband Commission Working Group on Education. Available: [Cited 16.05.2013] http://www.broadbandcommission.org/work/working-groups/education/BD_bbcomm-education_2013.pdf

UNESCO 2010. Figure Sub-Saharan Africa's Education Challenge, http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/ED/GMR/pdf/gmr2010/carte-ssa-en.pdf

UNESCO 2000. World Education Report 2000. The right to education: towards education for all throughout life. UNESCO Publishing. Available: [12.04.2010] http://www.unesco.org/education/information/wer/PDFeng/wholewer.PDF

UNFCCC. 2014. *A young girl showing off a solar lantern in the central charging station kiosk / Wim Verdouw'* Markus Linder. Available: [Cited 12.04.2015] http://newsroom.unfccc.int/clean-energy/nobel-prize-awarded-for-energy-efficient-leds/

UNIDO. SUSTAINABLE ENERGY FOR ALL: the gender dimensions. UNIDO (United Nations Industrial Development Organization, UN Women. Available: [Cited 12.09.2014] http://www.unido.org/fileadmin/user_media_upgrade/What_we_do/Topics/Women_and_Youth/GUIDANCENOTE_FINAL_WEB.pdf

Urban, G.L & Hauser, J.R. 1993. Design and Marketing of New Products. Pentice-Hall, Inc., Upper Saddle River, New Jersey 07458. ISBN-0-13-201567-6.

Varis O. 2006. Land Degration. Aalto University. AN EXPLORATION INTO AN URBANIZING WORLD: Interconnections of Water, Food, Poverty and Urbanization. Available: [Cited 14.06.2014] http://global.tkk.fi/course_material/Kirja_PDF/Chapter%206.2%20%20Land%20Degradation.pdf

Vincke P. 1992. Multicriteria Decision-Aid. John Wiley & Sons Ltd. ISBN 0-471-93184

Wang M. 2009. Applying anaerobic digestion for onsite treatment of domestic waste water and biowaste at a low temperature in Finland - considering the Chinese experiences. Master Thesis. Renewable Energy Programme, The Environmental Science and Technology Division, Department of Biological and Environmental

Science, Faculty of Mathematics and Science, University of Jyväskylä.

Available:[Cited 23.02.2010] https://jyx.jyu.fi/dspace/bitstream/handle/123456789/22714/URN_NBN_fi_jyu-200912284579.pdf?sequence=1

Watatu portal. 2014 May. African products to Sweden. Available: [Cited 30.04.2014] http://www.watatu.com

Wenger E. 2004. Communities of Practice: Learning, meaning, and identity. Cambridge University Press. ISBN 0 521 66363 6. First published in 1998.

WFP portal. 2015. World Food Program. Hunger. Available: [Cited 09.01.2015] http://www.wfp.org/hunger/who-are

WHO 2012. Health Indicators of sustainable energy in in the Context of the Rio+20 UN Conference on Sustainable Development, Initial findings from a WHO Expert Consultation: 17-18 May 2012. Available: [Cited 11.04.2014] http://www.who.int/hia/green_economy/indicators_energy2.pdf

WHO 2011. Health Situation Analysis in the African Region, Atlas of Health Statistics, 2011. ISBN: 978 929 023 1769 (NLM Classification: W16 and W17)

WHO. 2009. Global health Risks: mortality and burden of disease attributable to selected major risks. World Health Organization (WHO). ISBN 978-92-4-156387-1.

WHO Indoor. 2010. Indoor air pollution and household energy directory of references. Available: [Cited 22.5.2010] http://www.who.int/heli/risks/indoorair/indoorairdirectory/en/

WHO Malaria. 2013. Malaria Report by the Secretariat. WHO (World Health Organization). SIXTY-SIXTH WORLD HEALTH ASSEMBLY A66/21. Provisional agenda item 16.3. 22 March 2013. Available: [15.05.2014] http://www.who.int/malaria/report_secretariat_malaria_A66_21_en.pdf

WHO PM. 2011. Air quality and health Fact sheet No 313. Guidelines for Particle Matters (PM). Available: [Cited 18.10.2011] http://www.who.int/mediacentre/factsheets/fs313/en/

WHO&Unicef. 2013. Progress on Sanitation and Drinking Water. Update 2013. World Health Organization and UNICEF 2013. ISBN 978 92 4 150539 0.

Whyte W.F. 1991. Participatory Action Research. Newbury Park, California. Sage Publications, Inc. ISBN 0-8039-3742-3.

Wilkinson R., Pickett K. 2010. The spirit level: why equality is better for everyone. London. Penguin. ISBN 978-0-214-95420-4

Women's Bank. 2014. What is Women Bank? Available: [Cited 10.04.2014] http://www.naistenpankki.fi/en/

Women's Bank. 2014. Angola. Saving groups and small businesses. Available: [Cited 10.04.2014] http://www.naistenpankki.fi/en/our-projects/angola/

Women's Bank. 2014. DR Congo. Women's Bank supports two vocational training centers in Congo, where young women and girls get their start in small entrepreneurship and livelihood. Available: [Cited 10.04.2014] http://www.naistenpankki.fi/en/our-projects/congo/

Women's Bank. 2014. Uganda. Women's Bank supports savings and loan groups in Uganda. Available: [Cited 18.12.2014] https://www.naistenpankki.fi/en/our-projects/uganda/

World Bank GINI. GINI index (World Bank estimate) Available: [12.01.2015] http://data.worldbank.org/indicator/SI.POV.GINI

World Bank. 2014. World Development Indicators (WDI) 2014. The World Bank. Washington. ISBN (paper): 978-1-4648-0163-1, ISBN (electronic): 978-1-4648-0164-8, DOI: 10.1596/978-1-4648-0163-1.

World Bank. 2013 GMR. Global Monitoring Report 2013. The World Bank and International Monetary Fund. ISBN: 978-0-8213-9806-7, eISBN: 978-0-8213-9808-1, DOI: 10.1596/978-0-8213-9806-7.

World Bank 2013. Growing Africa. Unlocking the Potential of Agribusiness. AFTFP/AFTAI. The World Bank. Available: [Cited 12.03.2014] http://siteresources.worldbank.org/INTAFRICA/Resources/africa-agribusiness-report-2013.pdf

World Bank AFREA. 2012. Institutional Approaches to Electrification. The Experience of Rural Energy Agencies/ Rural Energy Funds in Sub-Saharan Africa. November 14–16, 2011 Dakar, Senegal. Washington, The International Bank for Reconstruction and Development/THE WORLD BANK GROUP. Available: [Cited 12.03.2014] http://siteresources.worldbank.org/EXTAFRREGTOPENERGY/Resources/717305-1327690230600/8397692-1327690360341/AEI_Dakar_Workshop_Proceedings_As_of_7-30-12.pdf

World Bank. 2012. Global Monitoring Report 2012. The World Bank and International Monetary Fund. ISBN 978-0-8213-9451-9. DOI:10.1596/978-0-8213-9451-9.

World Bank Cook. 2011. Household Cookstoves, Environment, Health, and Climate Change. A NEW LOOK AT AN OLD PROBLEM. Washington. The World Bank. Available: [Cited 13.09.2014] http://www.cleancookstoves.org/resources_files/household-cookstoves.pdf

World Bank Water. 2010. Flowing Forward, Freshwater ecosystem adaptation to climate change in water resources management and biodiversity conservation. Water Working Notes No 28. World Bank Water Partnership Program, WWF. Available: [Cited 19.04.2013] http://www.flowingforward.org/pdf/full.pdf

Yin R.K. 2009. How to Do Better Case Studies. Chapter 8 in in the book, Sage Handbook of Applied Social Research Methods/ ed. Bickman L, Rog D.J. 2009. ISBN 978-1-4129-5031-2

Yin R.K. 2004. The Case Study Anthology. Thousand Oaks, London, New Delhi. SAGE Publications. ISBN 0-7619-2926-6.

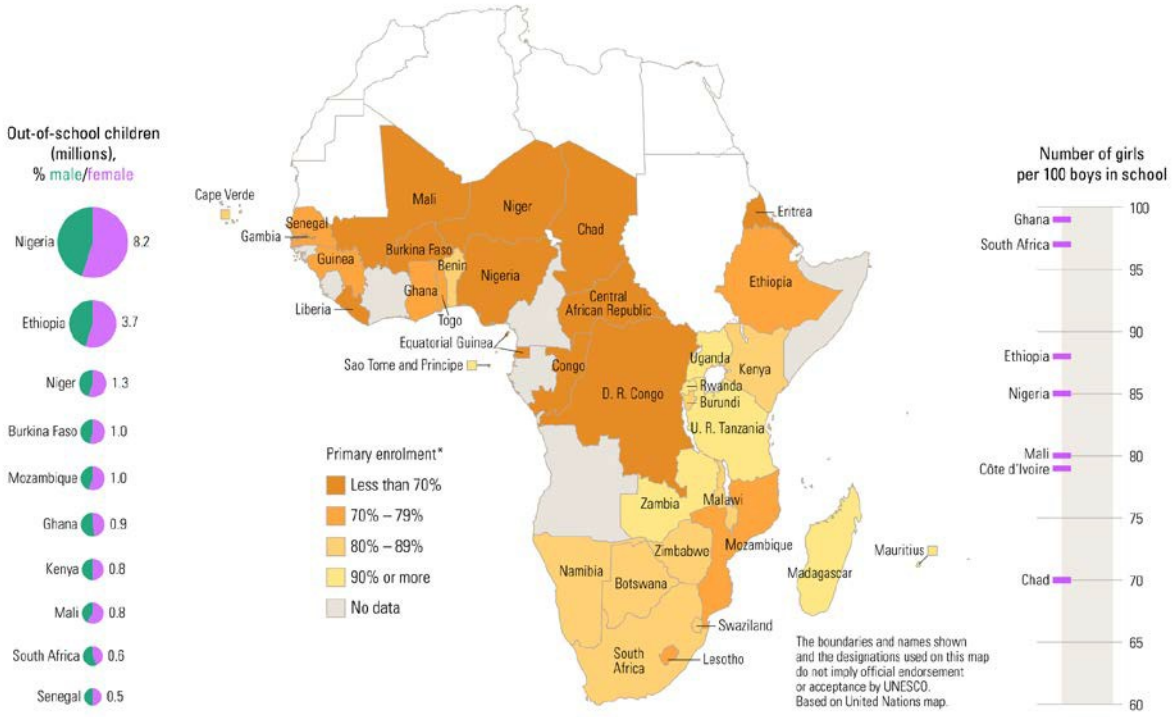
You L. Ringler C., Nelson G., Wood-Sichra U., Roberstson R., Wood S., Guo Z., Zhu T., Sun Y. 2010. What Is the Irrigation Potential for Africa? A Combined Biophysical and Socioeconomic Approach. Environment and Production Technology Division, IFPRI Discussion Paper 00993. IFPRI (International Food Policy Research Institute). Available: [Cited 21.04.2014] http://www.ifpri.org/sites/default/files/publications/ifpridp00993.pdf

Zahnd A., Jennings P. 2012?. THE ROLE OF RENEWABLE ENERGY TECHNOLOGY IN HOLISTIC COMMUNITY DEVELOPMENT. Available: [Cited 23.08.2013] http://mcedc.colorado.edu/sites/default/files/The%20Role%20of%20Renewable%20Energy%20Technology%20in%20Holistic%20Community%20Development.pdf

Zahnd A., McKay Kimber H., Komp R. 2006. Renewable Energy Power Systems for Remote and Impowerished Himalayan Villages in Nepal. Proceedings of the International Conference on Renewable Energy for Developing Countries. Kathmandu University. University of Montana. Available: [Cited 15.05.2010] http://www.udc.edu/docs/cere/Zahnd.pdf

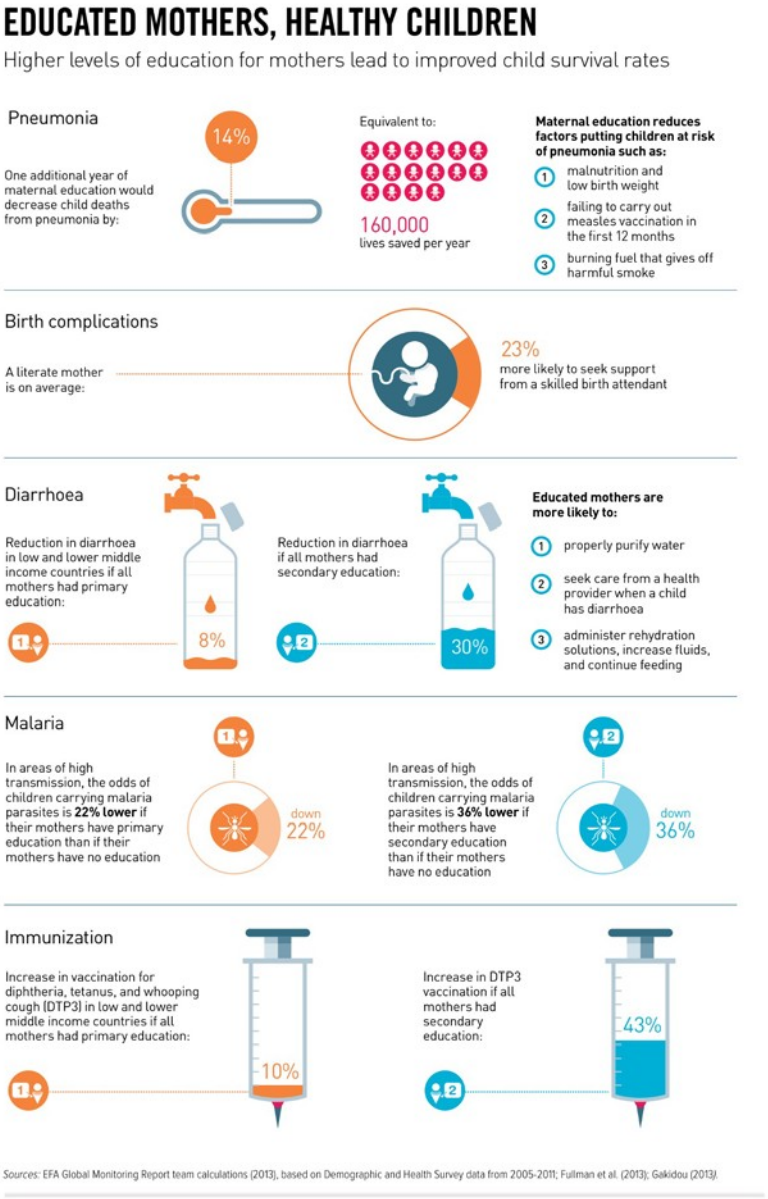
TAMAA Appendices

Appendix A Education in Sub-Saharan Africa



Source: Education Challenge, Sub-Saharan Africa, UNESCO 2010, http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/ED/GMR/pdf/gmr2010/carte-ssa-en.pdf

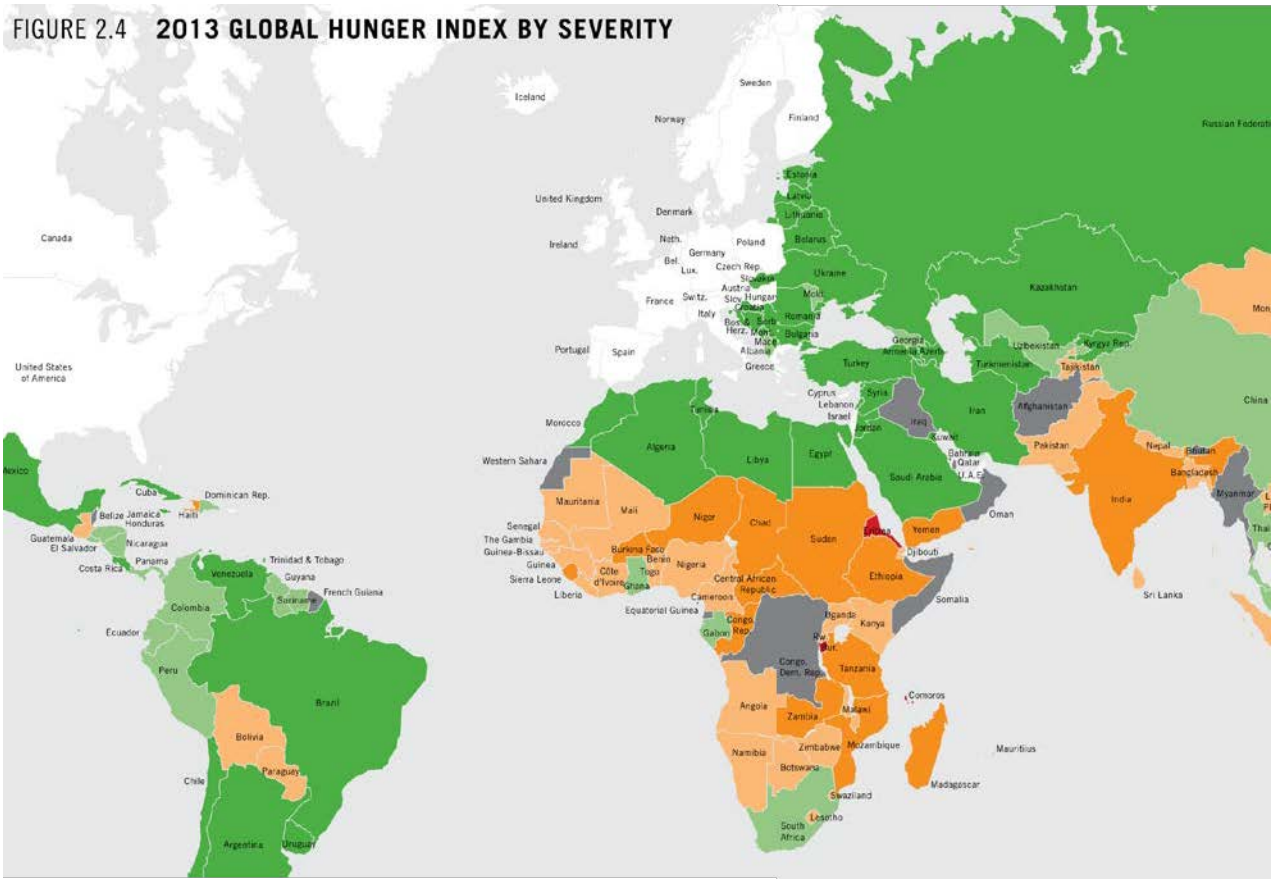
Appendix B Educated Mothers, Healthy Children



Source: EFA 2014, p.21

EFA. 2014. Teaching and Learning: achieving quality for all. Gender Summary. EFA Global Monitoring Report. United Nations Girls's Education Initiative (UNGEI). UNESCO. The Education for All (EFA) Global Monitoring Report is an independent annual publication. It is facilitated and supported by UNESCO. http://unesdoc.unesco.org/images/0022/002266/226662e.pdf

Appendix C: Global Hunger Index 2013



Source: von Grebmer 2013, pp.16-17

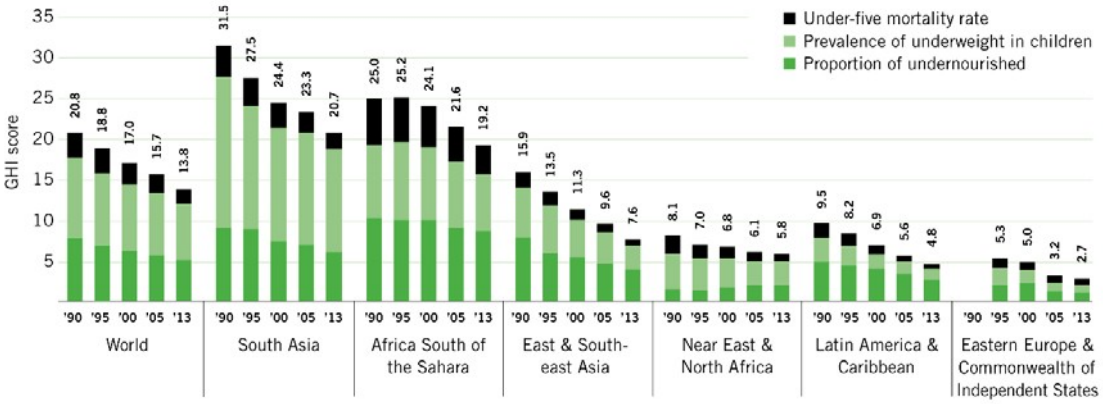
Food Security is defined according to Food and Agricultural Organization in the UN (FAO): "Food Security exists when all people, at all times, has physical, social and economic access to sufficient, safe and nutritious food which meet their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept to the family level, with individuals within the household as the focus of concern," FAO 2003; FAO 2008; von Grebmer et al. 2011, p.4. The Global Hunger Index (GHI) is a tool designed to comprehensively measure and track hunger globally and by region and country. Calculated each year by the International Food Policy Research Institute (IFPRI):

1) **Undernourishment**: the proportion of undernourished people as a percentage of the population (reflecting the share of the population with insufficient caloric intake)
2) **Child underweight**: the proportion of children younger than age five who are underweight (that is, have low weight for their age, reflecting wasting, stunted growth, or both), which is one indicator of child undernutrition
3) **Child mortality**: the mortality rate of children younger than age five (partially reflecting the fatal synergy of inadequate caloric intake and unhealthy environments) The diversity of GHI globally is large, South Asia and Africa South

of Sahara having the severest situation especially regarding children's underweight and the amount of undernourished people.

FAO defines food deprivation, or "undernourishment," (Hunger) as the consumption of fewer than about 1,800 kilocalories a day—the minimum that most people require to live a healthy and productive life.*

FIGURE 2.1 **CONTRIBUTION OF COMPONENTS TO 1990, 1995, 2000, 2005, AND 2013 GLOBAL HUNGER INDEX SCORES, BY REGION**



Source: von Grebmer 2013, pp.7-11

von Grebmer K., Hedey D., Olofinbiyi T., Wiesmann D., Fritschel H., Yin S., Foley C., von Oppeln C., Iseli B., Béné C., Haddad L. 2013. Global Hunger Index 2013. THE CHALLENGE OF HUNGER: BUILDING RESILIENCE TO ACHIEVE FOOD AND NUTRITION SECURITY. International Food Policy Research Institute (IFPRI), concern worldwide, Welthungerhilfe, Institute of Development Studies. Bonn, Washington D.C., Dublin. ISBN 978-0-89629-951-1. DOI: http://dx.doi.org/10.2499/9780896299511.

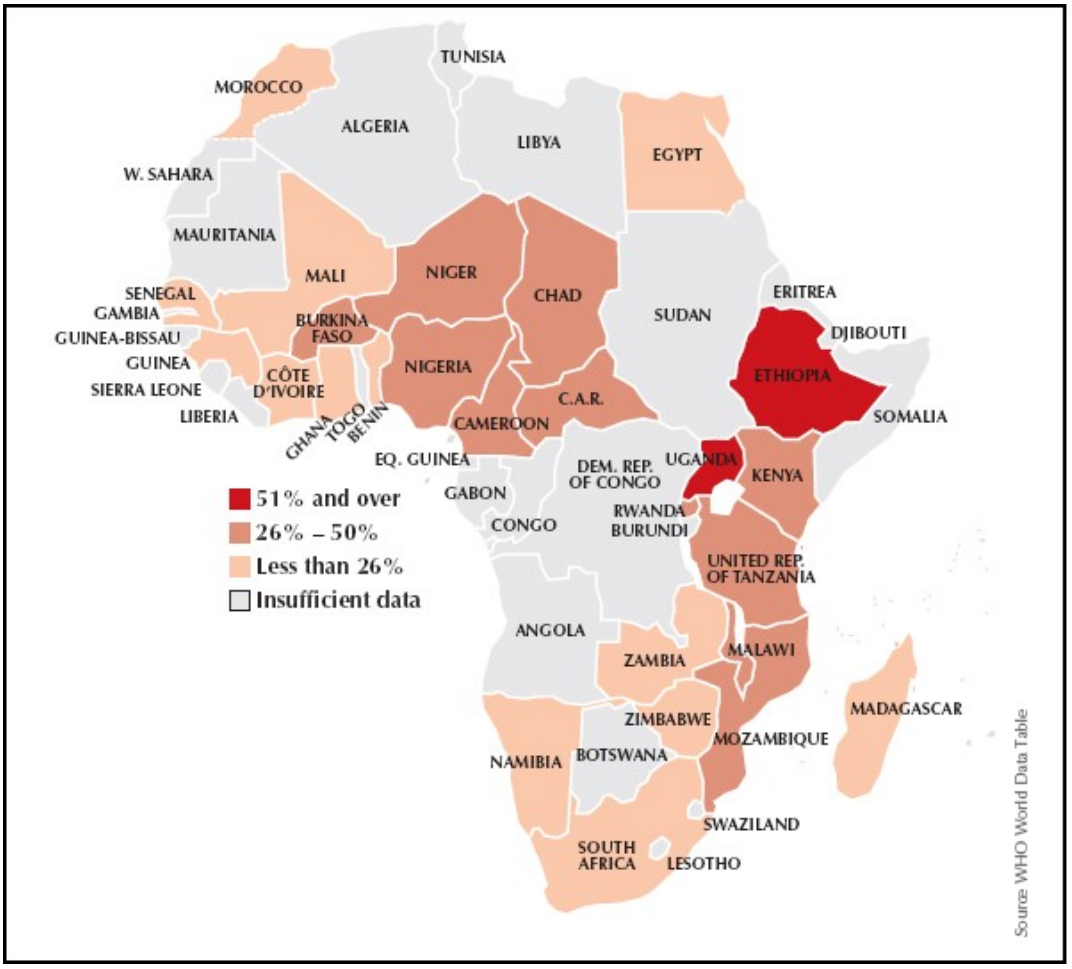
von Grebmer K., Torero M., Olofinbiyi T., Fritschel H., Wiesmann D., Yohannes Y., Schofield L., von Oppeln C., 2011. Global Hunger Index 2011. Challenge of Hunger: Taming Price Pikes and Excessive Food Price Volatility. welt hunger hilfe, International Food Policy Research Institute (IFPRI), concern worldwide. Bonn, Washington D.C., Dublin. ISBN 978-0-89629-934-4. DOI:10.2499/9780896299344ENGHI2011.

FAO. 2003. Focus on Food Insecurity and Vulnerability – A review of the UN System Common Country Assessments and World Bank Poverty Reduction Strategy Papers. FIVIMS Secretariat and Wageningen University and Research Centre. FAO. Available: [Cited 05.11.2012] www.fao.org/DOCREP/006/Y5095E/Y5095E00.htm

FAO. 2008. An Introduction to the Basic Concepts of Food Security. FAO. Available:[Cited 06.11.2012] http://www.fao.org/docrep/013/al936e/al936e00.pdf

Appendix D Time to fetch water

Population who must travel more than 30 minutes per day to get water

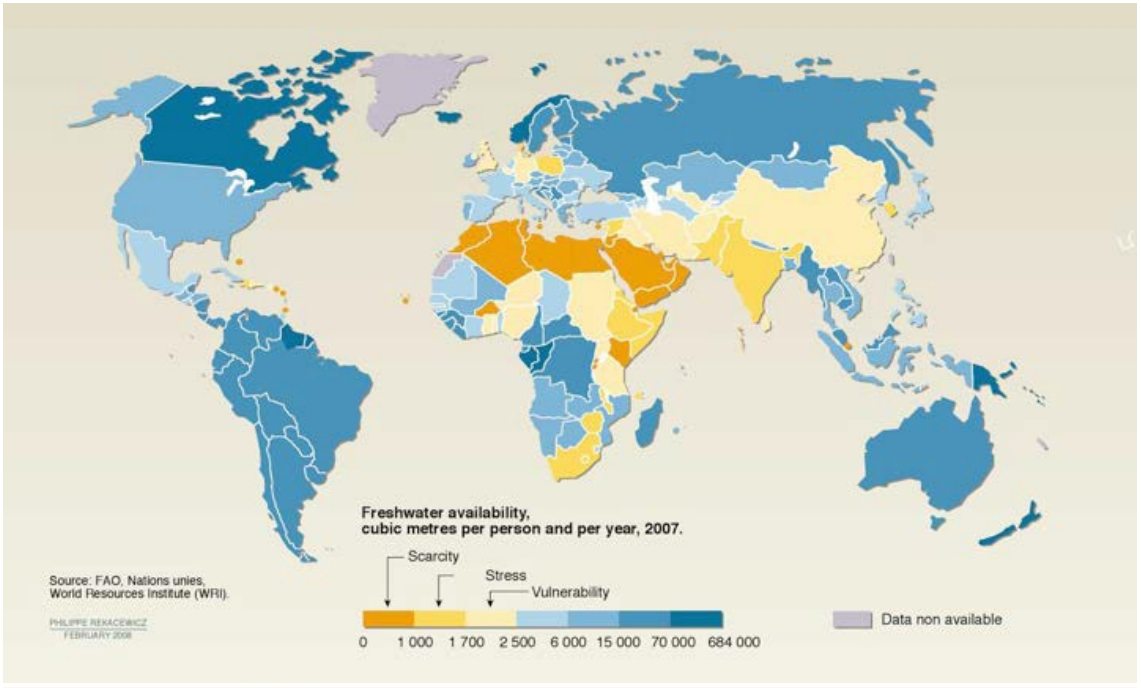


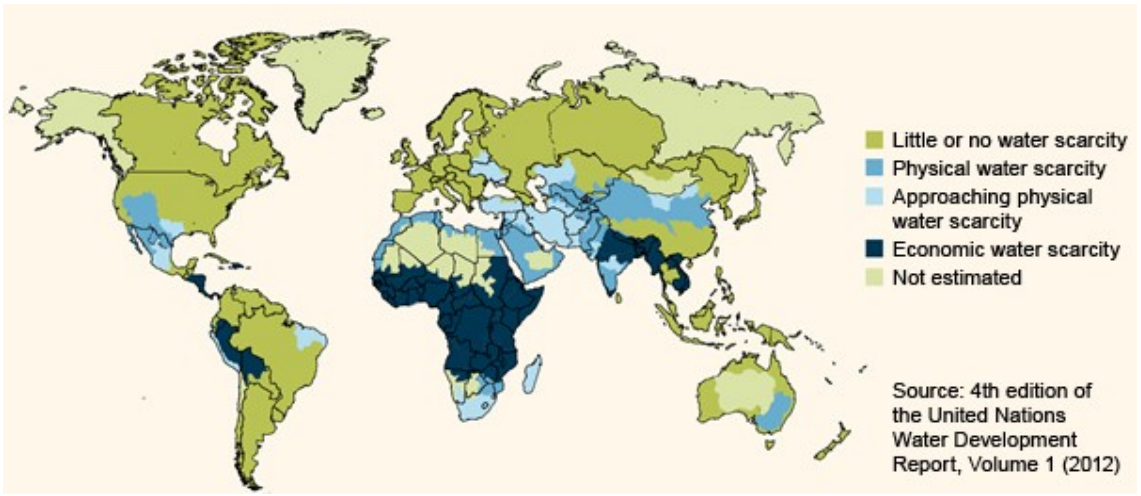
Source UN MDG, 2005, p.10. Percentage of the Population who must travel more than 30 minutes to fetch Water in Africa. Women and girls often walk 15 kilometres a day, to and from water sources, spending 8 hours or more per day collecting repeated loads weighing up to 20 kilos each time. The use of improved sanitation and drinking water in rural areas was presented in Annex G.

UN MDG. 2005. Achieving the Millennium Development Goals. A GEF (Global Environment Facility) Progress Report. GEF, September 2005. ISBN 1-884122-49-3.

Appendix E Fresh water availability and water scarcity

Fresh water availability (m^3) per capita in 2007, global physical and economic water scarcity in 2007



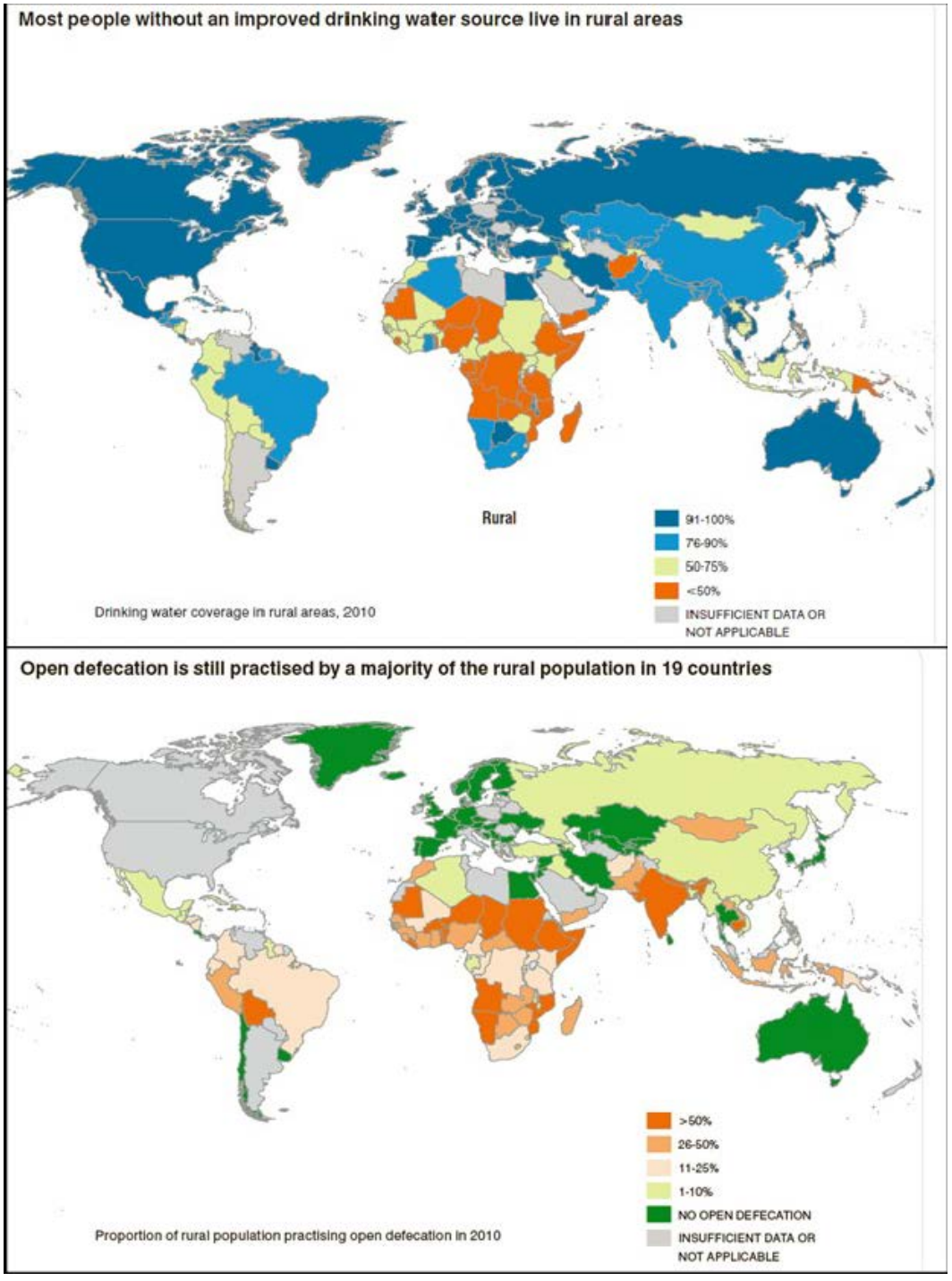


Source: UN Water WWDR4 2012, pp.124, 125. Economic water scarcity = described as a situation caused by a lack of investment in water, or a lack of human capacity to satisfy the demand for water (FAO Water 2012, p.6)

UN Water WWDR4. 2012. Managing Water under Uncertainty and Risks. The United Nations World Water Development Report 4. Volume I. UN Water. World Water Assessment Programme. UNESCO. ISBN 978-92-3-104235-5, e-book ISBN 978-92-3-001045-4

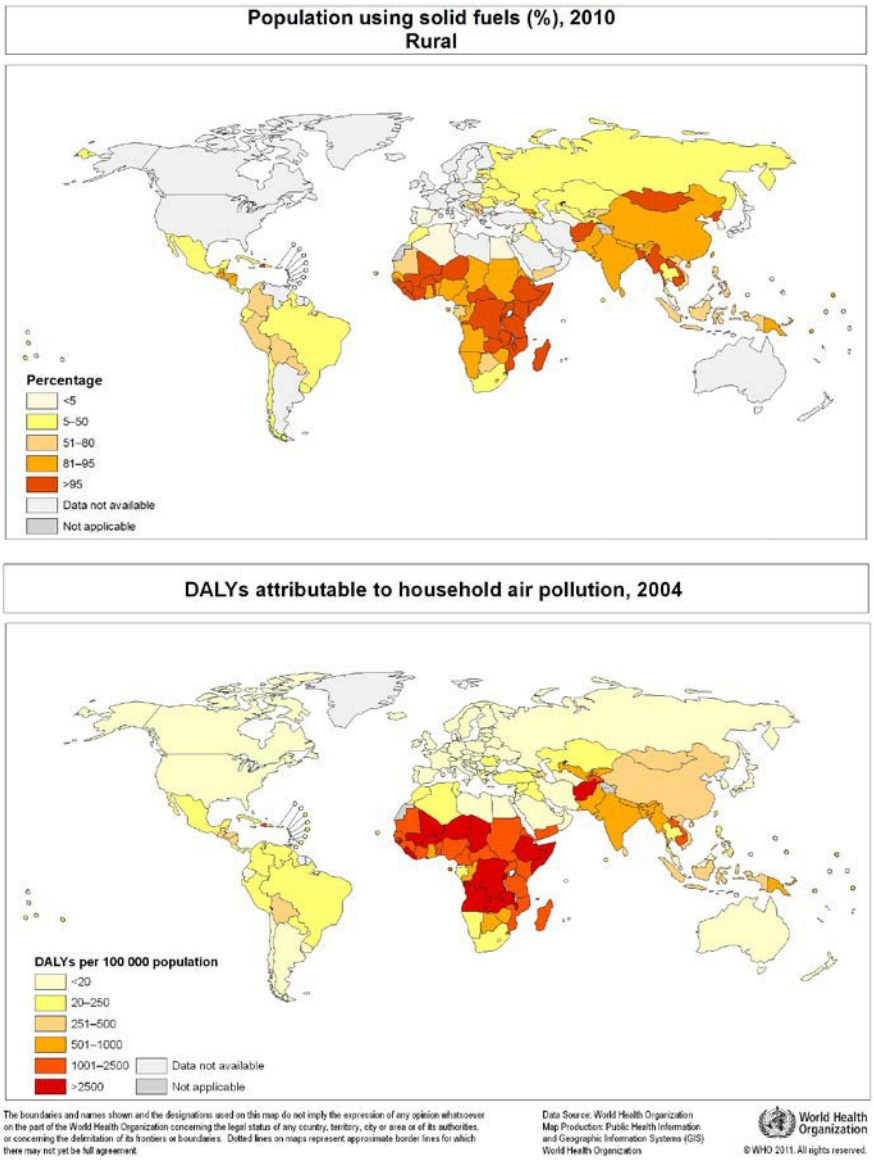
FAO Water 2012. Coping with water scarcity. An action framework for agriculture and food security. FAO Water Report 38. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS Rome. ISBN 9789251073049.

Appendix F Clean water and sanitation status in rural areas



WHO&Unicef. 2012. Progress on Drinking Water and Sanitation. Update 2012. Available: [Cited 30.08.2012] http://whqlibdoc.who.int/publications/2012/9789280646320_eng_full_text.pdf

Appendix G Health problems of solid fuels in rural areas



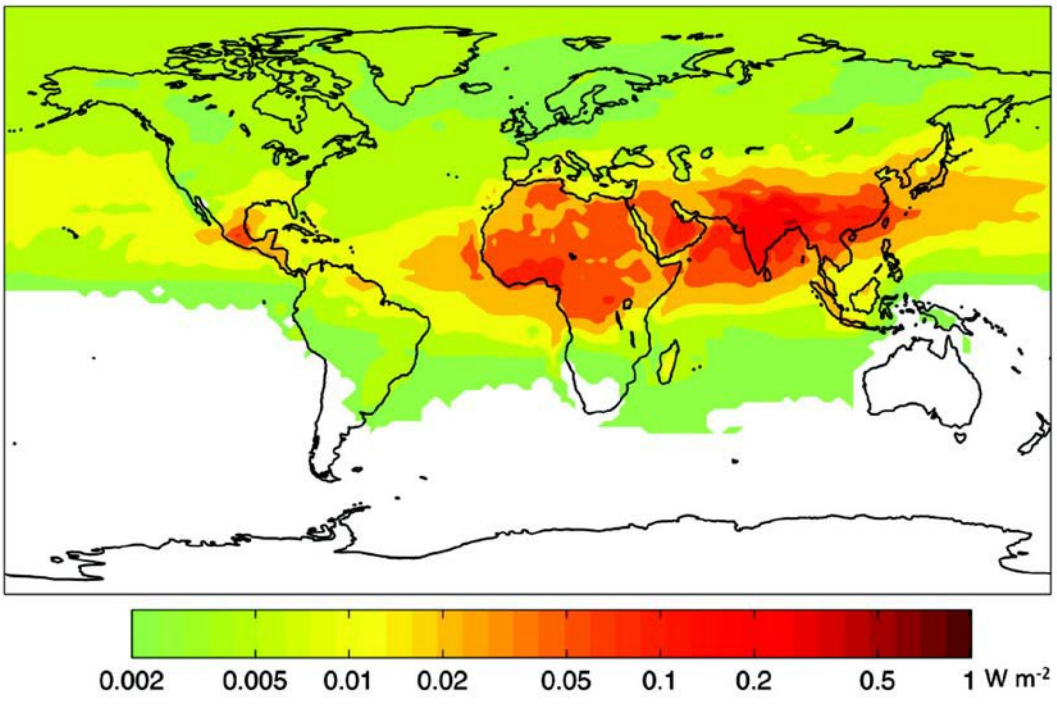
Source: WHO Maps. 2012. WHO Global Health Observatory Map Gallery. World: Population using solid fuels (%), 2010: rural, Available: [Cited 11.10.2012] http://gamapserver.who.int/mapLibrary/Files/Maps/Global_iap_2010_rural.png, World: DALYs attributable to household air pollution, 2004, Available: [Cited 11.10.2012] http://gamapserver.who.int/mapLibrary/Files/Maps/Global_iap_daly_2004.png

DALY=Disability-adjusted life year, In terms of lost years of healthy life. Combines loses years due to premature death with years of healthy life loses due to illness and disability WHO 2009, p.v. The deaths attributed to risks factors are shown as well in page 10.

Appendix H: Direct black carbon, kerosene lighting

Direct black carbon radiative forcing from residential kerosene lighting

FIGURE 2. DIRECT BLACK CARBON RADIATIVE FORCING FROM RESIDENTIAL KEROSENE LIGHTING (W/M²)

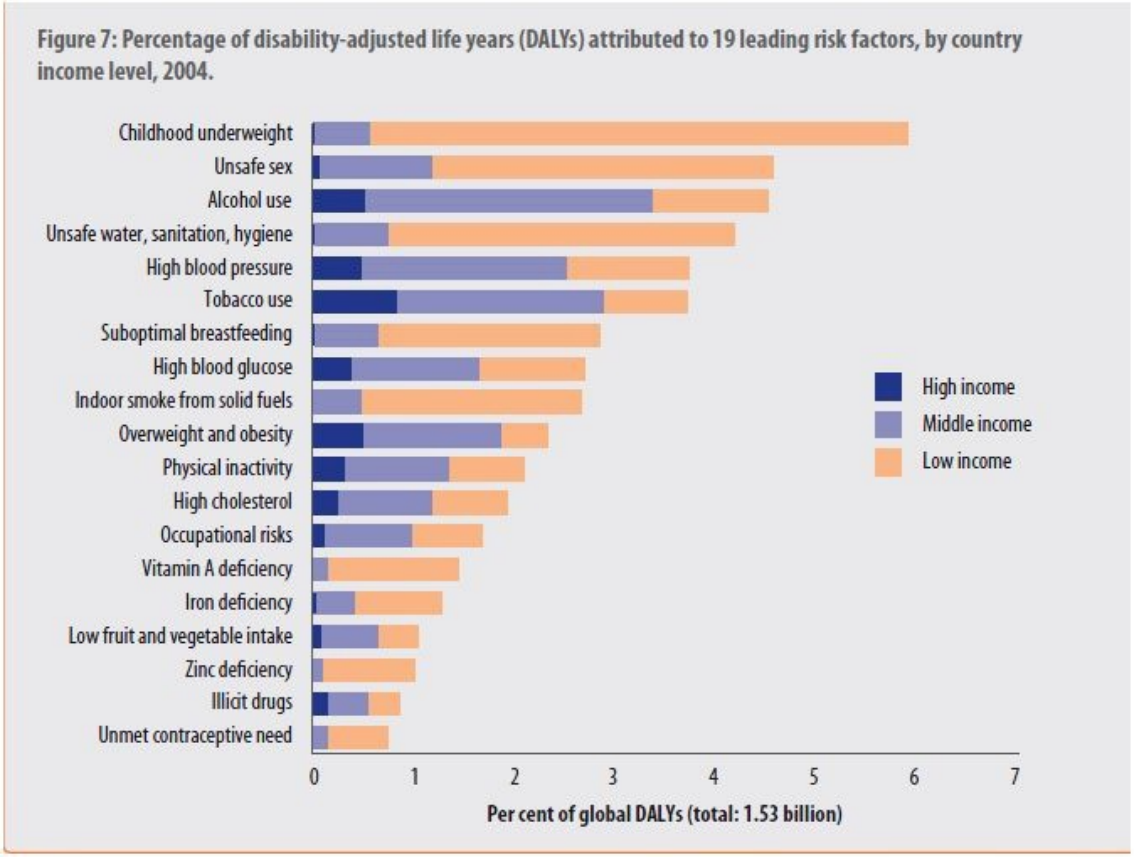


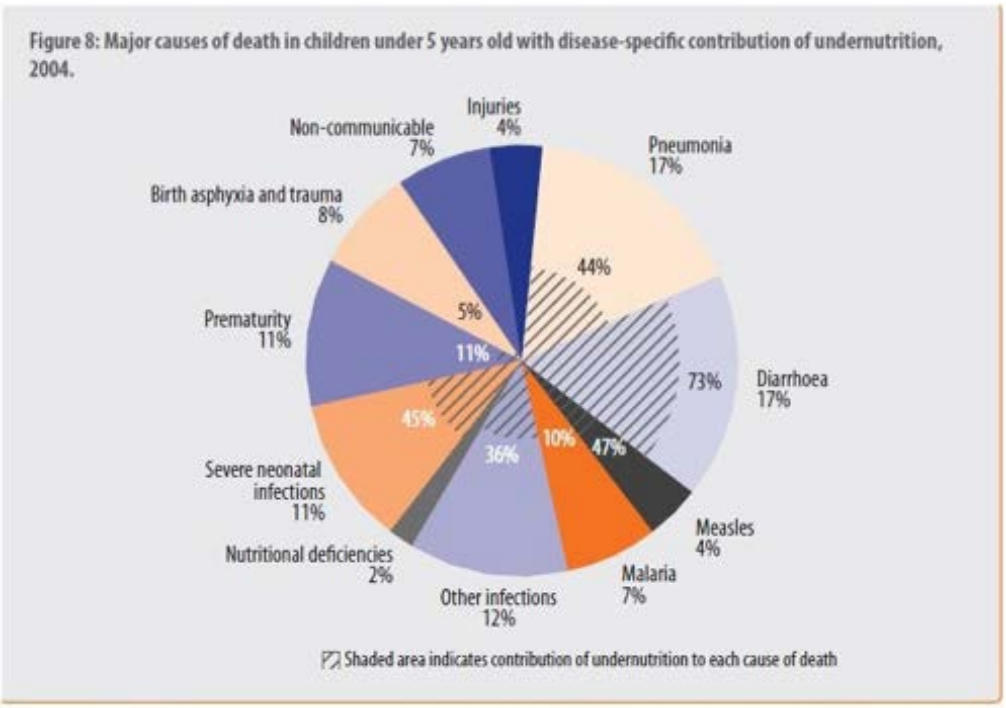
Reproduced from Lam, et al., 2012

Source: Jacobson A., Bond T.C., Lam N.L., Hultman L. 2013. Black Carbon and Kerosene Lighting: An Opportunity for Rapid Action on Climate Change and Clean Energy for Development. Global Views, Policy Paper 2013-03. The Brookings Institution. Massachusetts Ave., NW, Washington DC. Available: [Cited 12.02.2014] http://www.brookings.edu/~/media/research/files/papers/2013/04/climate%20change%20clean%20energy%20development%20hultman/04_climate_change_clean_energy_development_hultman.pdf

Appendix I: Top health risks globally in DALY's

Major causes of deaths in children under five years old





Source: WHO 2009, p.10, 14. DALY=Disability-adjusted life year, in terms of lost years of healthy life. Combines loses years due to premature death with years of healthy life loses due to illness and disability WHO 2009, p.v., 5. The deaths attributed to risks factors are shown as well in page 10.

Tenth biggest risk factors in DALYs in low, middle, and high income countries, source: WHO 2009, p.14

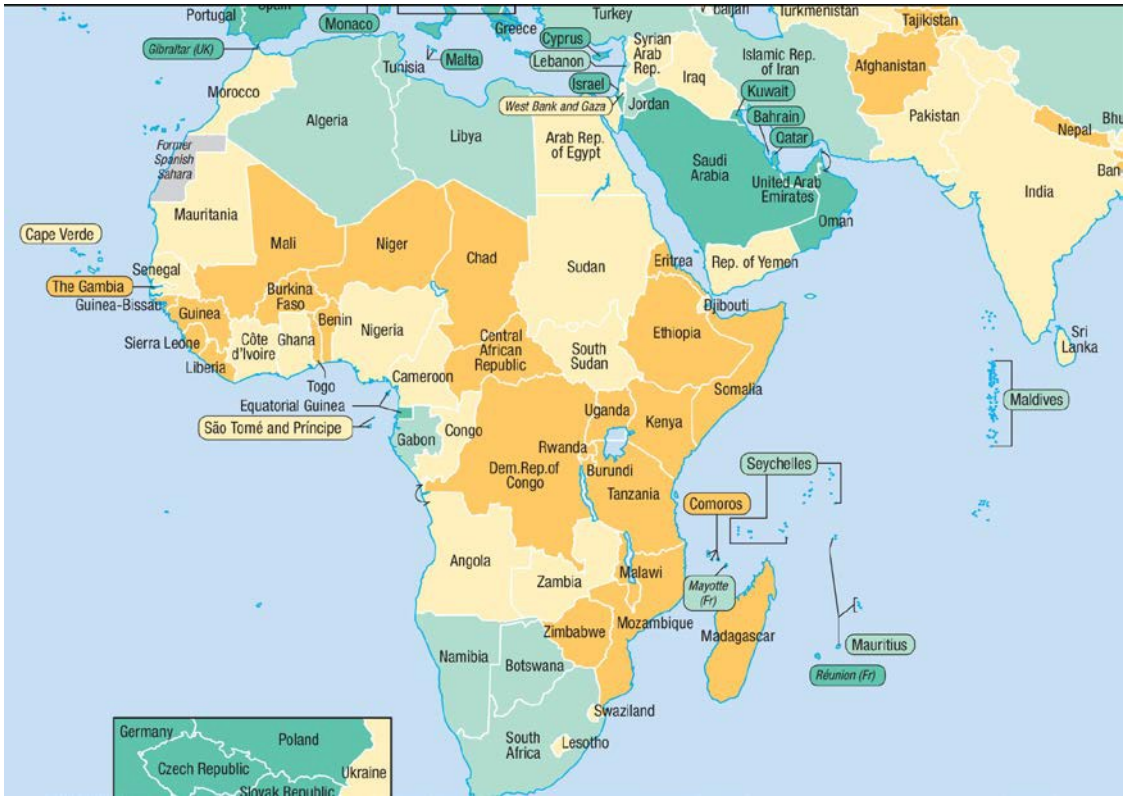
Table 2: Ranking of selected risk factors: 10 leading risk factor causes of DALYs by income group, 2004

	Risk factor	DALYs (millions)	Percentage of total		Risk factor	DALYs (millions)	Percentage of total
	World				***Low-income countries[a]***		
1	Childhood underweight	91	5.9	1	Childhood underweight	82	9.9
2	Unsafe sex	70	4.6	2	Unsafe water, sanitation, hygiene	53	6.3
3	Alcohol use	69	4.5	3	Unsafe sex	52	6.2
4	Unsafe water, sanitation, hygiene	64	4.2	4	Suboptimal breastfeeding	34	4.1
5	High blood pressure	57	3.7	5	Indoor smoke from solid fuels	33	4.0
6	Tobacco use	57	3.7	6	Vitamin A deficiency	20	2.4
7	Suboptimal breastfeeding	44	2.9	7	High blood pressure	18	2.2
8	High blood glucose	41	2.7	8	Alcohol use	18	2.1
9	Indoor smoke from solid fuels	41	2.7	9	High blood glucose	16	1.9
10	Overweight and obesity	36	2.3	10	Zinc deficiency	14	1.7
	Middle-income countries[a]				***High-income countries[a]***		
1	Alcohol use	44	7.6	1	Tobacco use	13	10.7
2	High blood pressure	31	5.4	2	Alcohol use	8	6.7
3	Tobacco use	31	5.4	3	Overweight and obesity	8	6.5
4	Overweight and obesity	21	3.6	4	High blood pressure	7	6.1
5	High blood glucose	20	3.4	5	High blood glucose	6	4.9
6	Unsafe sex	17	3.0	6	Physical inactivity	5	4.1
7	Physical inactivity	16	2.7	7	High cholesterol	4	3.4
8	High cholesterol	14	2.5	8	Illicit drugs	3	2.1
9	Occupational risks	14	2.3	9	Occupational risks	2	1.5
10	Unsafe water, sanitation, hygiene	11	2.0	10	Low fruit and vegetable intake	2	1.3

[a] Countries grouped by 2004 gross national income per capita – low income (US$ 825 or less), high income (US$ 10 066 or more).

WHO. 2009. Global health Risks: mortality and burden of disease attributable to selected major risks. World Health Organization (WHO). ISBN 978-92-4-156387-1.

Appendix J World by incomes in 2010

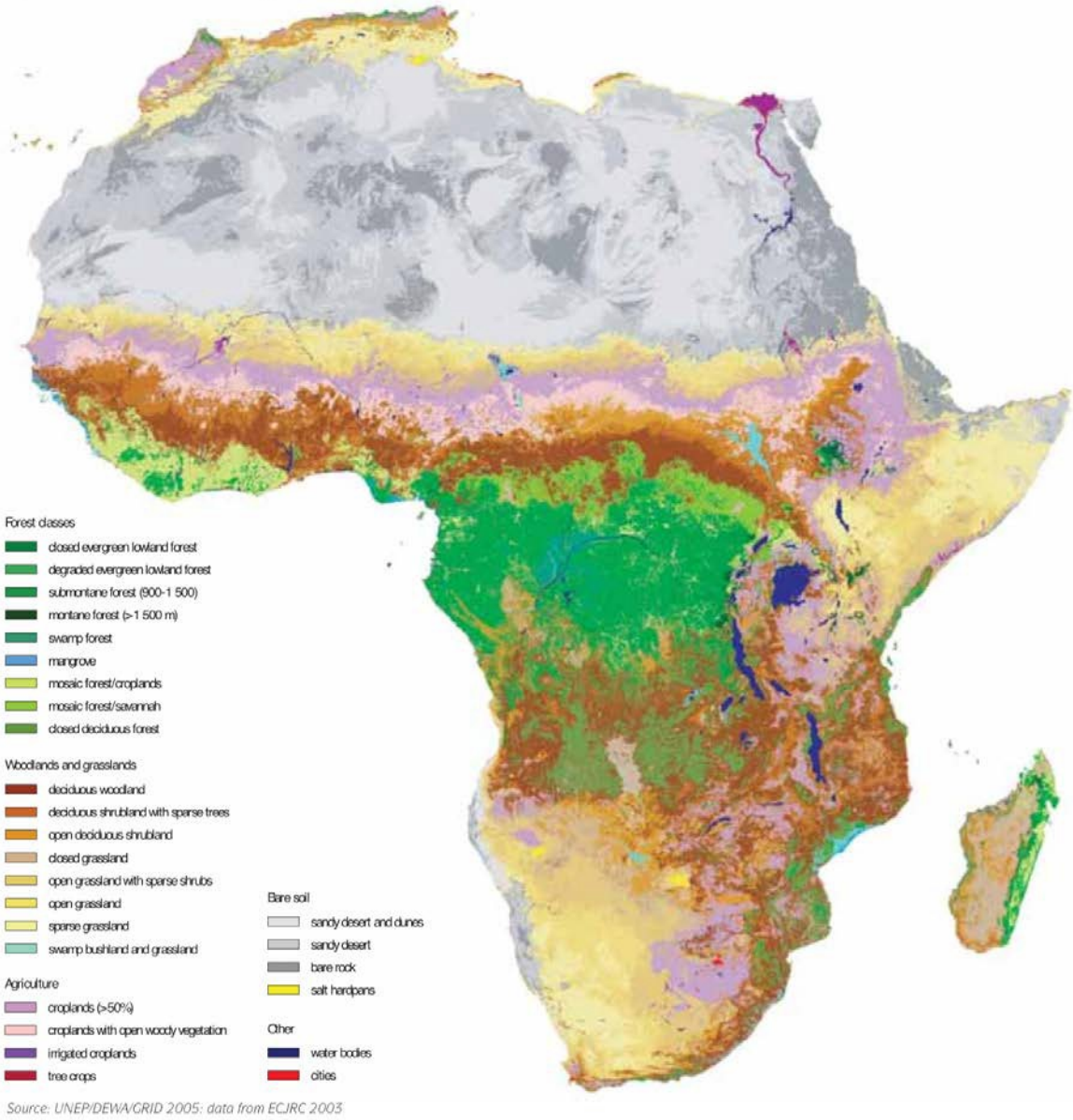


Source: World Bank WDI 2012, p.Cover 3. The incomes are classified according to World Bank estimates of 2010 Gross National Income (GNI) per capita.

World Bank WDI. 2012. World Development Indicators. The World Bank. Washington D.C. ISBN 978-0-8213-8985-0.

Appendix K Forest, woodlands and vegetation cover

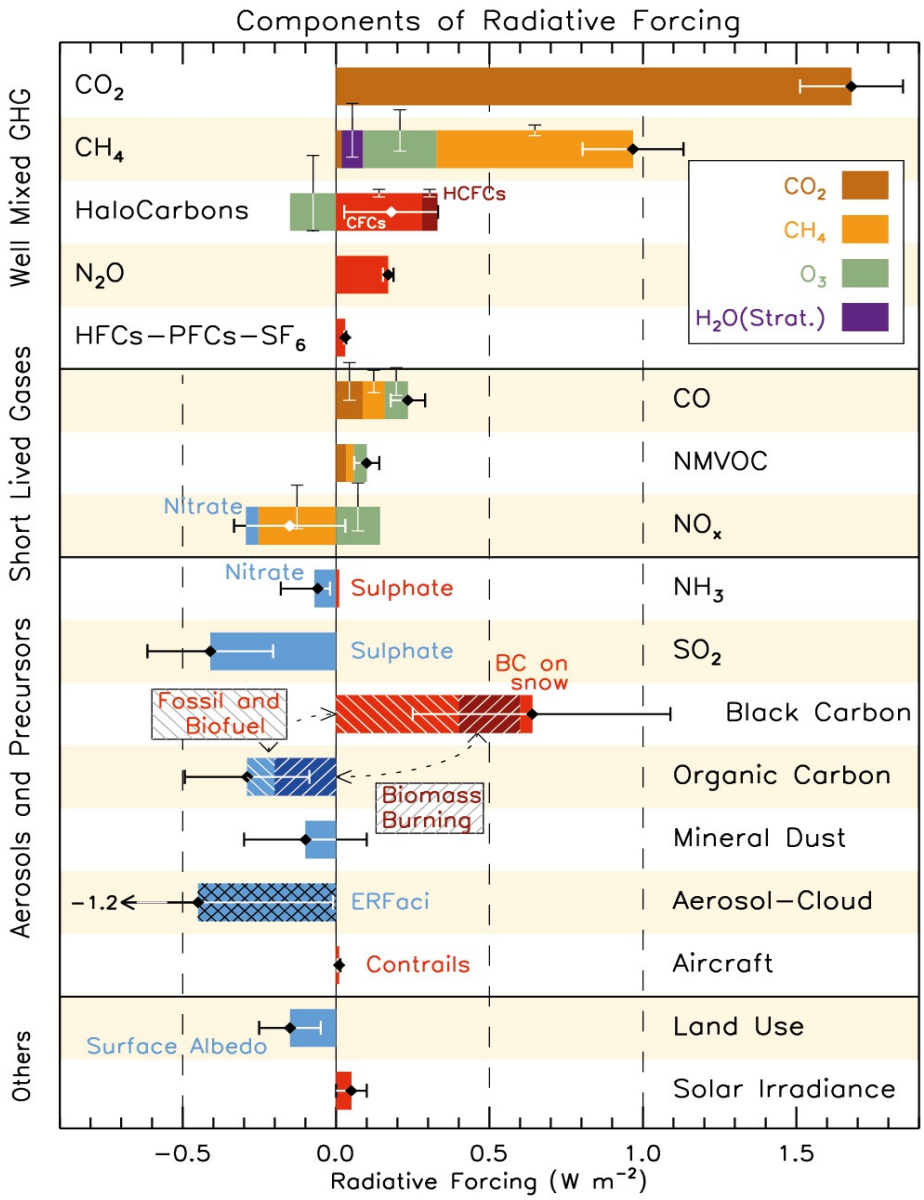
Figure 1: Forest, woodlands and vegetation cover



Source: UNEP 2006, p.197

UNEP. 2006. Africa Environment Outlook 2, Our Environment, Our Wealth. United Nations Environment Programme (UNEP). ISBN 92-807-2691-9.

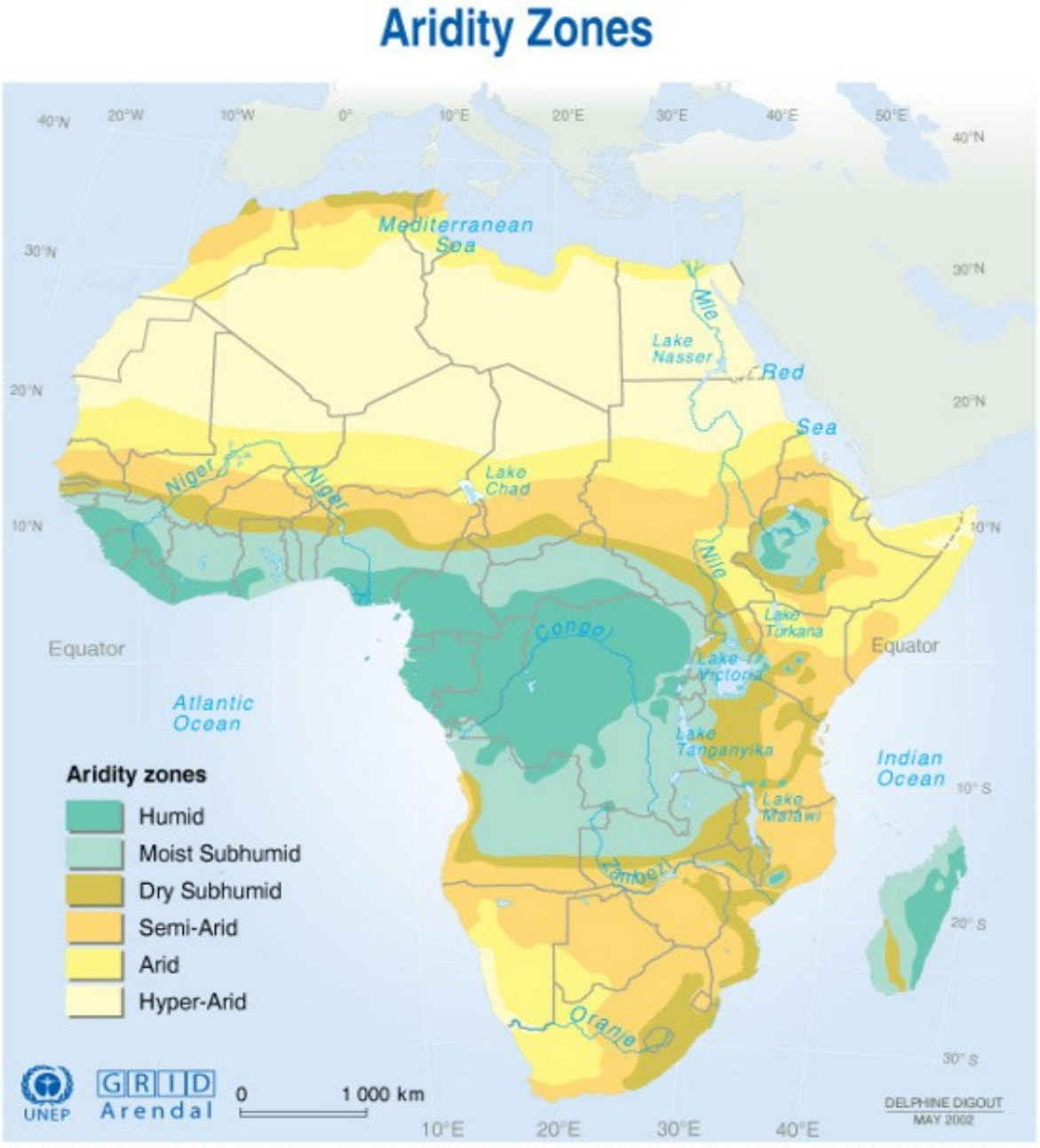
Appendix L: Components of Radiative Forcing



Source: IPCC 2013, p.4

IPCC. 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp, doi:10.1017/CBO9781107415324

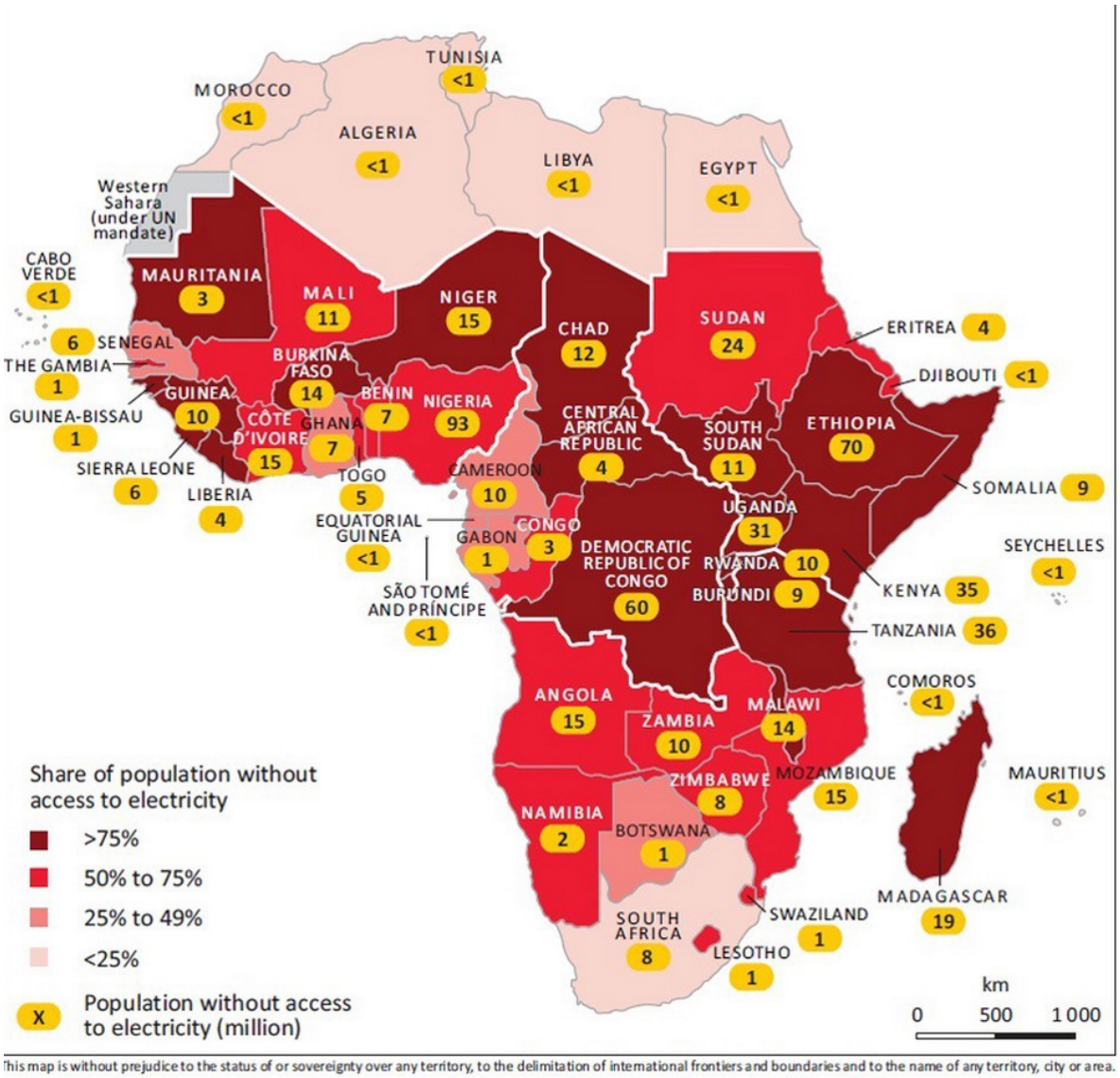
Appendix M Climate Zones in Africa



Source: World Meteorological Organization (WMO), United Nations Environment Programme (UNEP), *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Source: http://www.grida.no/graphicslib/detail/aridity-zones_a6d3

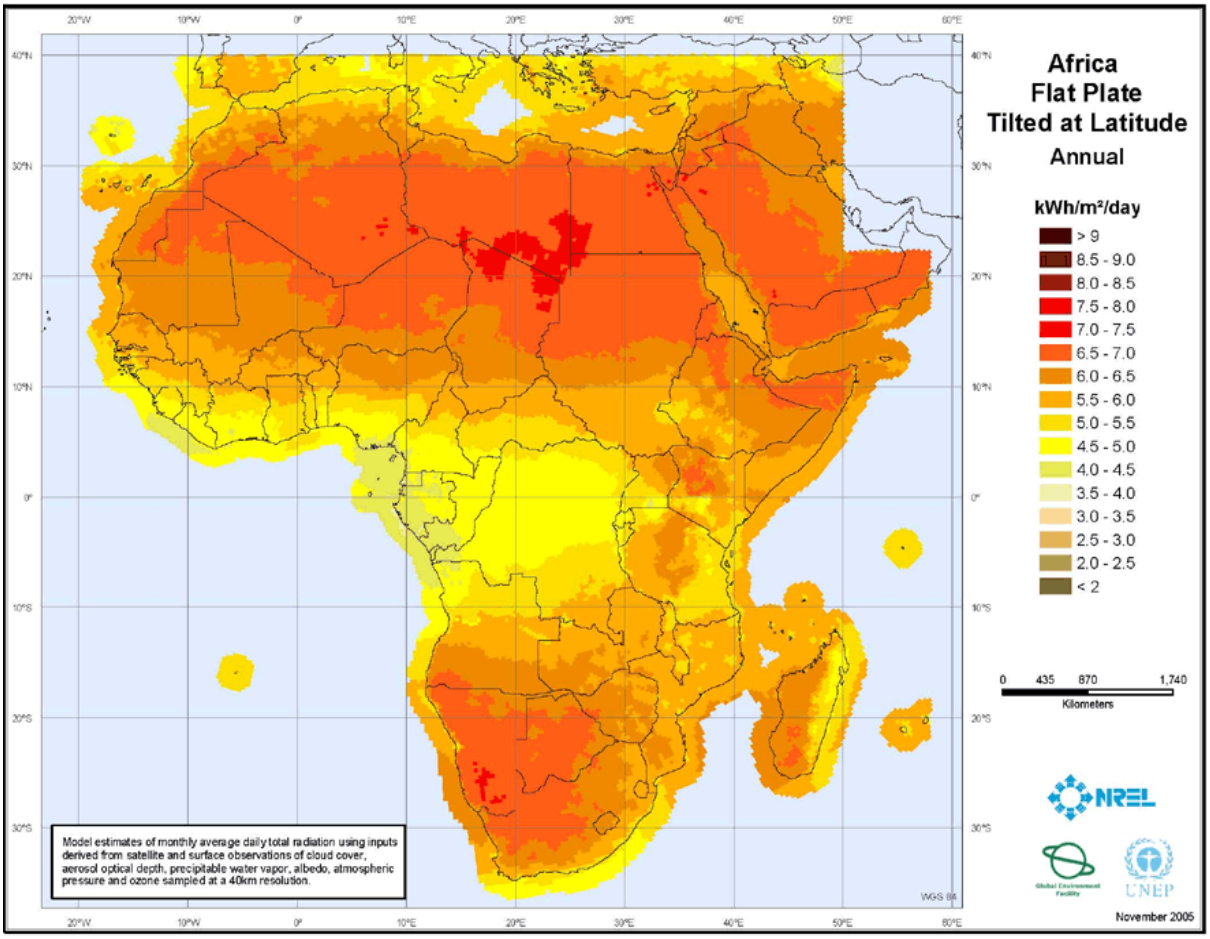
Appendix N: Access to Electricity in Sub-Saharan Africa



Source: IEA 2014, p.31

IEA. 2014. Africa Energy Outlook. A Focus on Energy Prospects in sub-Sharan Africa. World Energy Outlook Special Report. Paris. OECD/IEA. Available: [Cited 15.10.2014]
http://www.iea.org/publications/freepublications/publication/WEO2014_AfricaEnergyOutlook.pdf

Appendix O: Solar resources in Africa

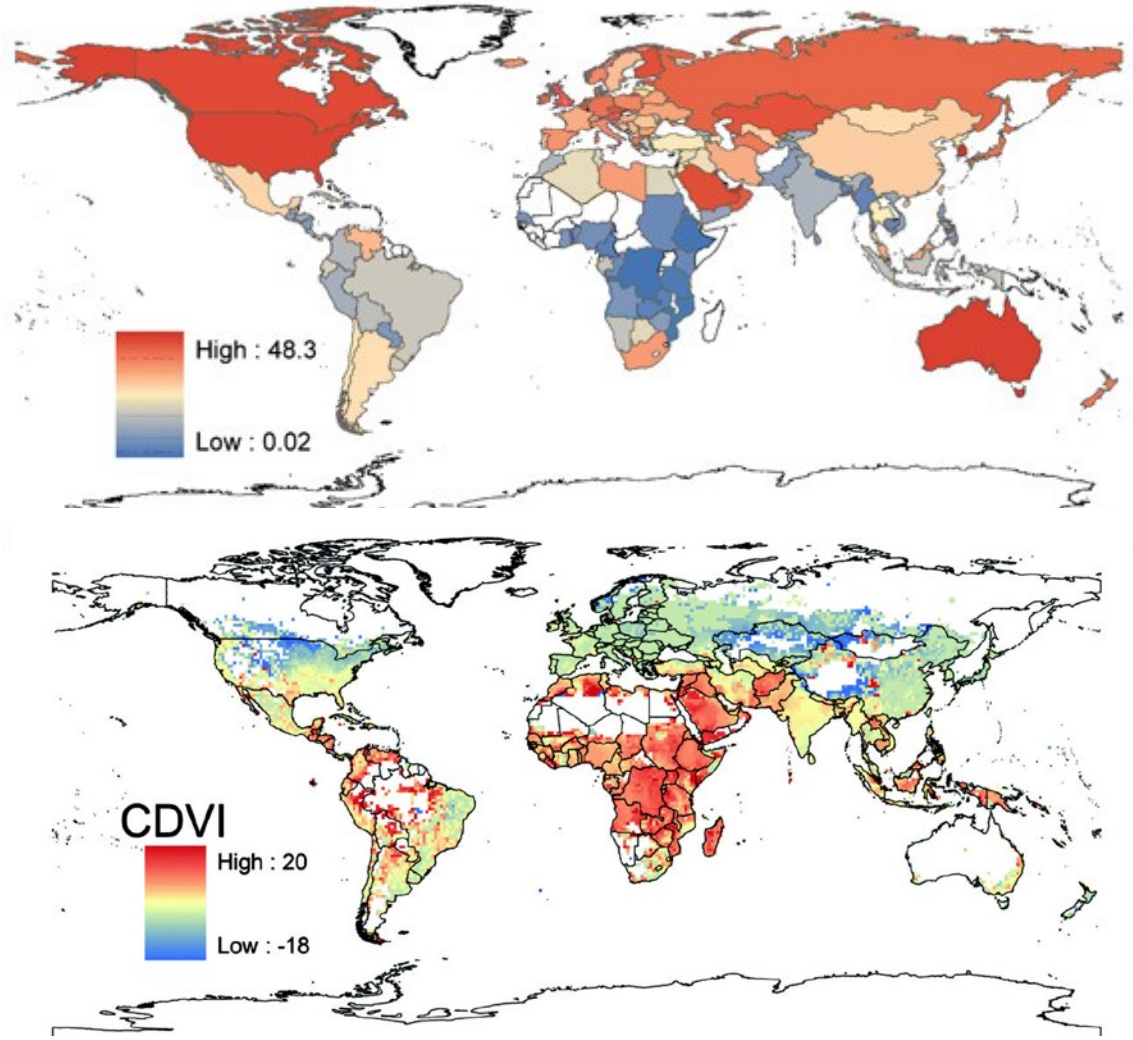


Annual Average Solar Insolation, Flat Plate Tilted at Latitude, kWh/m²/day

Source: NREL 2005, this map can be find in the reference Ramachandran 2008, p.26

Ramachandran V. 2008. Power and Roads for Africa. Essay. Center for Global Development. www.cgdev.org/content/publications/detail/15659. Available: [Cited 23.04.2013] http://www.cgdev.org/files/15659_file_AfricaPowerRoads.pdf

Appendix P: CO_2 emissions versus Climate change vulnerability



Source: Samson et al. 2011, p.538

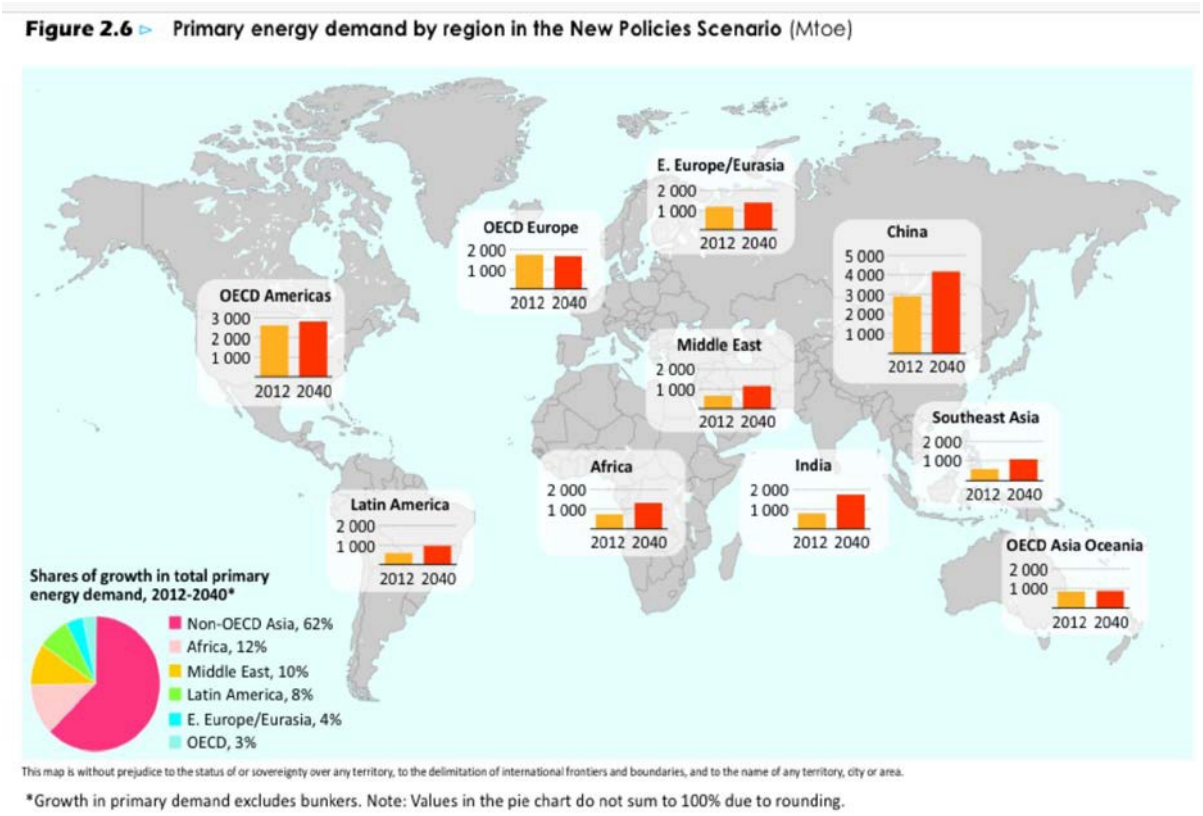
CDVI = Climate Demography Vulnerability Index
'This takes into account how regional climate will change as well as how much local population is expected to grow. They incorporated this index into a global map and found highly vulnerable regions included central South America, the Middle East and both eastern and southern Africa. Less vulnerable regions were largely in the northern part of the Northern Hemisphere.'

Sampson J., Berteaux D., McGill B.J., Humphries M.M. 2011. Geographic disparities and moral hazards in the predicted impacts of climate change on human populations.

Global Ecology and Biogeography? Volume 20, Issue 4, pages 532–544, July 2011.

DOI: 10.1111/j.1466-8238.2010.00632.x

Appendix Q: Primary energy demand by region in 2040



Source: IEA Energy 2014, p.63

TAMAA Interviews

Appendix IA: Reference interviews Brita, Irja, George
Appendix IB: ABC Water project
Appendix IC: Researcher's scientific CV
Appendix ID: First summaries of interviews
Appendix IE: Narrative stories of interviewees, first stage of interviews
Appendix IF: Second round of interviews, and feedback

Appendix IA: Reference interviews

A)

– Brita Jern, I am working within Swedish Lutheran Evangelical Association in Finland as the Mission Director.

– Energy is needed to fetch water (walking, carrying, using donkeys). People are usually not boiling their drinking water in rural areas in Kenya since it acquires too much fuel. In rural Africa they are usually not heating their homes by fire, but they are using fires to prepare food.

Energy is needed in order to produce food. People need to prepare the soil, plant seeds, fertilize, weed, harvest and grind the harvest into flour. Fuel and fire is needed to cook the food.

The relation between the basic needs of food and water is pretty much related to energy issues.

– Other basic needs in Africa are clothes and shelter, education, health, transport and sanitation.

– These are not immediately connected to household energy, but at least health and sanitation needs some energy.

– As a whole I suppose the basic needs are the same in rural as well as in urban areas. But in urban areas other types of energy is used, like electricity. I know of people in town who bring their charcoal stove to town because they are not able to cook when electricity too often is gone.

– Obstacles and barriers for people to fulfill these needs could be poor physical or mental health, poverty, large families, living in hard-ship areas and lack of education which often is related to poverty.

– New energy services are splendid solutions for Africa, especially solar energy. Usually there is plenty of sun in rural Africa, beside that solar energy is nowadays highly developed and the need for maintenance is almost nil. As far as I know solar energy services are functioning for decades. At least for the basic need for water the solar is an excellent solution. According to my experience wind mills for some reason are not functioning in the same good way.

– Barriers for rural people to use solar energy might be the cost. There are a lot of good systems in stock, even small ones for charging mobiles, but poor people can not afford them.

– I think the possibilities for community based energy systems are quite good. It needs a good structure. One challenge is implementation to bigger groups. In SLEAF mission work we have seen that smaller groups, with 5–10 people are the best functioning, while whole villages face obstacles when it comes to cooperation. One problem is corruption, not only regarding money, but also regarding power-sharing and democratic issues. Clan- and tribe issues are often hindrances.

– Nutrition and clean cooking in Africa face a lot of challenges. One is low education, another poverty. Health as a school subject would be the first thing to develop. From childhood they need to know that fruits are useful, and they need to know the importance of a balanced diet. But even if they know, if they are poor, it is difficult to cook good food. They need to know ways of planting trees also in dry areas, but the best thing would be to try to teach people to use solar cookers. The system is already there, but very few are using them. I think it might be because people are quite suspicious towards new things. Another obstacle in rural areas is that people are not used to technical issues and they do not know how to maintain things, or even the importance of maintenance. A lot of even simple devices are not in use because they have broke down. So using a simple solar cooker is a question of change in paradigms, which is not easily done.

– Clean and fresh water can be arranged in three ways in Africa. Where the ground water level is high, basic wells can be dug by hand, using concrete to plaster them. Where the ground water is very deep, bore holes can be constructed. And where there is none of these, gutters and tanks should be built. In order to get clean water people are usually using tablets for disinfection. I have also seen systems with different types of water filtering through sand and different layers of murram, but common people do not know much about such things.

– Education, training and working needs good teachers and different types of school-materials, and in Kenya at least, an improved teaching of English as a different language. It does not help even if you have books, if people do not understand them, or lack interest in reading because of poor vocabulary. I think it is a question of building a good system within the challenge of a poor country. But it is not only because of poverty, it is also because of corruption that systems are not working. But here again much can be done if corruption is defended. In schools for example, solar power can be used to get lamps to pupils so that they can study in the evenings.

– I think new types of energy services can serve communities in many ways. But what about exporting and business? That one I do not know.

– New energy services can decrease diseases. Bringing clean water through bore holes is reducing the level of diseases. That one I know from experience.

– New energy services can provide security, promoting health issues by giving people clean water, and reducing costs of preparing food by solar cookers. But we also need to teach people to use these things.

– Obstacles and barriers are there, very much related to low education and lack of training how to use technical devices. I think it is possible to arrange courses on this topic and educating instructors. I think the girls and the women are the target. We need to teach them, they are the ones who are preparing food, fetching water, feeding children and so on.

– Giving a healthy environment to people, is inspiring them to build a latrin, keeping the compound clean and tidy, teach them to avoid dirty water, plant fruit trees. At least for planting trees a lot of water is needed, where for example solar energy could be in use.

– New technology to Africa is a challenge. It is difficult because small children in Africa are not used to technology in the same way as we are in Europe. Here we are surrounded be scissors, pencils, papers, toys from small. But of course the skill is there in Africa. I recently heard of a nine-year boy in rural Kenya who himself had created four simple lamps out of batteries and bulbs!

– Try to teach the need of maintenance, try to show that the whole community is profiting from a system, thus avoiding thefts, planting a we-spirit, educate people who can maintain devices and supervisors who can do check-ups. Bringing knowledge to common people, not only to experts, is part of the solution to integrate new energy systems to daily life of rural people in Africa.

23.3.2014
Brita Jern

B)

Irja Aro-Heinilä: PhD in theology and are working as volunteer for Kimbilio

Telephone, 30.04.2014:

- most important is education at all level: primary, secondary school, training for new socio-economics systems like these new technologies, professional schools, trade school, technical school, universities, learning by doing.
- the other and even more important key to make a change happen, is the inner human capacity which we need to release, make people ready to help themselves and excel in their own capabilities and learn new things
- money is needed for all development, whiteout it is impossible to have a proper education and job and earn your own living. The society needs as well money to educate their people.
- The other issue is that the community is a large family and relatives, there is no experiences to take care of other people than relative

e-mail, 30.04.2014:
Näkökulmani on keskiluokkaisten ja toisaalta köyhien ihmisten keskuudessa toimineen näkökulma. Pitää muistaa, että Tansaniassa kaikkea on laidasta laitaan. Suurimmalta osalta tämä ajatteluni on siis yleistystä.

Kaikkein tärkeintä tansanialaisessa maailmasta on kouluttaminen, koko kouluttamisen laaja kenttä. Sillä luodaan perusta analyyttiseen ajatteluun, jota tarvitaan kaikkialla, ei vain tekniikan maailmassa. Tällä hetkellä suurimmalla osalla tansanialaisista on taipumusta flegmaattisuuteen ja passiivisuuteen. Tämä koskettaa erityisesti naisia. Se ei ole ihme, kun katsoo historiaa. Naiset ovat erilaisten heimoperinteiden puristuksessa oppineet vaikenemaan ja olemaan näkymättömiä, vaikka heidän voimaansa ylistetäänkin yhtenä päivänä vuodessa; naisten päivänä. Naisiin ja lapsiin kohdistuva väkivalta on edelleen yleistä. Jos ruumiillista väkivaltaa ei olisikaan perheessä tai työpaikalla, se voi pukeutua uudenlaisiin muotoihin, joita olen saanut itse nähdä. Naisten ajatusten ja toiminnan mitätöiminen ja heidän määräilevä ohjaamisensa on huomattavaa. Tämäkin käyttäytyminen on ymmärrettävää, kun katsoo naisten epäröivää ja miestä mielistelevää käytöstä. On ymmärrettävää, että miestä suututtaa, mutta on myös ymmärrettävää, että nainen ei osaa muuta. Hän on pärjännyt tähän asti kyseisellä hiljaisella ja huomaamattomalla, päätöksiä tekemättömällä ja toimeen ryhtymättömällä käytöksellä. Ei ole helppoa ryhtyä toiseksi, kun on oppinut muuta. Sisäisen energian vapauttaminen onnistuu, ehkä, vain koulutuksen avulla.

Tämän ja monen muun seikan vuoksi se energia, mikä on naisen sisällä, pitäisi aktivoida jo ihan vauvasta asti. Tämä sukupolvi ei ehkä ehdi nähdä muutosta, mutta seuraavalla on jo kenties mahdollisuuksia. Ei auta paljonkaan, jos Tansaniaan viedään teknisiä laitteita, sillä niiden käyttöä ei useinkaan tulla osaamaan. Laitteet ovat liian vaikeita. Ihminen ei ole kasvanut teknisyyden henkeen mukaan. Vastuussa olevat henkilöt eivät ole syntyneet kännykkä kourassa. Heidän juurensa ovat maan mullassa tai katujen pölyssä, siinä mitä tänään syödään, ei huomenna, vain tänään.

Kun heittelen näitä ajatuksia, puhun aina yleisellä tasolla. Poikkeuksia on aina puoleen ja toiseen. Pitää muistaa, että Tansania on hyvin rikas maa ja samalla sen ihmiset ovat köyhiä. On alueita, joissa on toisinaan jopa nälänhätää, varsinkin jos tulee suuria tulvia. Tulvissa omaisuus huuhtoutuu virran mukana ja yleensä muuta ei ole kuin se, mikä kodissa on. Raha ei ole pankkitilillä.

Tansaniassa on juuri löydetty maailman suurin luonnonkaasun esiintymä Intian valtameren alta. Maaperässä on timantteja ja kultaa, öljyä jne. Maa on viljeltävää, kunhan vain saadaan vettä. Olen nyt tajunnut, että Kimbilion saaman kaivon myötä Kimbilion alueella on mahdollisuus saada neljä satoa vuodessa. Eräs pappi, joka on OPISKELLUT Morogoron yliopistossa administraatiota, bisnestä ja maanviljelystä näytti meille oman peltonsa. Siellä käsitin, mitkä mahdollisuudet Kimbiliolla on nyt, kun vettä on riittävästi, kun on porakaivo. Puutarha-alan koulutuksen, markkinointikoulutuksen ja tihkukastelulaitteisiin kohdistuvan koulutuksen avulla alueelta voidaan kerätä hyvä sato monta kertaa vuodessa. Tämä on koulutuksen saaneen paikallisen pastorin silmin aivan mahdollista.

C) George Pindua: 4 September 2014

WHAT ARE BASIC NEEDS OF RURAL PEOPLE IN AFRICA CAN BE MET BY PROVIDING SUSTAINABLE ENERGY SERVICES AND HOW?

Questions and answer

QUESTIONS	ANSWER
1.1. What are basic needs of people who live in Africa?	▪ The basic needs of people in Africa Include, Food, shelter, clean water,electricity,education, hospital and infrastructure,
1.2 What are the different between rural and urban area?	▪ Of course there are different between rural and urban. The difference are due to the availability of basic needs as indicated above while some villages they do not have clean water, electricity, good road, hospital and schools that can provide better education to their children. For that reasons, in urban there are overpopulation due to the available services while in rural there are depopulations because people are moving from rural to urban to look for opportunities.
2. My opinion	▪ The government should provide all necessity services both in rural and urban. The presence of the services mention above will make some youths to remain in villages instead of going to the cities to look for green pastures. Further, the school, road hospital should be improved through providing good services. This will reduce infant and maternal death.
What are an obstacles and barriers faced people ?	▪ To start with hospital, People use to walk about one hundred kilometer to seek for health care services on the way to hospital some people died. This is very common to children under five year and pregnant women. However, in some place, of course they have rough road which can be passable during the dry season while during the rain is not possible to pass. In addition to that in rural are people experience shortage of medicine in the public health center, in that case therefore,
	the patients should go to the cities, if you do not have bus fair, it means that death is an avoidable. ▪ ▪ Secondly, in rural area they do not have electric that can influence investors to go and invest there. In that case, people in rural area are depending on activities rather than employed in other industries. ▪ Clean water, In villages people use water from rives which is not clean for human use. This may cause to get some disease like diarrheal, typhoid and other associated with unclean water. ▪ Last but not least, in rural area people are missing basic needs in way that with no solution because the government cannot abe to facilitate the services into all villages due to adequate funds
3. How is new energy service connected to basic needs? What are the most important in using new energy services to people live in Africa?	▪ Of course, there is connection between the new energy and basic need for people. For instance we need energy for cooking, we need energy for run machine, industries , charging our cell phone, light and influencing investors to come in rural area that will result to offer job opportunity and reduce deforestation that cause by human being. Today, we are whiteness our trees cutting down for making charcoal burn in order to use for cooking.
4.What are an obstacles and barriers for using new energy?	▪ What I think, the economy of people in rural Africa can be one of obstacles. People are poor and cannot afford to pay the bills for electricity or purchase solar panel. Secondly, some people in rural areas, their house were roofing by glass of which you cannot install electricity in such houses.
5. What are the possibilities for people to be part....."	This question is not clear to me, would you please re-write it?
COMMUNITY	**ANSWER**

Continues in the next page

How do you think nutrition food and cooking can be arranged in Africa culture?	▪ I think, this can be done through provide education which relates to food nutrition and clean cooking. It is anticipating through education people could change their mind setup.
How do you think clean water can possible to arrange in Africa?	▪ First of all, you have to know that clean water is most available in the cities while in rural areas is very difficult to access clean water. In respond to your question, I think we need to investigate the place where we can make drill wells in villages that will be a solution to community especially those who, live in rural areas. In short, water can be arranged in Africa, through making drill wells.
How about education training and working environments? What do you think is the connection to energy and what kind of energy?	▪ I am not very much sure if this question is clear to me however, I would like to answer like this, training premises is challengeable in Africa continent at large. It so because, we have overpopulation than standard suggested by the ministry of education. ▪ Secondly, we do not enough desks in our schools promises that will provide chance to students to study comfortable. Regard on the kind of energy applied to our community. As I said before in some places, they are using electricity while other place solar energy however, the majority use kerosene means of energy. ▪ I think, it has direct connection in the sense that if you want to have a very good performance, students need an extra time to review what they have been studied at schools, in so doing there is possibility to improve the performance of the students because they need a light.
How new energy services could provide live hood opportunities and exporting possibilities? What kind of business models there could be?	▪ The presence of new energy will improve the life of people in Africa. First, it will provide job opportunities to community because the investors can make processing industries that cannot work without using electricity. ▪ Secondly, It will increase production, create market from local products and improve infrastructure. In this case, the community could have very good opportunity to do different business include processing products from farms. ▪ Not only that it will influence private sectors to build schools, hospital, and hotel.
How these energy services might decrease and improve healthy environment?	▪ Yes, it true that new energy will reduce environment problem to community in the sense that people will not continue to cut trees that cause deforestation in the country. By protecting our forest, the community will enjoy through receiving rain, fresh air, timber and water throughout year.
What do you think new energy services can provide security for people? What these energy services could be? Security meaning health, food, water and living costs?	▪ I think solar energy, Gas and electricity services can provide security to people. These services will facilitate to make processing products hence reduced the living expense include health, food and water.
How do you access to these new energy services? How do you think this is possible to arrange? What do you think is the biggest obstacles and barriers to get new energy services?	▪ The accessibility of new energy services to poor people is very difficult because it needs sources of income to facilitate the installation of the energy. ▪ It is possible to arrange this program to be done through supporting poor people in order to have an access to new energy However, you could not take all of them still you can identify few of them as sampling. ▪ I think the biggest an obstacle to get new energy to them is facilitation on how they can able to access it (financial issue)
How about health environments for people? What is your opinion?	▪ Health environment for people is friendly however they do not

Continues in the next page

What kind of new energy services can contribute this?	have energy to support their daily life. My opinion, we need to look possibilities on how we can support the poor people in order to protect their environment. ▪ The kind of energy service can be solar power and Gas can improve the life of the people.
What do you think, what are the most important things to create and transfer new technologies for people living in Africa? What are an obstacles and barriers?	▪ I think there are need to train people from my country or Africa in order to acquire new technologies. It is my hope that the knowledge and skills obtained will help them to continue using that knowledge for the benefit of his/her country and supporters. ▪ ▪ The main obstacles are, the majority cannot afford to meet universities expenses. In that case, you can find very few people can get opportunities to obtain such knowledge.
What do you think, how these new energy services and basic needs like food, water, health, and education can be part of people's life? How all these needs could be integrated and combined to new	▪ I think as human being needs all necessity basic needs as indicated in your question. I am sure without having those things; there is something missing or no life at all. It can be integrated in the sense that all of them are part of the basic needs. We need education for the purpose of preparing skilled people who will serve the nation and worldwide. We need health so as to male our life well and survival, we need clean water and energy.

George Pindua, Feedback

5 September 2014:

Dear Ritva,
I am very sorry for my delaying to reply your email. I also happy to making it clear. First of all you have to understand that solar power is new technology to people who live in the countryside. If, I am not wrong it is about five or ten years since the technology introduced to us.

Secondly in rural area, there were few people who roofed their house by iron- sheet while the majority were roofing by glass. In this respective therefore,you can see about 20% use solar power while 80 % were not using solar power due to nature of their house. In order to arrange this program to take off, we should provide education to them for the purpose of change their mind and build good houses.

For the people who have already built good house, they can able to own solar and pay the necessity costs while the poor people cannot afford to buy the panel and maintenance of the system once corrupted. This also should be in your mind that some villages there is electricity but people are not installed in the house due to economic crisis. I think, this question is very clear to you. In case of any thing please let me know.

Dean Pindua

Appendix IB: ABC Water project

ABC Water project: http://www.slef.fi/utlandet/utvecklingssamarbete/vattenprojekt/abc-vattenforsorjning

3 April 2014, Hej!

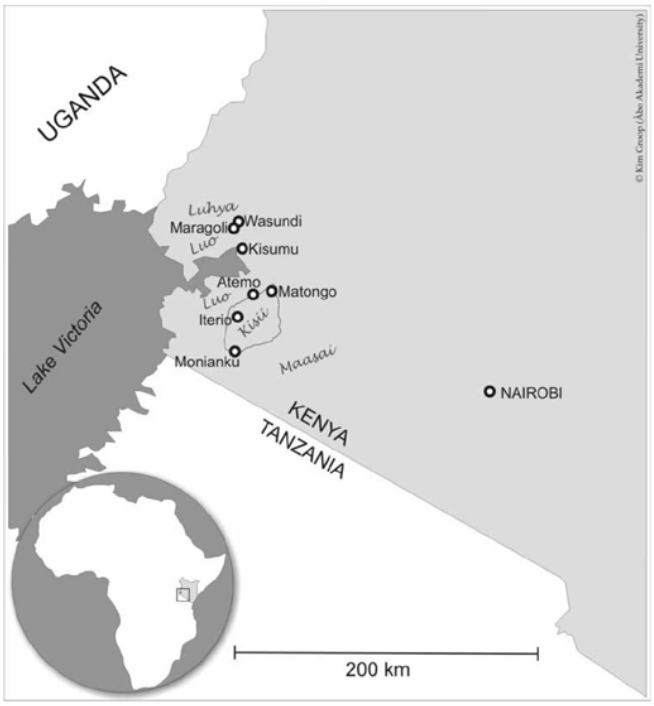
Systemet på ABC så är överlämnat till ABC Colleget som har ansvaret för dess funktion. Deras dagvakt kopplar på och av pumpen vartefter det behövs. För själva pumpstället som används av ortsbefolkningen så ansvarar en dam som bor alldeles nära. Hon tar betalt för vattnet enligt de avgifter som man kommit överens och antecknar i ett häfte. Tyvärr så har Aburu Falls Community gruppen inte ännu öppnat ett bankkonto (jag har åtminstone inte fått information om det) , utan pengarna förvaras nog bara av denna dam tillsvidare. De skulle ha ett penninginsamlingstillfälle i början av förra året, men jag vet inte hur det utföll. De behövde få ihop 5000 Kenya shillings för att kunna öppna bankkontot. Det här är ett problem som ännu måste följas upp.

Tekniken för vattenpumpningen finns alltså på Atemo Bible Colleges tomt och sköts av dem.

De pengar de samlar in skall användas för att underhålla pumpsystemet, åtminstone de mindre kostnaderna. Ifall det blir större kostnader fungerar det så kallande "harambee"-insamlingssystemet (talko) bäst i Kenya, dvs att man samlar in medel när de behövs.

h, Solveig (Solveig Nylynd, SLEF)

23 Nc



Source: Lounela J 2007, p.75 Mission and Development. Finnish Pentecostal, Lutheran and Orthodox Mission Agencies in Development Work in Kenya 1948-1989. Turku Finland. Åbo Akademi University Press. Available: [12.06.2014] http://www.doria.fi/bitstream/handle/10024/29217/LounelaJaakko.pdf

Appendix IC: Researcher's scientific CV

Doctoral student Saarinen finished her M.Sc in 1980 from Helsinki University of Technology (currently Aalto University) on the process automation for co-firing Circulated Fluidized Bed and has actively worked with cost-effective applications in Combined Heat and Power systems. In 1994, she started her doctoral studies on multimedia learning organisations and mobile Internet applications. In 2009, after several years working experience, she returned as Research Scientist to multimedia applications for bio-based energy systems. She has actively been involved in the participatory scientific research of the user acceptance of sustainable renewable energy services, which are capable in meeting basic needs of rural people in developing countries, her future research interest focusing on mutual advantages partnership concepts and their social acceptability. A Village Community concept as a collaborative visual meeting place for villagers from children to adults, is her mission, a place for mutual equality, sharing and taking care of each individual as a valued human being. Her research topic is 'Wellbeing of African villagers within their community empowered by sustainable new energy services' at Aalto University, School of Electrical Engineering in the research focus area 'Wellbeing and a smart living environment, Research Focus Areas: http://elec.aalto.fi/en/research/focus_areas/, Departments: http://elec.aalto.fi/en/departments/

Ritva Saarinen has finished her Licentiate of Science (Technology) 16 June, 2015, the thesis published online: https://aaltodoc.aalto.fi/handle/123456789/16542

LinkedIn: Ritva Saarinen, http://fi.linkedin.com/in/ritva.saarinen/

Appendix ID: First summaries of interviews

N	Individual	Community	Social
1	water, wells, sol energy, food, cooking, **work** Unhealthy wood traditional stove no el. rural, charcoal discontinuous el.urban	trad. stove->improved stove! irrigation, pumping, solar-energy, clean water, cattle, small gardening,	communal people large families-> security but no secure income and work
2	Poverty, no money, no investment	after rains heavy draughts controlling	education after secondary school expensive, education for profession, contacts, knowledge share
3	access to water, long distances, wells by NGOs, state	access to water and fuel wood near to people, more education, knowledge, behavioral change	lack of clean water, training, how to do and arrange
4	Poverty, **no work**	education, training->work, preliminary education unexpected good	infrastructure, roads, mobile phones exist everywhere
5	now no communal/village systems but state-owned if exist	basic health services, sufficient clean water and near to people	tackle poverty, access to water and resources, access to energy
	work, water, food, education, support others, professional training, bigger picture		

N	Individual	Community	Social
1	clean water, well, toilet, security, work, education, land for gardening (food)	change through women, gardens and irrigation, organizing, selling, get assets, learning best practices, training, projectizing, project management more education, knowledge, behavioral change, cultural change, hope	access to land and water, change through women, behavioral change, village, agricultural practices, work
2	Poverty, fuel wood and el-costs, slums, men go to work to towns or other countries		commitment, lending money, villagers, donors, NGOs, trusted partners lack of clean water, training, how to do and arrange
3	improved stove, human rights, women groups		
4	old traditions beliefs rulers	basic security in weekdays, land rights, cultivating, UN human rights, ID, banking	knowledge sharing, best practices, small-scale, practical, women, gardening, land rights, human rights. Barriers old traditions, beliefs, rulers
5	women empower changes, small practical systems, step by step changes, small-scale energy power systems	basic health services, clean water, wells, toilets, food, lighting, small-scale energy	
	Practical small-scale energy systems, change through women, Human Rights		

N	Individual	Community	Social
1	electricity, banking, mobile phone, charging, light, education, cooking, well-being, prices. Rural fuel wood free, off-grid. Urban electricity network	biogas systems seldom working at home in Africa, need central control, regulations and guidelines but e.g at schools . Effective improved stoves at school, wood gathering, less wood needed. Lights at school near to parents	more secure energy service, mitigate disasters. Resources, fuel wood, effective use/stove lessens conflicts, equalization, decrease poverty
2	poverty, no money, no investment		unequal distribution and access of energy. improve access to energy, transfer to three villages, from your own-roots. efficitive large-scale kitchens schools, work
3	lights, practical, efficient stoves: oven, injera pancake.		
4	lack of knowledge, money, practices to use, user training	effective stoves, knowledge transfer, mobile phones, sales prices, time savings, small business	practical, simple, knowledge of new practices, dialogues
5	If traditions for community based practices-> common interest to maintain, cheaper	indoor air improved stoves/ lights. hospitals, solar, cooling, vaccines	energy is a basic need, food, water, for common practical use
	meets true needs, do not provide what is not needed		

N	Individual	Community	Social
1	water, healthcare, education, jobs, sustainable development, water and solar energy	food crisis but otherwise African food good, clean water is the most important, wells, water pipes	small steps, gradual education. In cities marginalization and slums threath
2	corruption, tribes a social unit, identity, in a country many tribes. conflicts	clean water, toilet, not only one need but integration	we here need a humble mind to listen, local needs
3	hydropower, solar, sustainable versus harmful	even the poor wants mobile phone but the significance of clean water to health needs education & info	partnership, mutual sharing and understanding, local people do by themselves
4	a human being is equal everywhere, no money to buy basic things	subsistence economy in agriculture, corruption, how to share fares for common things when no taxes	
5	Poverty sharing, no-one takes care of common things at free of charge	basic health services, clean water, incomes and growth in economy, infra	what needs: even the poor buys mobile phone not the foot water pump
	mutual benefits and knowledge, equal relationship and partnership		

N	Individual	Community	Social
1	work, livelihood, urban might be poor as rural person, basic needs like educaded has been aided by church	villagers enabled by Church Women Bank, Finn Church Aid, Christian entrepreneurs, social workers, Change Makers, missionary workers	Education, Women Bank, building small own business, education for occupation, profession lack of knowledge, info, better practices e.g farming
2	no work-> marginalization, climate change		
3	water, food	communication, what happens in the field, how we can help, like wells for water and education, visits	empowering people. Barrier: not observing other's talents and capacity
4	no work, poverty	training, work, Christian entrepreneurs, Women Bank, small business, fairs, going were people are	trade and technology school, people can, prober attitude towards neighbors, mutual knowledge and sharing, working together, change makers
5	Finn Church Aid and Women Bank helped villagers, family relatives	wells for clean water, public education, knowledge	
	values influence on society		

N	Individual	Community	Social
1	water, light, cooling, sanitation. Rural petrol, wood, no el. Urban discontinuous electricity	clean water, pumping, gardening, lights, solar, cooking, what kind of stove rural (no el oven, efficiency?) mobile school, hand lights, charging kiosks	Security/street lights, financing/banking ownership capital national structures
2	investments (life-cycle 20 years) for off-grid solar, no money		investments, money, traditions, GDP, learning by doing, own-basis, training, how to do and arrange 'The water brought to the well doesn't stay in there'
3	food, water, pumping, light, cooling, sanitation, solar electricity. Urban electricity network	light education, cooling stone-house, light at home, solar for 100-sockets, charging	
4	social government structures, financing, land rights, rights for farming, subsidized-petrol	street/outdoor light-> gathering small business, mobile phone charging kiosks, sockets place, cooling selling ice	simple systems/services, can you read!, how the village community can maintain new system, grass root movements
5	depends on what is the tradition to community-based owning working	Hygiene, light doctors nurses, cooling vaccines, ices. Improved lights/stoves	common values, government, laws
	light to people		

Continues in the next page

N	Individual	Community	Social
1	education, food, water, health, electricity, el-light, improved stove	transportation infra	fertile soil, water pumping and irrigation, cooling/ heating, selling surplus
2	enablers:education,public education, books, papers	groundwater pumping, waterworks, bottled water?	money, funding, building, education, construction
3	clean drinking water, power for equipments, machines e.g pumps	public education, long-term change, clean water, hygiene	
4	lack of knowledge, illiteracy, old traditions, not money	through empowerment, e.g. hand-made furnitures, original no energy-intensive, small change-> large change	empowerment, infra, trade, education transfer between countries, visits, public education
5	village elders, Lead users, pilots	water, hygiene, clean cooking, energy enabler	NGOs, public education, social advice info, layman work
	role of energy to society: simple, reliable, leverage to livelihood and energy services, e.g. Light, Clean Water		

N	Individual	Community	Social
1	water, sanitary, electricity, light. Rural petrol, wood, no el. Urban charcoal, wood, discontinuous electricity	clean food, own land or buy, surplus for market, productivity agriculture. integrated system: clean cooking, light, toilet	how handle conflicts. opportunities to do something else. Access to resources
2	Rural no network, lines expensive. Poverty, no money, no investment	clean water, toilet, not only one need but integration	lack of knowledge, info, better practices e.g farming
3	hydropower, solar, diesel	more education, knowledge, behavioral change, maintain own system, technology transfer	lack of clean water, training, how to do and arrange
4	transmission costs ->off-grid system batteries maintenance	training, project training, productive farming, simple small things available, step-by-step	training, transfer your knowledge, visits places for better practices, how to run projects, pilots
5	energy system owned by two or more households/ people close enough	basic health services, clean water, pollutions contaminated water food	all things integrated working together, pilots
	integrated together, all should hand-in-hand		

N	Individual	Community	Social
1	light, mobile phone charging, water pumping, solar power, school food, improved stove, biogas. No network infra	How to change traditional stoves, fast simple cheap. Trad. Stove in use even el-lights in use. Water pumping	street lights security of girls and women, water pumping ownership model
2	poverty, just money to buy perhaps a generator and charcoal	clean water, now even a common pump people get water from the river	lack of knowledge. databank and info of best practices
3	cost-effective, light, street lights, school lights, moderate running costs	What kind of solutions to meet the real needs. Village school and training best practices	WASH toilet and biogas. School kitchen
4	ownership, common systems, quality assurance (QA), money, investments	village school/house, school kitchen, garden, training-education, sales to market, micro-economics	school, children open to new solutions, step by step, real benefits to users
5	village school/house, garden, sales to markets, livelihood, street lights micro-business	Improved stove, water pumping, school kitchen and food, garden	Integrating, village school/ house, kitchen, garden, training new practices for adults, micro-buisness
	among people simple steps by steps towards what people need in collaboration		

N	Individual	Community	Social
1	Water, food, health, education, energy, solar energy, water purification, rural the minimum use	versatile food cultivation, irrigation, perhaps greenhouses with artificial lights and solar	Food, water, health security, see individual and community
2	Technology knowledge, information, economics, materials	groundwater pumping, water purification, efficiency, rivers	Tribes, tribal origin, culture, identity, policy makers and government. Country level, character and values of leaders and responsible people, country policies and how they are implemented. Education, infra
3	clean drinking water, water purification, access to energy, irrigation, solar, wind, cultivation	education of new technologies like solar, need to know: why this system exists here	
4	history, colonization, wars, lack of education, infra, food, water	through sensitive discussions in collaboration as equal partners, searching own ways to do things	
5	Politicians working for all people, education and co-operation, knowledge transfer, sustainability	Well-being, clean water, food, education	Politicians working for all people, education and co-operation, knowledge transfer, sustainability
	Sustainability and knowledge transfer		

N	Individual	Community	Social
1	Energy is a tool for better life, agriculture, farms, schools, hospitals, education, charging. Environment friendly Solar energy at affordable price, monthly incomes. Urban, rural difference very huge, rural almost 0% energy, urban not enough and energy is delivered only in some time-slots.	Food, cooking, traditional stoves due to lack of electricity, enough it will provide all cooking possibilities. Solar.	Solar energy needed also in cities, today noisy generators and often broken. For mobile systems, you need charging, now you go for long distances to buy charging. In cities you have your own money and can buy food, but rural areas you need to buy food on daily basis. Garden and irrigation is a source of money for a whole year, e.g. you can put up restaurants, these will change your mindsets.
2	lack of investments, energy sector opportunity, solar.	Clean water, now far too expensive, and sometimes faraway to get. Community energy system for clean drinking water and domestic animals.	Access to land: you first discuss with government, then to community leader and his team, show your projects benefits for communal land and community, you work through community.
3	Solar-based systems for houses, factories, customer projects	Energy system for schools: improvement in quality of education, connected to better materials, investment to next generation	Technology transfer: through communication like here we do, what is solar systems, you need to call some of people in community and put them into training. In long-run you need to have Internet-Cafes, people can send there e-mails, and be connected. Educating them. Secondly, you have to employ some of them to your project where the can work with you, and you transfer your knowledge to them. From them it will be transferred to community level. Through training, through employment, through community discussions.
4	Wars, conflicts. Lack of Money. Education. Investments	With that village-system you can invest in a commercial mangos and ananas juice-factory and get local employees. You get wages and can live your way of life, total change in your village.	
5	Village-community based energy (solar) system. Things are done based on a community, this our thing, community-based service	With energy medicines in cold, and midwifes and nurses working. Sanitation and health with new practices due to jobs and boss' guidance and advice. Energy changes your life and mindset.	
	Collaboration: therefor I exist, Energy is a mean for a better life		

N	Individual	Community	Social
1	Irrigation, clean water, shelters for water wells, education, healthcare. Poverty<>wealth, urban people are not aware of rural people's poverty. Rural education poorer than urban	Only small fields, most of in village market places, information sharing. No self-sufficiency, live from hand-to-mouth. Land crapping, China leases land for their own people.	There exists national electric utility. Electronic stores sell electrification to houses. Poor people can not afford them. Cities also electric stoves.
2	Hard to get out of poverty. Infrastructure of society. Financing, e.g education, school-uniform, -teries, -trips, home works and lighting.	Protect mountain-water wells, by gravity in pipelines up-to couple of kilometres. Collecting rainwater from roofs. Now from river, clarification and cooking.	Money is a big obstacle to get energy.
3	Today fire wood, diesel pumping river-water and clarification by calcium and boiling. Water from roofs. Clean wells needed. Electricity	Training and education of new technologies like solar at schools, how to build projects. From Finland pupils taught how to build a solar heater. National electric utility.	Hospitals are owned by state. Long distances. You go by walking or other people carry you to hospitals, donkey or horse. There exist in rural areas hospitals by mission organisations.
4	Wars, conflicts. Money. Education. Eucalyptus construction material but terminates drawbacks. Deceases like malaria, old harmful traditions.	Coffee, teffi exports. Agricultural products like fair trade. Micro-credits.	Education, teach teachers to teach new technologies. Public education
5	Village-well and we-spirit will make maintenance easier, man-power people need each others, people are not separated but belong to society.	Lighting for children to study. Clean water, wells. Fire-wood and charcoal, stoves? Now three-legs stoves, new ones from clay. Incomes small-scale like hen, lambs, small field-plots.	There exist a lot of people and growing. Money is needed and jobs and education. And manufacturing and exports. Stipends to go Finland, but better projects in your own country, learning by doing.
	Peace and citizens working together		

Appendix IE: Narrative stories of interviewees

Story 1, Jyrki Myllärniemi

Story 2, Tapio Keränen

Story 3 Pramod Bhusal
Story 4 Solveig Nylund
Story 5 Mikko Juntunen
Story 6 Paula Tommila
Story 7 Vuokko Alanne

Story 8 Tomi Järvinen

Story 9 Pasi Aaltonen
Story 10 Paulo Pinho
Story 11 Seppo Vehko
Story 12 Majok Kariom

Story 13 Mika Vehnämäki

Story 14 Helene Taal

Experiences:
These are not in the same order as stories

Experience 1: international solar-energy company working in 140 countries mostly in developing countries, Ph.D in physics, CERN, Nokia, light-emitted-diodes for medicine sector, solar cells and systems several years.

Experience 2: international University. Master thesis student in business management. From South-Sudan and lived in Finland for some years.

Experience 3: international power companies, In development co-operation in Ministry of Foreign Affairs of Finland and in international Christian NGO, 12 years experience in Africa

Experience 4: international Christian NGO, 17 years in developing country Africa clean water projects building wells, after that in Finland as controller (economy, finance, administration) for this NGO since 2003 for managing funding and aids for NGO's projects.

Experience 5: International Church NGO, own association since 2009 co-operation with Finn Church Aid developing school-concept, aim to create a prototype concept to some target country, evaluated school construction work in Haiti, a coordinator for school construction work, experienced in construction work, education and training, further developing school-concept in developing countries like Kongo and south-Sudan, Philippines

Experience 6: international university, developing countries like Nepal, Thailand, Vietnam, Philippines, Ethiopia, EU countries, several years experience

Experience 7: Espoo Evangelical Lutheran Church, a sending organisation responsible for several mission and development aid for target developing countries. 28 years as mission coordinating secretary and other activities.

Experience 8: International sustainability consultant firm. In development co-operation in Ministry of Foreign Affairs of Finland and then in international sustainability consultant firm, several years.

Experience 9: Espoo Evangelical Lutheran Church, a sending organisation responsible for several mission and development aid for target developing countries. 12 years as mission coordinating secretary, before that as assistant in business environment. 10 cr international diaconate DIAK course. Cooperation linking work with parishes, mission organisations, mission workers, other organisations.

Experiences 10: over 30 years Espoo Evangelical Lutheran Church, different kinds of work, church international work practices in deacon multicultural work and work among young people in Finland working together 14-30 years, hope to make change to happen: wells to Senegal, school fares to children in Brazil and in Ethiopia, long-term work, new views to carry out international deacon work KUA, SLS, interactive, conversational, how money is spent, photos and stories of supported countries, learn a new way to do your work learning curve 2-3 years, change makers, in Zimbabwe, India, integrating all parish practices to serve both international and domestic parishes, joint responsibility

Experience 11: International Church NGO, Since 1996 international development co-operation work, PhD in empowering partners

Experience 12: Dr. Economics, valtiotieteenlisentiaatti, senior economics advisor Department for Development Policy Ministry of Foreign Affairs, for co-operation development in all foreign affairs and especially development in private sector. Advisors do not run programs, and for those are different people.

Experience 13: D.Sc. International University teacher and researcher, electrical engineering. B.Sc in Other Europe country. M.Sc in Finland in electrical engineering inverter power electronics.

Experience 14: International power company over 30-years, several positions, D.Sc

Appendix IF: Further rounds of interviews and feedback

A) Tomi Järvinen, Pasi Aaltonen 15 May 2015:

2. Clean Water:

ABC reference case, how maintenance of solar-based water-pumping, is there an employee to take care of? How the village-community was created about 1000 villagers? Cheap clean water, how ?

Haiti school as a second reference, a school, Pasi (telephone 14.08.2014) the presentation from Haiti.

3. Light

Finn Aid reference, costs for a school, Pasi

4. School Garden

Solar-based Drip-Irrigation, reference Benin

How about a school and garden, is yields enough for food for pupils? Are parents involved? SGT?

4) Concept, puzzles, building blocks for villagers to solve their problems

5) sub-Sharan Africa BOP market

Pasi and Tomi: all in schools e.g. in Haiti clean water. Light in school, costs, how the school community arranged? How maintenance and taking care? Who owns? Who owns 'maintenance, who is maintenance staff? responsibilities. compare SELF/NAPS Benin case. What is the output: services as Clean Water, Light, gardening for Food, and concepts as village-school concept. Landownership. Can a school-garden produce enough food for school-children? There is no mechanisms for school-masters to create school gardens, school-masters are responsible for their school and it's maintenance, how possible even this school food is considered importance? Kongo, a small invest was given and they could decide by themselves what to do with this investment, how to get incomes to school, probably first for teachers' salaries, school maintenance and in the end for school food, Some micro-start like a small kiosk beside the school and possibility to sell tea and coffee. The structure might be: when the sate is weak, and not capable to independently to build a school system, then parents of school children have to take the role, and this kind of involvement will arise from the need that you have to do this in order that your children will get education, will this lead even worse situation so that the state will not take its responsibility? Negation sand dialogue with the state is

needed, and also challenge the state with good practices and examples how to arrange education, Unlock the potential, so that local people themselves will start to take care of themselves and try to find their own solutions. E.g. It took seven years to get a project plan for a local youth centre, sometime it is good to have time for locals. Now this centre is running locally. Or to give a start investment and let local to decide how to use it. How to self-actualise locals? Learning by watching and doing (Thier RTS), there huge amount of text-materials in these development co-operation contexts, we do research for our purpose for our research community or EU standards, we are forced to convince that their is the knowledge behind our work, we must prove. Einstein said, that if you are not capable to explain your phenomenon to your mom, you do not know your stuff. Methodology in TAMAA case report, why needed?

Professional education? Education by companies? Those who are living in streets, they should have education which can give them immediately some wages like apprenticeship contract, they do not endure to wait couple of years to get out of school and after that some wages, (they do not have anything at street!). How about agriculture and gardening? You need food but you want get out of agriculture? How transportation and logistics, co-operative farms? On the other hand, there were a beer-brewery in the other end of road and there were many lorries. Hardship and lack of appreciation in traditional agriculture. What would be alternative ways to arrange agriculture, roads and infra? Mobile phone more important that the education of children, because of the need of appreciation and status.

08 October 2014: Tomi Järvinen

Petri Hautaniemi, Ministry for Foreign Affair in Finland. Haiti Pasi. South-Sudan?.

B) Jyrki Myllärniemi 11 June 2014

Culture, how we express our values and beliefs and how we value a human being. E.g. Christianity is the foundation of our culture. The cultures of African countries, e.g Tanzania official languages Swahili and English, religions major Christians, minor Muslims, and Maasai people. Most schools are Christian in Sub-Sharan Africa. Differences and different expressions of culture and religions can add richness among our country. Spirit, Soul. (Collier A. 1999. Being and worth 'Humans and unique and equal in respect having a life to live'; Figure 12; Frankl V.E. 1983, 2010).

Village-School concept, Jyrki Zimbabwe, village pilot, there is no ideal model, we are not perfect people and there are both success stories and failures, locality and small-scale concepts, many systems are so difficulties and corrupted and traditional so that large-scale systems are difficult to build and the development is so slow, in these small systems grow from down to upwards as micro-loans and micro-business at village levels. Barriers like land ownership issues, land reform, international rights, human rights, national laws, corruption, fare trade of resources like coffee, cacao, minerals. These small-scale systems have advantages that they are uncoupled from those structures of power, off-grid systems like water and electricity and schools, for those that lacking land reform is not so big problem, e.g. schools by churches. Building a farm owned by some institution or church or co-operative society, and it rents land plots to people for cultivating, and e.g about 1000 people could have possible to farm a one

big farm and the rent would big enough for maintaining infra (compare Ilunda Ward Water project), self-actualising and people like to work for family and their children, human needs and voluntary, mutual advantages, differences of humans, independence, human values, rights for education, healthcare, banking, co-operative working, equality also in practice.

Confirming Zimbabwe village story. -> also learnt to prepare soaps and other things which then people were able to sell, micro-business, local production, no need to go migrant work.

C) Pramod Bhusal 22 May 2014
Very many topics, too many things there and here, what this report wants to tell? More clear and compact, one page abstract, Introduction just introduction, whose vision and goals?, what is the topic of work this TAMAA case, (now the topic on the cover page RTS), are goals and vision your (RTS) recommendations or which. What is the order of introducing your (RTS) work and the current situation of basic needs? Literature review what others have done (now in licentiate thesis but background review for basic needs as a baseline in TAMAA case RTS). Gap to fill, case study. Then theory and methodology (now in licentiate thesis but shortly in TAMAA case, only Interviews more comprehensively, only my used methodologies), combining major methodologies and grouping. The results: my methodologies and created processes, e.g. How Light Service created, and Interview results. Result Needs covered, result services as Light, Clean Water, Drip-irrigation for Food market. Then concepts created which are not yet exact services. Mention in the beginning that you are going to do this and this (related to results) and what methodologies you used for those. Village-school concept is a suggestion (proposal) based on interviews and include created services. Professional education, what the role in TAMAA case? education for new created services. Chapter for recommendations. Village concept, a first draft what it could be.

D) Tapio Keränen 26 May 2014

Definitions, abbreviations. TAMAA, SMILE and others like NGO. Purpose ok, chapter Strategic goals vision etc. strategic goals are strategic steps, vision: what is the target for future, mission shorter and more exact. Figure 2 Basic needs, the meaning of hungry people hunger malnutrition. Background of basic needs chapter ok, why Africa? -> journey to TAMAA. (Why Africa? Is now in Chapter Market perspective RTS). Methodology:

Research questions (at the moment divided in more specific questions RTS). Figure 4 Scientific enquire my process, Georg Henrik von Wright, the term definition. Qualitative and quantitative research, ok. Creation process, for what? (Now, Service Creation Process, RTS). Critical realism: perspective, Philosophy, paradigm, at upper level, this is chosen, in sociology, also in natural science e.g. they work together e.g. Wright. Figure Ackroyd et al., in organisation studies and in sociology. Complex systems. Case studies and interviews at same level (methodology or method). Complex system theory. Community is a target organisation to study. Community is a complex system and methodology/Philosophy critical realism. Learning organisation related to complex system and organisation theory. Learning organisation a character of community. Conceptualisation, concepts. Visualisation e.g. matrix analysis, maps, flow-

charts. Validation, verification. Technology: sustainability theory to beginning to background and my LCA calculations to results. Technology transfer: to background and to my results. Results to sub-chapters as Services, Concepts, professional education for new services might be in discussion and discuss relation to others work. Recommendations. results own chapter, discussions it's own. 6-7 chapters totally, sub chapters.

E) Mikko Juntunen 5 June 2014, written comments

Hei,

Lueskelin nyt tuota TAMAA raporttia (versio 28.5.). En alkanut oikeasti kattavasti läpilukemaan, ja erityisesti ohitin teoreettiset viitekehykset, joita esittelet melko laajasti. Oletan, että tämä raportti ei ole lisensiaattityösi, vaan lisuri perustuu tähän?

Raportissahan on mahtavasti tärkeää asiaa. Sen esille saamiseksi tarvittaisiin vielä jäsentelyä (kuten itsekin siellä huomauttelet itsellesi). Jäsentelyn kautta pääsisit varmaan eroon myös toistosta jota siinä mielestäni esiintyy. Osa siitä on tietenkin välttämätöntä (kun sama asia tulee vastaan introssa, leipätekstissä ja yhteenvedossa). Mutta teepä kokeeksi haku sanalla 'solar', jonka minä tein etsiäkseni pikaisesti kohdat, joihin minulla voisi olla asiallista kommentoitavaa. Vaikutelmakseni jäi, että samoja asioita tule vastaan monessa paikassa.

On the positive side, minulla ei ole niihin sisällöllisesti mitään olennaista huomautettavaa ja näyttää siltä, että haastattelukommenttinikin on ymmärretty ja dokumentoitu mielestäni täysin riittävän oikein.

Yleisesti ottaen minun oli vähän vaikea (visuaalisesti) hahmottaa tätä. Onkohan tämä vähän raportti – presentaatio –hybridi. Muotoseikat eivät ehkä tässä ole niin tärkeitä, mutta lukemista helpottaisi lyhyempi rivi (leveämmät marginaalit/kapeampi palsta) sekä ahkerampi kappalejakojen käyttö. Samoin logopohjan käyttö ja kuvien sijoittelu jokaisen sivun headeriin on mielestäni tarpeetonta ja tekee dokumentin levottoman näköiseksi, varsinkin niillä sivuilla, joilla kuvia on muutenkin runsaasti. Lisäksi, vaikka siitä tulee lisää sivuja, mielestäni sisällysluetteloksi sopii taulukkoa paremmin ihan perusmalli, jossa asiat ovat peräkkäin ja alaluvut sisennettynä.

Jos haluat tehdä raportin, joka saavuttaa lukijakuntaa, ja jota ehkä voitaisiin käyttää case esimerkkinä tai käsikirjana maailman parantamiseksi tätä reittiä, tästä pitäisi saada dramaattisesti tiiviimpi. Ehdottaisin, että kirjaisit paljon tiiviimmin tai osa kokonaan pois nuo opinnäytteelle tyypilliset osiot, kuten kirjallisuuskatsauksen, menetelmäkuvauksen, ym ja keskittyisit siihen, miksi ja mitä tässä tehtiin ja saatiin aikaan sekä mitä tästä opittiin ja miten voidaan ja pitää jatkaa. Eli vähentää opinnäytemäisyyttä ja lisätä raporrti-/esitysmäisyyttä. Opinnäytteessä puolestaan nämä painotukset toisin päin.

Haastateltavalistassa minun kokemukseksenі mainitaan ’LEDs medical’, jota en ymmärrä. Olet yrittänyt lyhentää ’X-ray detectors for medical imaging’, tai ’photodiodes for medical imaging’, joka ei tuohon laatikkoon mahdu. Laita siihen vaikka vain medical imaging.

Tsemppiä!

Terv.
Mikko

F) George Pindua

5 September 2014
Dear Dr. Ritva,
I am very sorry for my delaying to reply your email. I also happy to making it clear. First of all you have to understand that solar power is new technology to people who live in the countryside.If , i am not wrong it is about five or ten years since the technology introduced to us.

Secondly in rural area, there were few people who roofed their house by iron- sheet while the majority were roofing by glass. In this respective therefore,you can see about 20% use solar power while 80 % were not using solar power due to nature of their house. In order to arrange this program to take off, we should provide education to them for the purpose of change their mind and build good houses.

For the people who have already built good house, they can able to own solar and pay the necessity costs while the poor people cannot afford to buy the panel and maintenance of the system once corrupted .This also should be in your mind that some villages there is electricity but people are not installed in the house due to economic crisis. I think, this question is very clear to you. In case of any thing please let me know.

Dean Pindua

24 September 2014
Dear Dr. Ritva,
Many greetings from Pastor Pindua.

I would like to take this opportunity to congratulated you for very good job you have done in this paper. This paper is touch the well-being of people in rural area. The findings that you have shown in this paper will help in writing project proposal which intends to support the community. For instance the issue of health, clean water and solar power are very important.I think you have to make a plan to visit me so that we can have direct talks.

I will be ready to write an invitation letter to you. We are want to support our people but we do not know where to send our proposal as you know donors are willing to work with somebody of whom they trust.It is my hope that through this channel we can make tangible things to our community. I will appreciate to hear your inputs in this regards. In his name. Dean Pindua.

25 November 2014
Dear Ritva, Many greetings from pastor Pindua.It is my hope that you are doing very fine with daily activity.I at also happy to have Dt Irja here in Tanzania together with Dr.Mikko.They are all accepting the idea of having solar power in future at Kimbilio.Despite the planing were thinking in poverty alleviation still we have to figure out about solar power too.Dean Pindua

G) Majok Kariom 28.10.2014
Report comprehensive, those things included that are valuable to South-Sudan, Kenya, Tanzania, Uganda etc. in Africa. When creating new services and business.

SMILE Base Case, Water

Hybrid energy systems are considered appropriate solutions for electrification of remote rural areas, where the grid extension is not economical and available. Rural hybrid power systems have several kinds of systems as one solution such ad the hybrid off-grid solution, which consists of a wind turbine, a solar photovoltaic (PV) array, a generator and an inverter (Figure a). The optimization of rural hybrid solution in order to find the best combination of energy components benefits the strengths of each type of sources that complement one another. They are usually more reliable and less expensive than systems relying on a single source of energy. The importance of availability of spare parts, operations and maintenance as well as training for village people should be included into the design process of the new energy services. (Ashok, 2006; Bekele, 2009; Bernal-Agustín & Dufo-López, 2009; Greasen, 2010; Muralikrishna & Lakshminarayana, 2008; Ouma 2011; Zahn et al., 2006)

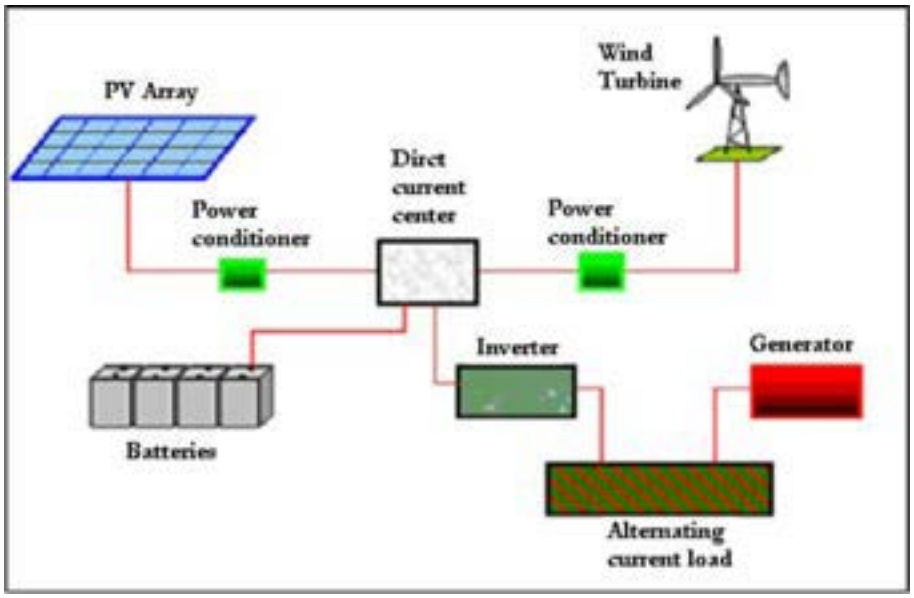


Figure a. PV-Wind system, source Bekele 2009, p.44. The solar power is captured by Photovoltaic (PV) arrays. PV arrays: exploit solar energy resource, Wind turbines: exploit wind energy resource, Batteries: energy storages, Inverter: draws its DC energy from batteries charged by PV arrays, Generator: back-up diesel or petrol generator

The solar-powered system with drip irrigation is watering the school garden in the Singida region of Tanzania, where the solar-wind hybrid pumping provides clean water for drinking and food preparations. The system has a submersible pump able to pump large amount of water for 24 hours per 7 days per week, the solar panels are located on the roof of the well-house, and the chlorination system makes its own chlorine and injects the correct amount directly into the flow line from the pump. The water purification technology is in use. Solar panels and submersible pump worked at the first phase (diesel generator as a back-up) and at the second phase the wind turbine was added to the system. The water project for Gunda Secondary School started in 2006, wells were located by the Global Positioning System (GPS) and by help of local men, in

consequences that several of these wells and storages needed maintenance (Outreach Education). The solar-powered real-life groundwater pumping in the ABC Water project was assessed in Chapter 4.1 Clean Water Service and in Appendix IB ABC Water Project and the ongoing Nyagowa Water and Health clinic in (SLEF Nyagowa, 2015). Solar-powered water pumping is considered stable and reliable, the other real-life cases are delivered by NAPS Solar Systems (NAPS Water, 2015), which have referred in this TAMAA Case, see Figure b below. Submersible pumps were illustrated in Chapter 4.1 Clean Water Figure 4.5 and in the licentiate thesis (Saarinen, R., 2015b). The Lorentz solar water pumps for clean water and irrigation are found in (Lorentz portal, 2015).

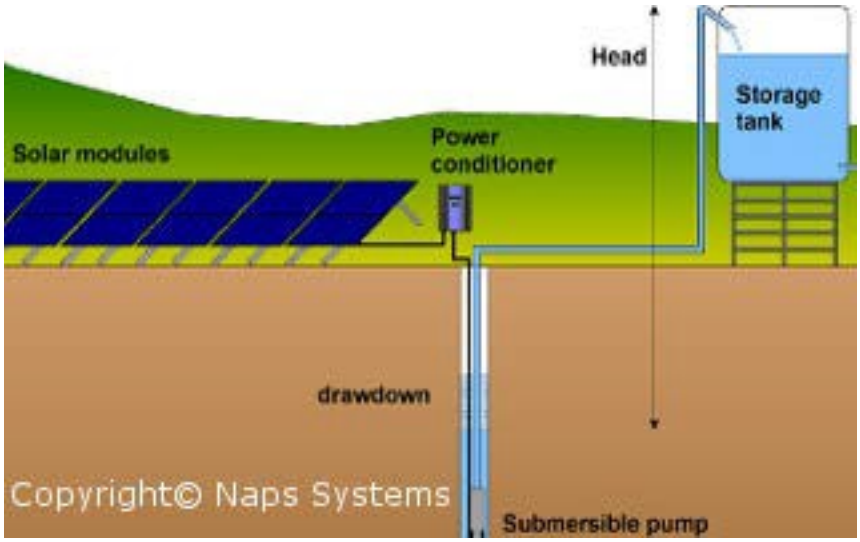


Figure b. Naps solar pumping systems

Outreach Education, Available: [Cited 20.11.2015] http://outreachprogram.org/about-outreach/our-4-promises/education/

Outreach Water, Available: [Cited 20.11.2015] http://outreachprogram.org/about-outreach/our-4-promises/water/

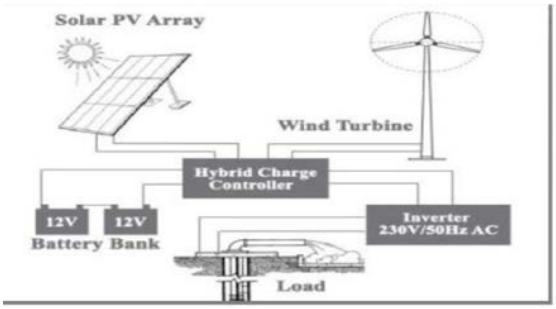
Stricklin A.D.(2006) Ilunda Ward, Tanzania Water Project. Outreach Africa. Pumping with Solar Power. Water and Wind LLC. Available: [Cited 12.04.2010] http://www.outreachprogram.org/wp-content/uploads/2011/05/waterreport-2006-10.pdf, this document is not available any more in the Internet, but available by the researcher Ritva Saarinen

Solar-powered drip irrigation for gardening was assessed in Chapter 4.2 Service, Drip Irrigation to Food Markets and in the licentiate thesis (Saarinen R., 2015b)

Services, Clean Water and Drip Irrigation to Food Markets, operate without wind turbines, the hybrid systems were not the focus in this TAMAA Case nor in the licentiate thesis. Bekele & Getnet (2012) continues their studies in hybrid systems in Ethiopia. Whereas, Shivrath et al. (2012) introduced PV-Wind Pilot in India in order to

demonstrate a continuous and reliable power supply and decrease in the amount of batteries needed. The study hybrid system consisted of a 700 W wind turbine, two 240 W PV panel each amounting to 440W, and two batteries as shown in Figure c. The need for hybrid system was to pump water for drip irrigation of 1.5 acres (6 000 m² of mango crops), and the pump selected was a submersible pump with daily capacity of 16 650 liters. Further work is required to establish the viability of PV-wind hybrid systems in developing countries.

a)



b)

Hybrid System Component	Unit Specifications
Sizing of wind generator	700W, 24V DC
Solar Array	240W,24V DC
Battery sizing	12V,120Ah
Inverter sizing	3.0kVA

Figure c. Solar-wind hybrid system in India case study: a) Hybrid energy system model; b) Hybrid system components, source: Shivrath et al. (2012).