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Unlocking High Sustainable Energy Potential in Zambia: An Integrative Collaborative Project Approach

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Abstract

Enjoying abundant hydro and solar resources, and relative socio-political stability, Zambia has the potential to be fully energy independent with high sustainability. However, in response to frequent power outages, symptomatic of a worsening energy deficit, the Zambian government's proposed energy strategy seems to offer only short-term fixes, exemplifying the inadequacies of business-as-usual development practice. The assessment/planning process has little stakeholder engagement with civil society, and pays no attention to capacity building on a societal scale. Indeed, globally, while calls for 'integrative' approaches are getting louder, operational details are lacking. We suggest alternatives to the proposed strategy and conventional development process, and improvements to operational stages using an *integrative collaborative project (ICP) framework*, arguing for a *capacity building innovation network* that scales up or down by linking local and regional projects together. We consider: How can society unlock high sustainable energy potential in Zambia, in ways adaptive to changing conditions and climate instabilities, scalable up or down, and replicable to other settings? Our preliminary technological recommendation – subject to a full stakeholder process - combines solar farms, off-grid solar, improved hydroelectric, and optimization of thermal plants for baseload stability. But technical outcomes are a function of social processes. For our process innovation, we asses all operational stages: conceptual design, assessment, planning, implementation and management, and monitoring. For each we describe existing practice and suggest improvements, then consider capacity building needs and networks. Zambia could be an exciting model for sustainable development processes and resultant energy systems in challenging settings.

Keywords: energy, collaborative, integrative, sustainable, Zambia

1. Introduction

1.1 Global Context

In its critical reflection on the first 25 years of sustainable development work, the United Nations provocatively states: "[A] new political deal is needed, which provides a clear vision and way forward for the international community, national governments, the private sector, civil society and other stakeholders for advancing the sustainable development agenda in an integrated manner" (UN/DESA 2016, p. iii). While most development agencies now call for integrative approaches (e.g. USAID, DFID, UNDP, World Bank, GEF), we challenge the U.N.'s claim - "We have the means and methods"; all that is needed is "political will" (UNGA 2014). Significant barriers and gaps in concepts and capacities continue to limit success (see a critique of the Millennium Village Project in Carr 2008).

Africa surely presents some of the greatest challenges for sustainability. Exemplifying this context, the need for a sustainable solution to Zambia's worsening energy deficit provides a compelling case study of business-as-usual (BAU) development practice and its structural inadequacies. It offers us an opportunity to propose an integrated collaborative project (ICP) process that reframes SD challenges in terms of strengthening societal capacity to respond to existing and projected needs. A 2013 report by *International Renewable Energy Agency* states:

"Unlocking Africa's huge renewable energy potential could help to take many people out of poverty, while ensuring the uptake of sustainable technologies for the continent's long-term development" (IRENA 2013, p.1). Energy is a *gateway sector* for transformative progress on sustainability because it is closely interrelated with many other key sectors like water resources, food and agriculture, urban and rural development, human health/wellbeing, and climate-change adaptation.

1.2 SD Conundrums

Integrative collaborative development design/practice is enjoying strong impetus. For example, the Global Environment Facility states: "To solve the sustainability challenges of cities, we need greater knowledge sharing, integrated approaches, and to start thinking differently" (GEF 2015). Integrated water resource management (IWRM) has seen some notable success, using the watershed as the unit of analysis (Reimold 1998). However, three "conundrums" persist that undermine progress (Downs et al. 2017; Downs and Mazari-Miriart 2017):

1) *The Socio-Ecological Complexity Conundrum*: Socio-ecological systems are inherently complex dynamic systems, requiring us to model them in appropriate ways. The question is: *How can complex systems be represented, analysed and presented in ways accessible to diverse stakeholders, without over-simplifying?*

2) *The Varying Temporal/Spatial Scales Conundrum*: Development projects run on short timeframes, do not match natural cycles of change, nor are they designed to adapt to the unexpected. SD work demands much longer time scales (25-50 years) with greater inherent uncertainty. *How can projects address immediate needs and wants, while setting their sights on important long-term goals, and being adaptive to change?* Likewise, choosing appropriate spatial scales poses challenges – but also opportunities - with big implications: strong interdependencies exist between system components larger and smaller scales. *How can development projects operate at multiple spatial scales, recognizing the interdependencies among regional, local and neighbourhood dynamics?*

3) *The Stakeholder Diversity Conundrum*: Development projects impinge on diverse participants with differing goals, values, capacities and assets. They may participate (or be excluded) in different ways, and the positive and negative impacts of projects are highly unevenly distributed across populations and landscapes. *How can development projects be responsive to stakeholder diversity, leverage it, and create a coherent process with outcomes that increase equity and sustainability?*

This paper responds to two coupled questions: 1) What are alternatives to the proposed Zambia energy strategy? 2) How can we improve development practice and operational stages for energy projects in Zambia? In sum: How can society unlock high sustainable energy potential in Zambia, in ways adaptive to changing conditions and climate instabilities, scalable up or down, and replicable to other settings?

2. Background

The impetus to improve Zambia's energy and electrification has grown as drought and associated power reductions from hydro capacity have worsened. For a decade, the focus has been on increasing capacity through upgrades to existing hydro infrastructure and increasing stability in the hydro electricity market (IHA, 2015). **Figure 1** shows settlement density by district and surface hydrology, revealing high energy sustainability potential via hydroelectric projects. However, hydroelectric projects - poorly designed and deployed - have historically characterized BAU failures in Zambia and globally, and caused global actors, like the World Bank, to begin to promote more integrative projects.

2.1 Social Context

Zambia has an annual population growth rate of 1.9% (BBC, 2016). About 99% of Zambia's population is composed of *Bantu* tribes (Riggs, 2017). The human development index has ranked Zambia 164th in the world, putting it in the bottom quartile. The Millennium Development Goals (MDGs) of Zambia called for equal access to education for all people regardless of gender, and for more effective HIV/AIDS and malaria interventions (Kwesiga, Bhebhe, Mukungu & Gisela, 2010). Worthy of note in terms of enabling conditions for sustainability, tribalism and divisive ethnicity are becoming less influential in Zambia's national politics: it is one of only a handful of African countries which have not experienced ethnic conflict (OMCT, 2001). According to the Zambia vulnerability assessment (2002-2003), poverty is concentrated in rural areas where 64% of the population lives below the poverty line, and about 60% of female-headed households were classified as extremely poor (ZVAC 2002). Other prevalent societal issues for women include: domestic violence; gender discrimination on education; lack of property rights; unemployment; and child welfare for those whose parents die with HIV/AIDS (Riggs, 2017).

2.2 Political Context

Zambia was previously a British colony known as "Northern Rhodesia", until winning independence in 1964. Upon independence, the country changed its name to Zambia and was ruled as a one-party state. Peaceful elections in 1991 transitioned Zambia from one-party rule to a multiparty democracy under Kenneth Kaunda (Burnell, 1998, 2). In 1992, Zambia joined the South African Development Community (SADC) comprising 15 countries. The 2001 election was marked by administrative problems, with three parties challenging the ruling party candidate Levy Mwanawasa who won and was then re-elected in 2006 (Hawes, 2003). Upon his death in office, he was succeeded by vice president Rupiah Banda, and in 2011 Michael Sata was elected President (CIA World Factbook, n.d.). Michael Sata also died in office, with his vice president Guy Scott becoming acting president (Guy Scott's Rise to Zambia's Presidency, BBC, 2014). Within three months, Edgar Lungu won the special election in January 2015 (CIA World Factbook, n.d.).

The ultimate power in the government lies with the executive branch in the hands of the

President who is elected through popular vote for a five-year term. The President acts as both head of government and state, and as Commander-in-Chief of the armed forces. She/he is able to dissolve the National Assembly and call elections. The Legislative Branch is made up of the unicameral National Assembly, which debates and amends bills for the President to sign into law. Legislators are elected through popular vote for five-year terms. Zambia has acted as a major advocate of social change in Southern Africa, supporting liberation movements across the region and peacekeeping missions through the United Nations (Zambia: Government, Global EDGE, n.d.).

2.3 Cultural and Historical Contexts

The country has 72 ethnic groups with a similar *Bantu* dialect but with different customs and views. The majority of the population is part of the *Bemba*, which mostly occupy the Central, Copperbelt, Luapula, Lusaka, Muchinga and Northern Provinces. While the Southern Province has been historically *Tonga*, the Western Province has been mainly *Lozi*, and the Northwest Province comprises mostly the *Lunda* and *Kaonde*. History can be broken into pre-colonialism, colonialism, independence and post-independence. Throughout these periods, there were many changes in religion, politics, gender issues, and social customs. Due to Europe's colonial influence, Christianity spread and traditional practices waned or were altered (Taylor, 2006). Zambia currently has a mix of Christians, Muslims, and Hindus, however Shamanism still has a foothold in society. The current role of men and women in Zambian society has changed slightly, however, women are still valued less than men (Taylor, 2006). Only about 40 percent of Zambians live in urban areas. Materials used to construct homes are dependent on availability and tribal customs (Zambia: Society, n.d.), with structures typically roofed with poles and thatch. Chiefs/Chieftainesses play an important role in Zambia's culture and traditions: they are able to award land to, or take land from, anyone in their chiefdom for any purpose, and they are used as arbiters to settle disputes and drive change (Binsbergen, 1987). They are thus primary stakeholders in civil society, although it should be remembered that they may not represent the diversity of interests of the groups they lead, especially marginalized groups. SD projects need to find ways to engage with marginalized groups in meaningful ways since they are often the people most adversely impacted.

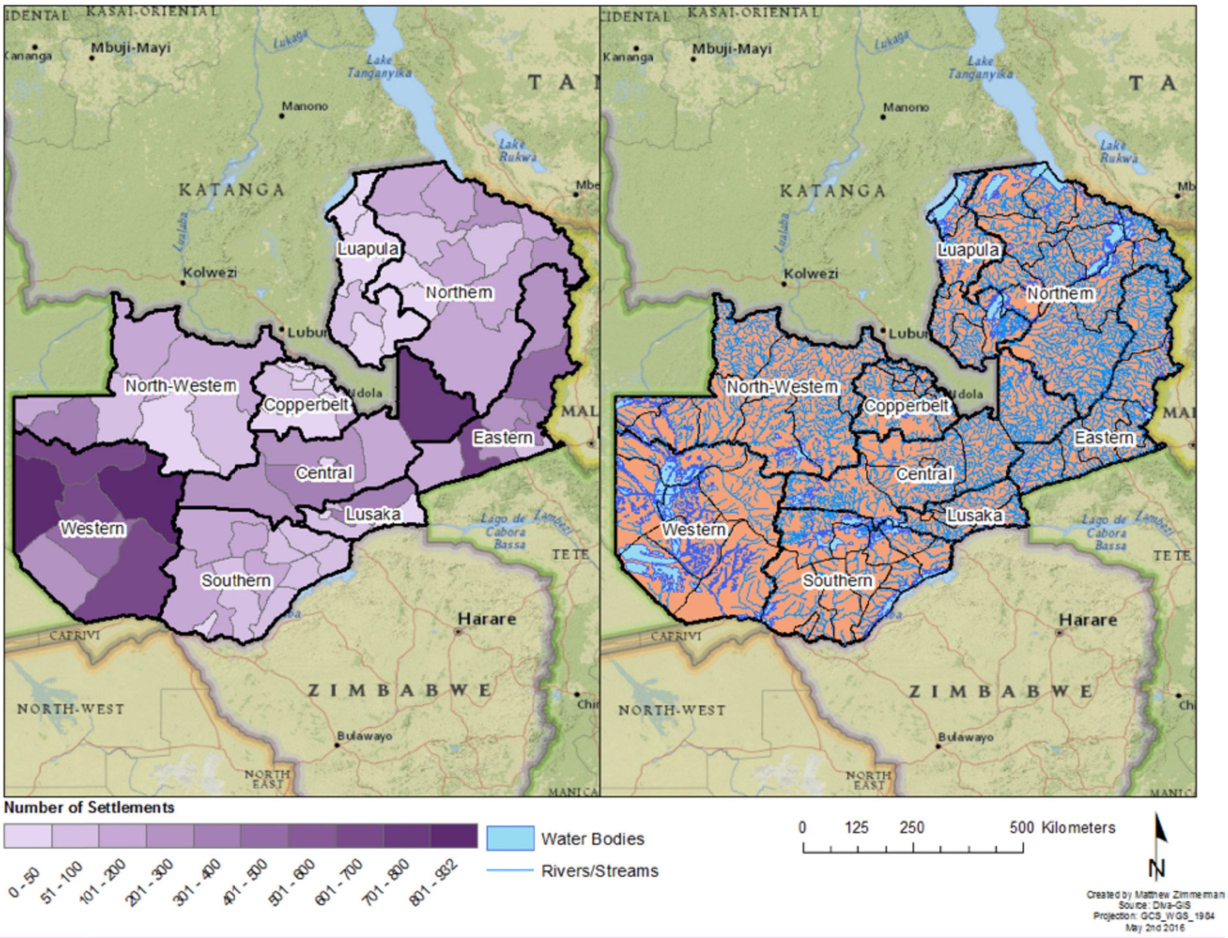

Figure 1. Settlement density by district and surface hydrology

2.4 Economy and Aid

Zambia is characterized as an underdeveloped nation. The mining industry extracts copper for export, which accounts for much of GDP. Copper extraction is extremely energy intensive but Zambia has been able to provide reliable, clean power through its network of hydroelectric dams. Since 2000, Zambia's GDP has grown an average of 3.9% (World Bank, 2018). Zambia's 2017 GDP was US$25.8 billion, with a GDP/capita (adjusted by Purchasing Power Parity) of US$3689 (Trading Economics 2018).

From 2006-2013, Zambia received nearly US$1.2 billion in Financial Intermediary Funds (FIFs) including nearly US$300 million in 2013 alone (World Bank, 2016). Nearly all of this money came in the form of grants with over US$1 billion targeting health priorities: AIDS, tuberculosis, and malaria. In addition, US$113 million was received during 2006-2013 from UNDP, African Development Bank, and the World Bank, targeting environmental and climate change issues (ibid). Under the sustainable development goals (SDGs), the UN continues to fund projects in the areas of: environment and climate change; democratic governance; gender and women's empowerment; and poverty reduction (UNDP 2018).

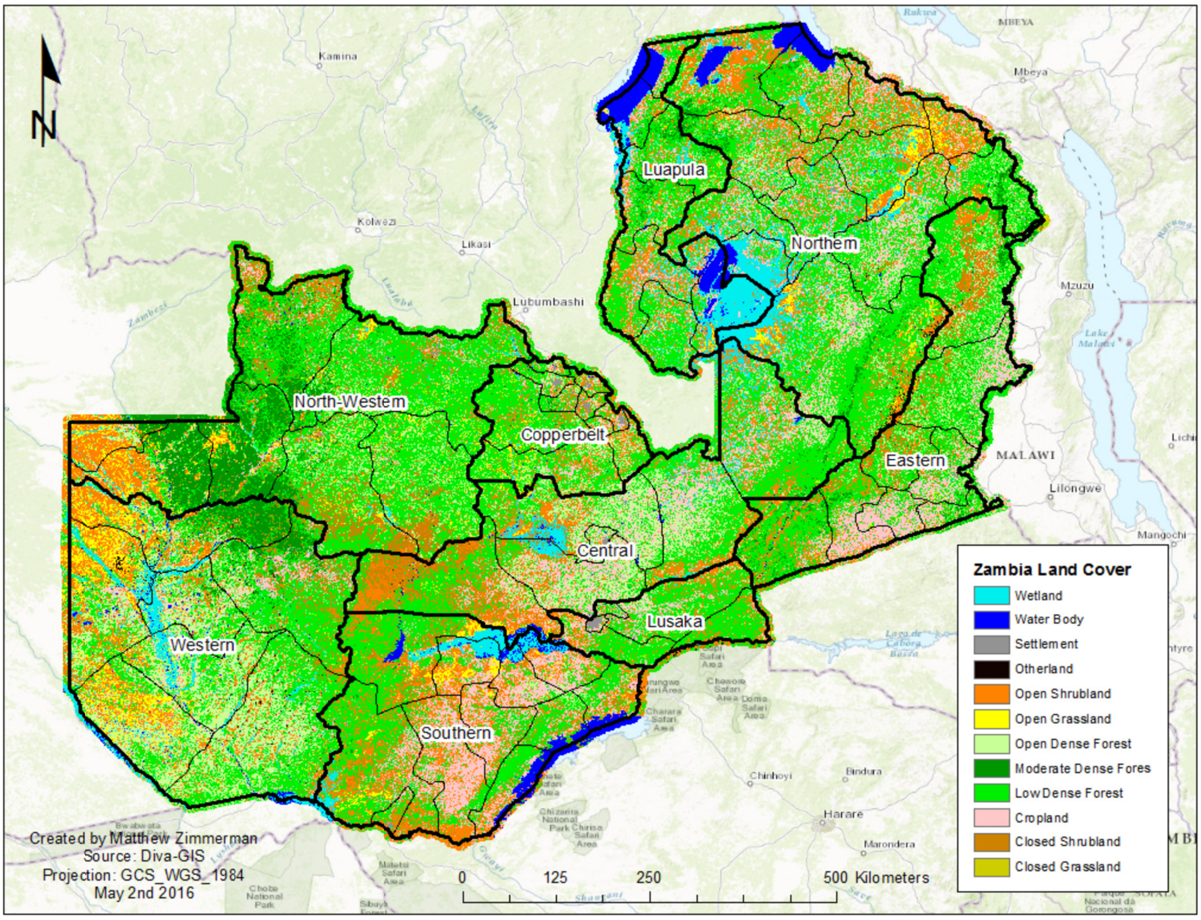

Figure 2. Land cover in 2010

2.5 Ecology and Land Cover

Zambia is a landlocked country of 752,000 square kilometers. The elevation of the country ranges from 1060 to 1363 meters above sea level (ZTB, 2016). It has a highly variable climate throughout the year and about 40% of the land is covered with diversified forests (Riggs, 2017; Aregheore, 2009). Although only 15% of the land is cultivated, 47% of Zambia's land is arable. The country is rich in wildlife due to swamps or flat habitats. However, human activities negatively influence biodiversity and wildlife: Zambia's water resources are threatened by overfishing, and drought (WWF Globe, 2016). The hydrology and land use/land cover of Zambia can be seen in **Figures 1** and **2** respectively.

2.6 Climate Change

Pollution from mines, industries, automobiles, deforestation, land change and indiscriminate waste disposal has magnified the effects of climate change in Zambia (Sichinga, 2015). Zambia has experienced the impacts of climate change recently with dry spells adversely affecting farming districts and food security (ibid). Since 1960, the mean rainfall of the country has decreased by 1.9mm/month, while the mean annual temperature has increased by 1.3℃ (World Bank, 2016). Projecting scenarios, Zambia's mean temperature is expected to be 3 to 5 ℃ warmer by 2070 (Mukheiber, 2007; Tadross, Jack, & Hewitson. 2005), leading to an increase in evaporation from water sources and increasing water stress (Arnell, 2004). Droughts and floods have occurred with greater frequency and the country's climate change resilience is being tested. Due to a majority of Zambians living in rural areas, the consumption of biomass for charcoal fuel is extensive and has led to deforestation (SARUA 2014). Climate change has also begun to affect Zambia's economy due to negative impacts on agriculture, health, energy, and natural resources, as well as the cultural identity of indigenous peoples. (GRZ, 2015).

2.7 Conundrums in Zambia

The *socio-ecological complexity conundrum* manifests in Zambia in the same way it does in many settings, by designing and deploying projects in a fragmented manner that ignores this complexity and interdependencies among sectors and issues. Thus also, the *temporal and spatial scales conundrum* is not adequately confronted: BAU does not take into account the spatial and temporal dynamics of river basins, and does not treat the landscape as a fabric of watershed ecosystems with interrelated issues and complementary solutions (**Figure 1**). Presidential elections happen every 5 years, so planning tends to be short-term, ignoring the need to consider in parallel, short/urgent-, medium- and long-term planning horizons. The most serious issues, however, stem from the failure to tackle the *stakeholder diversity conundrum*: the BAU process is classically top-down, driven by donors and central government, especially presidential preference, often underpinned by ethnic/tribal discord. This has led to short-termism that runs counter to SD principles and needs (inter- and intra-generational equities), limited sharing of information that could be beneficial to a multitude of different actors, decisions and activities that are carried out in a vacuum with respect to other stakeholders, and duplications of effort that can stretch already limited government funds and resources.

3. Energy Sector Stakeholders

There are five major stakeholder groups in Zambian SD work: government; private sector; civil society; donors; and academic institutions. Responding to the pivotal *stakeholder diversity conundrum* calls for appropriate levels and modes of stakeholder engagement to be considered for each stage of a project, using participatory development methods and tools suited to social, political and cultural contexts (see, for example, Chambers 1995, 1997, 2008), and driven by a forceful socio-technical enterprise philosophy. Table 1 is a preliminary stakeholder analysis for the energy sector: category, name, level of influence, method of influence, involvement, and whether currently involved in energy planning.

Table 1. Stakeholder Analysis. Shows category, name, level of influence now, method of influence, involvement, and whether currently involved in energy planning

Category	Name	Level of Influence now	Method of Influence	How involved in/relevance to energy projects	Currently involved?
Government Agency	The President	High	Head of State; Elected Official	Head of Executive Branch; Involved with the Legislative Branch; Exercises provisions of the constitution solely or by proxy	YES
	Vice President and Cabinet	Medium	Elected and Appointed	Advises President	YES
	State Agencies and Departments	Medium	Consultations and Regulations	Carries out President's orders	YES
	Parliament	High	Elected, Creates Laws	Can create or enact laws influencing participation in projects	YES
	City, District, and Provincial Governments	Medium-High	Elected; governs at the local levels	Enforces laws and regulations	YES
	ZESCO	Medium	State Owned Utility; Operates most of energy production and distribution	Controls operations for energy production and distribution	YES

Private Sector	Manufacturing Companies	Low- Medium	Influence Economy	Use of resources and energy for production	SOME
	Extractive Industries	Medium-High	Influence Economy	Value analysis of land	YES
	Commercial Farmers	Medium-High	Influence Economy	Value analysis of land	SOME
	International Business	Medium-High	Influence Economy	Economic interests in country	SOME
Civil Society	Chiefs	High	Tribal and Traditional Influence	Can be opposed/supportive of land use types	YES
	Headmen	Medium	Communicates with Chiefs	Can influence Chief slightly	SOME
	Landless	Very Low	Negligible	N/A	NO
	Local NGOs	Low- Medium	Can work with larger NGOs with more influence	Capacity building, monitoring and evaluation	SOME
	Small Scale/Subsistence Farmers	Very Low	Receives much funding from NGOs	Target of programs and aid money	NO
Donors	International NGOs	Medium-High	Investment and Aid	Control project and monetary allocation	SOME
	Foreign Governments	Medium-High	Investment and Aid	Control project and monetary allocation	SOME
	International Agencies	Medium-High	Investment and Aid	Control project and monetary allocation	SOME
Academics and researchers	Universities and colleges (Zambia has > 20)	Limited but medium-high potential	Education and research	Networks of universities (numbering 10-15) can serve as the support for the knowledge network, and as innovation catalysts.	SOME

4. Methods

To critique practice we previously developed an integrative collaborative project (ICP) framework of six domains (Downs et al. 2017): 1) project framing, concept and design; 2) development topics and sectors (including gateway topics/sectors that resonate with stakeholders); 3) stakeholder interests, relationships and capacities; 4) knowledge types, disciplines, models and methods; 5) temporal and spatial scales; and 6) socio-technical capacities and networks, including education, information, policy, technology and enterprise development. We apply the perspective this framework offers to firstly identify alternatives to the BAU energy proposal, and secondly provide a constructive critique of each operational stage of Zambian energy project development: 1) conceptual; 2) assessment; 3) planning; 4) implementation and management; and 5) monitoring. For each stage we: a) describe existing practice; and b) suggest improvements. We then describe capacity building needs.

5. Alternatives to Business-as-Usual (BAU)

Table 2 shows alternative types of energy projects – including BAU - which could be developed individually or conjunction with others, with drivers and barriers. Alternatives could be interconnected via the electricity grid, with the potential to eliminate the country’s energy deficit and provide scaled-up adaptive energy capacity over time, improving electrification countrywide in areas that are not connected to the energy grid. One project (#2) aims to increase the efficiency of existing hydroelectric power plants throughout the country, including updating transmission lines. Another (#3) aims to improve and establish district-level solar farms with utility lines to clinics, community centers, and schools. Another (#4) aims to establish a micro financing scheme for individualized, household solar projects to increase rural electrification. A version of the BAU proposal (#1) to build new hydroelectric capacity should also be considered during any integrated energy development effort.

Table 2. Alternative projects to address the energy deficit. Creative combinations of projects are needed for an integrated, sustainable response. The main thrust of business-as-usual (BAU) is #1

Alternative	Description	Drivers	Barriers
1. Hydro - New Capacity (BAU)	Continue with ZESCO and USAID's current approach of building new dams.	Proven reliable and cheap source of energy for past several decades and a zero-emission source of energy.	Severe impacts on downstream stakeholders who may be deprived of vital water resources in the dry season and times of drought which will be more likely with climate change. Potential public opposition from loss of land.
2. Hydro - Increase Current Capacity and Efficiency	For the previous decade USAID and the Zambian government have focused on increasing the efficiency of capacity of existing hydro infrastructure to meet increases in electricity demand. This includes upgrading the existing power stations with newly developed efficient equipment.	Proven reliable, cheap source of energy. Allows for increase in energy output without installing new infrastructure. Utilizes existing infrastructure.	Already been utilized during past decade. Future gains may be harder to achieve. Also, during periods of drought increases in efficiency may not result in major gains in electricity output.
3. Solar - On Grid	Install and build solar farms at the district level around the country.	Clean, abundant resource. Low level of maintenance. Allows for local engagement and participation of Civil Groups.	Intermittency in electricity output. Expensive installation costs and also the potential for large, expensive battery storage systems.
4. Solar - Off Grid	Develop micro-loan structure with Banks and non-profits for people living in areas too remote to be connected to the grid. Promote Solar installation at the household level.	Cost effective way to provide power to remote areas unable to connect to the grid Power sufficiency at the household level reduces the load on national grid.	Extremely challenging to create a micro loan market for people living in remote and often impoverished areas. Maintenance of equipment, collection of delinquent payments are challenges. Dependent on the financial needs of individual families.
5. Wind	Develop Wind Farms on the district level in areas of Zambia with favorable wind resources.	Clean resource. Uncultivated, dry land with no vegetation can be used.	Intermittency in electricity output. Regular maintenance required. Only certain regions with good wind resources. Sound pollution along with disturbance to bird flight.

6. Import Oil	Oil currently accounts for around 5% of Zambia's electricity needs. Increasing oil imports would provide needed energy immediately.	Flexible in deployment. Can power small-scale generators. Reliable energy resource.	Fossil Fuel which contributes to climate change. Inefficient energy resource which would hurt trade balance. Zambia faces frequent fuel shortages.
7. Import Electricity	Neighboring countries have excess energy capacity. Importing energy would help to immediately relieve energy deficit	Flexible resource that is available on demand.	High and variable costs. Would hurt trade balance with other countries. Climate change may also impede energy development in neighboring countries.
8. New Coal Thermal Plant	Utilize Zambia's coal resources and build a thermal plant.	Low cost and reliable power source not affected by natural variations (like solar, wind, or hydro).	Fossil Fuel which contributes to climate change. Negative health effects on the human population and ecosystem.
9. Energy Conservation (Load Shedding)	Reduce power consumption by initiating rolling blackouts and cutting the amount of time power can be consumed.	Low cost option. Could reduce need for new power infrastructure.	Already implemented due to power shortage. Questionable how much more reduction could be achieved. Current load shedding program is not very effective.
10. Energy Conservation (Demand Side Reduction)	Reduce demand by engaging with businesses, government to eliminate non-essential demand for electricity.	Low cost option. Could reduce need for new power infrastructure.	Questionable how much consumers would willingly reduce their power consumption.
11. Energy Efficiency Program	Reduce demand by engaging with businesses, government to reduce non-essential demand for electricity by replacing inefficient lighting, and HVAC with more efficient technologies.	Low cost option. Could reduce demand for any new power infrastructure.	Difficult to change the behavior of people in a short time. Replacement of already installed systems is costly.

Zambia should continue to upgrade its current power infrastructure because it provides 95% of the country's current power. Upgrading infrastructure and increasing efficiency of existing hydro will be cost effective and have little to no impact on the environment. The decrease in power output from the current hydro plants due to the drought cannot only be solved by installing other renewable resources like solar which only provide power intermittently. In order to provide reliable power a steady base load is needed. By deploying a small number of cleaner, more efficient thermal plants around the country, Zambia can ensure that a steady, reliable power supply is available to its economy, particularly the mining sector which accounts for 55% of the energy consumed in Zambia and provides two thirds of the country's $10.6 billion in exports (Kaunda et al., 2013). Local stakeholders like head tribesmen should be involved in the location of the deployment of these facilities to decide the best locations.

Based on the variety of alternatives available to address Zambia's current power deficit (Table 2) our *preliminary recommendation* is for an integrated strategy including: 1) Deploying small - medium size (1 MW - 20 MW) solar farms at the district level in Zambia to connect to the grid; 2) Deploying off-grid solar by leveraging micro loans from local banks and NGOs; 3) Increasing the efficiency of current hydro and 4) Optimizing a small number of thermal generation plants to ensure stable base load power is provided. Increasing the deployment of solar power has already been recommended by Zambia's Minister of Energy and Water Development as a response to the deficit and it calls for the installment of at least 300 MW of solar power (GIZ, 2015) and up to 1,200 MW of solar power by August of 2016. (ESI Africa, 2015).

6. Critique of Practice

In general terms, project stages need to be re-cast with stronger interactions between assessment and planning, and stronger feedback from monitoring to earlier stages in order to adapt to new information, the impacts actually observed (as opposed to those projected during assessment and planning), and changing needs and conditions over time (Downs, 2007, 2008). Adaptive capacity and resilience building follow ecological theory (after Holling, 1978; Walker, Holling, Carpenter, & Kinzig 2004; Berkes, Colding & Folke 2000). There needs to be vibrant stakeholder engagement tailored to inform each project stage, sensitive to the social, cultural, economic and political contexts (see 2.0). Table 3 summarizes the main differences between the BAU approach and the integrative approach for each stage.

Table 3. Comparison of BAU process with suggested integrative collaborative project (ICP) approach by operational stage. Key differences shown

Stage	Existing - BAU	Suggested - ICP
1. Conceptual, design	Goal of reliable, available, accessible energy services for rural and urban areas by 2030. National and regional governments collaborate, but largely top-down actions. National Energy Policy is somewhat capacity building oriented on paper, but realization is limited.	Re-frame as a socio-technical capacity building enterprise. Pay attention to linkages among related sectors: water, food, industry, health, climate change. Partner with diverse stakeholders, see them as assets and resources. Overall integrative design that attends to conundrums and diverse needs.
2. Assessment	Centered on energy supply and demand, and capacity projections. Needs framed in terms of energy deficit. No concerted effort to gather comprehensive baseline data. Weak connection with planning, undermining impacts assessment.	Integrative approach allows for the collection of diverse data for participatory baseline assessment. Knowledge base is co-created and shared to inform policy options and modeling of scenarios – but also acts as the basis of a scalable knowledge network.
3. Planning	Top-down, driven by national and regional government; civil society excluded. Expansion of hydro is preferred, with some solar: a largely BAU option. Weak connection with assessment: alternatives to BAU do not emerge, and policy analysis/EIA is poor such that tradeoffs are not well understood – even for the BAU scenario.	Needs to be a blending of top-down and bottom-up: a multi-stakeholder enterprise. Planning is transparent and inclusive, respondent to diverse needs related to energy and related issues. The link between assessment and planning is vibrant and b-directional. Activities include capacity building that sustains the energy sector.
4. Implementation and management	Top-down, government and donor driven activities with a traditional project management approach that is energy technology and infrastructure centered.	Needs to be inclusive, with a socio-technical enterprise approach. Activities in the integrative energy plan are diverse: education and training, through policy, technology and the economy – thus implementation is multi-modal.
5. Monitoring	Little capacity to undertake monitoring, and little impetus to do so. Not linked to assessment. No adaptive capacity, so vulnerable to instabilities.	Make monitoring integral to adaptive response and capacity building. Make vibrant links between monitoring, assessment and planning.

6.1 Conceptual Stage

6.1.1 Existing Conceptual Approach

The government of Zambia has established plans to increase electrification in urban and rural areas through the *Rural Electrification Master Plan* (REMP) and the strategic *Vision: 2030 Goals*. The *Vision: 2030 Goals* has a targeted increase of urban electrification from 48% to 90%, and rural electrification from 3.1% to 50.9% (Global

Electricity, 2010). The 2013 *Renewable Readiness Assessment* showed that Zambia has been challenged by low rates of electrification - 45% in urban areas and only 3% in rural areas (Singh et al. 2013). According to the ZESCO, the country currently suffers from power deficits and must undertake load management in order to match supply with demand (Kaunda et al. 2013). There is a priority need to increase energy production in order to meet electrification goals, while also meeting the needs of other sectors. The existing REMP recognizes both rural and urban area needs improved access to electricity, with medium and long-term goals requiring major innovation.

The Southern Africa Development Community (SADC) is pursuing sustainable energy for its entire 16-nation region; the Zambian Government is working with other governments to encompass the MDGs/SDGs in an ambitious *Sustainable Energy for All* initiative, or SE4ALL (AEEP, 2013). The ambitious plan envisions universal access to clean, reliable and affordable energy from various sources at the lowest economic, financial, social, and environmental cost. According to a 2013 report by *International Renewable Energy Agency*: “Unlocking Africa’s huge renewable energy potential could help to take many people out of poverty, while ensuring the uptake of sustainable technologies for the continent’s long-term development” (IRENA 2013, p.1).

A regional leader, Zambia’s *National Energy Policy* (NEP) of 1994 sought to ensure availability of energy supply at the lowest cost possible, including environmental and social costs (AEEP, 2013). Foreshadowing an ICP approach, NEP’s guiding principles were: development of appropriate technologies; development of human capacity; optimization of energy efficiency during production, delivery, and end use; incentives to enhance the performance; and creation of partnerships with both the private sector and civil society, with increased community participation (AEEP, 2013). The NEP and further liberalization in 1995 aimed to attract private sector companies to participate in the generation, transmission, and distribution of electricity in Zambia (Mudenda et al., 2013).

6.1.2 Suggested Conceptual Approach

This is the most important stage to reimagine since it drives the rest of the work. The project needs to be reframed as not merely an energy development project, but as a pivotal part of a multi-sector, multi-stakeholder vision for the country, for which the energy sector is a gateway sector. Traditional SD practice overemphasizes technological aspects and devalues social aspects (see, for example, Carr 2011, Mitchell 2002, Escobar 1995, Ferguson 1994). We must not merely balance the social and the technological aspects, rather actively integrate them at the outset during project conception and design. The integrative response to the persistent conundrums of sustainable development is thus framed as a socio-technical enterprise to which diverse stakeholders contribute capacities and assets and garner enhanced individual and collective capacities to respond to complex needs and challenges. Conceptually and in project design, the approach at the outset pays attention to all six domains. In practice, this would mean that energy is recognized as an integral part of the larger operating system of sectors (e.g. industry, agriculture and food, health and wellbeing), with interconnections reasonably well described qualitatively and quantitatively (data permitting); building adequate systems understanding is part of the ongoing capacity building for this sector and others. Stakeholder interests, relationships and capacities need to be mapped and actively mobilized, and stakeholder engagement activities are to be designed to enable them to be energized in favor of shared ownership, empowering roles and equitable but differentiated responsibilities.

The suggested approach has four spatial scales to consider: 1) localized rural, peri-urban and urban areas; 2) intersections among these areas to form a socio-ecological regional scale (e.g. watershed); 3) national scale comprising regional units; and 4) Southern Africa Development Community (SADC) multi-national regional scale. It is important that all four major stakeholder groups take part in the conceptual stage and the articulation and prioritization of legitimate needs to justify the project in the first place, with greater transparency and coordination with stakeholders. Our suggested approach is also to maintain a 5-year short-term planning horizon to tackle urgent energy issues that can be resolved with existing capacity (in-line with presidential terms), in parallel with a medium-term planning horizon out to 2030 (in-line with the SDGs), and a long-term planning one out to 2050. The 2030 and 2050 horizons allow for capacities to be developed to meet projected needs such that the response to the energy problem are not constrained by the limits of existing capacity, rather these are viewed as growing to meet changing needs and conditions.

6.2 Assessment Stage

6.2.1 Existing Assessment

In terms of needs expressed by the government, in 2014, Zambia had 2,257 MW of installed hydropower capacity out of 6,000 MW of potential hydro capacity and generated 11.62 TWh (IHA, 2015). In 2014, hydropower was 94% of the total energy available in Zambia and the national annual energy demand has been growing by 150 MW to 200 MW/year (ibid). Also in 2014, the country had a power deficit of 985 MW due to a water level reduction from a severe drought in Kariba North Bank Power Station, Kafue Gorge Power Station and Victoria Falls Power Station (Zambia National Budget, 2015). In November 2015, power suppliers reduced the water level at prime powerhouses by power load-shedding (Mukanga, 2015). Climate change variability has significantly reduced the water level and caused a further decrease in energy production by 300 MW in 2015 (IHA, 2015). The Zambian energy minister announced an ambitious goal of 1200 MW of solar energy to be added in the grid by 2016 with help from independent suppliers (ibid). In order to fill the gap, Zambia plans to import 100 MW from Mozambique and 60 MW from South Africa. Zambia has the potential to increase its generation capacity of all types of renewable energy sources, including solar, wind, biomass, geothermal, and hydropower. Incoming solar radiation is approximately 5.5 kWh/m^2/day, and the country receives around 3,000 sun hours per year. Solar power proliferation has been slow despite its proven effectiveness and wind energy could be explored as well.

The Ministry of Energy plans to assess feasible areas for wind energy installation and will need investment in the locations identified. Biomass energy is another possibility due to over half of the land cover being forest. The Zambian Development Agency (ZDA) states that there are 80 hot springs in the country, but the operational costs of obtaining geothermal energy are expected to be high. Lastly, hydropower has approximately 2,000MW that could still be harnessed, and meet the entire electricity demand for the country (Kaunda et al., 2013). The peak demand for electricity is projected to continue to grow and exceed the installed capacity until 2020 according to the Zambian Ministry of Energy and Water Development (ibid). The country is importing renewable energy technology from China through the China-Zambia South-South Cooperation on Renewable Technology transfer with the objective of “Sustainable Energy for All”. The government of Denmark is supporting this project with US$2.63 million as a major financial component. Zambia spends very little per capita on energy generation and policy development to counter this trend is hindered by a lack of accurate energy information and data to guide planning (AEEP, 2013).

There is no process in place for garnering and critically assessing the needs of diverse stakeholders, or constructively assessing the needs expressed by the government to justify the project. In terms of baseline assessment, there is no concerted effort to gather comprehensive baseline data on a diverse set of social, cultural, economic, political and ecological indicators, or a subset of the same to be used for integrated environmental/social impacts assessment and scenario modeling (BAU vs. alternatives).

6.2.2 Suggested Assessment

Central to improved assessment is the garnering of an adequate understanding of, and engagement with, diverse, legitimate stakeholder needs concerning energy (and related sectors). These needs exist, have emerged, are emergent or are projected to emerge under a socio-ecological fabric of ‘baseline’ conditions and contexts: social, economic, cultural, ecological, technological, climate-change related, and political. This stage needs to be strongly integrative in all the ways articulated by the ICP approach. In essence, this stage is the stage at which stakeholders *co-create a shared information and knowledge resource* that undergirds all other efforts toward energy sustainability. It is at this stage we ask: What are the existing and projected needs for energy in Zambia? What is the existing capacity, and the deficit over time? What are the baseline conditions and indicators of relevance to the assessment of impacts and tradeoffs – positive and negative – for a BAU energy project compared against a set of viable alternatives? The indicators used to compare the projected impacts of BAU vs. alternatives need to be a subset of the indicators used to monitor and track baseline conditions.

Assessment and planning stages need to be closely interconnected: a diverse set of sustainability indicators needs to be used, determined by way of a deliberative and generative stakeholder engagement process. The indicators become the metrics and modes of assessing baseline conditions, as well as the criteria for comparing the projected positive and negative impacts of alternative solutions. In this way, we draw on, and enhance, conventional environmental impact assessment (EIA) to make it an integral part of the sustainable development assessment and planning process (Downs, 2008). The indicators are measured in units that are most appropriate, and we resist the tendency to reduce all impacts to monetary units, so that tradeoffs between one type of impact and another can be made explicit and kept transparent (ibid). Among the criteria list of indicators will be those related to the Sustainable Development Goals (SDGs) for 2030 and 2050, but it is important that any set of indicators used for decision making be chosen via vibrant stakeholder engagement. The stakeholder diversity conundrum reveals that more sustainable solutions/responses depend on democratizing how needs are defined, how alternatives for meeting those needs are considered, how criteria/indicators are chosen, and how the deliberative process takes place. In this sense, the assessment stage, and the way it informs planning, sets the stage for successful outcomes.

6.3 Planning

6.3.1 Existing Planning

There is no robust connection between assessment and planning, so multi-criteria comparisons of alternative projects is weak, and civil society is excluded from the planning stage of energy projects. The key actors in planning are the Ministry of Energy and ZESCO, followed by donor groups like USAID and World Bank. The partnership between USAID's Trade Hub for South Africa and the Zambian Government has allowed the government to purchase renewable energy at a predetermined cost, decreasing price volatility and attracting public and private investment in hydropower (IHA, 2015). With this stability in place, the Zambian Government and USAID look to increase the number of hydro plants in Zambia over next five years (ibid). However, the lingering drought is calling hydro into question because it may persist. Load shedding is a major piece of Zambia's current strategy to combat their power deficit. In July of 2015, Zambia began load shedding 455 MW from its three largest hydro plants (GIZ, 2015). This shedding has not been very effective as customers often just postpone power consumption until power is turned back on (ibid). The government has however, begun the process for the deployment of 300 MW of solar power throughout the country.

6.3.2 Suggested Planning

The suggested planning approach would involve engagement with all major stakeholder groups, with vibrant interaction between assessment and planning stages such that alternatives can be compared using a diverse set of criteria impact indicators under modeled scenarios. Civil society is a key stakeholder in this stage, especially the chiefs, and head tribesmen who have extensive knowledge on the importance and use of current lands. Zambia has the potential to expand its power grid to all regions of the country such that tradeoffs among energy, agricultural, social and ecological values need careful consideration, as well as compensation for lost values. Deploying community scale off-grid solar will help to electrify rural Zambia which only has an electrification rate of 4.3% (GIZ, 2015). Engaging with NGOs and local banks will help to create a market for microloans for solar in remote areas while also achieving Zambia's goal of 51% of rural electrification by 2030 (Kaunda et al., 2013). Community groups need to be involved in the design, deployment and shared ownership of solar in these isolated communities.

6.4 Implementation & Management

6.4.1 Existing Implementation & Management

Governments and state agencies have the greatest influence over development projects in Zambia. Being Zambia's largest energy producer and supplier, ZESCO is in charge of updating transmission lines for hydropower plants and for increasing the efficiencies of existing hydro and thermal power plants. To fill any gaps, private entities are contracted to help implement and manage energy systems. The Rural Electrification Master Plan (REMP) sets both short and long term goals for the implementation of cost-reflective tariffs, utilizing financial resources to investigate feasibility of approaches, to prepare the regulatory framework for rural electrification, and the continuation of top-down awareness campaigns (e8-GEF-UNDESA, 2010).

6.4.2 Suggested Implementation & Management

ZESCO would be heavily involved in district-level solar projects and connecting farms to the main grid. However, for efficiency, the government would likely take a back seat to donors in establishing a micro financing market for community solar projects, with some level of regulatory oversight. Community-private partnerships would be best suited to take the lead on developing localized systems – up-scalable to regions/districts. All of the proposed alternative projects (Table 2) require the building of additional hardware and infrastructure: energy projects can have major positive impacts on the economy. Consistent with the capacity building model (Downs, 2001, 2007), enterprise development should make sure that local and domestic providers are involved in the energy program and benefit from it, instead of giving over the sector entirely to foreign corporate interests. Reflecting the suggested planning timelines, the implementation/management timelines would consider short-, medium-, and long-term horizons in parallel.

Civil society in Zambia should have reasonable influence over the suggested rural electrification project, so it is vital that local and regional people (chiefs, headmen, farmers, and community members) be centrally involved. Donor institutions would play a major role in any rural electrification project, and there are several international organizations including USAID, World Bank, and the IMF that have stipulations requiring stakeholder engagement at all levels; if all levels of the community are not involved, the money is withheld until the process is inclusive.

6.5 Monitoring

6.5.1 Existing Monitoring

Existing monitoring is very limited in its scope: ZESCO and companies who manage the hydro plants are the only stakeholders engaged in monitoring and maintaining the energy infrastructure. Their metrics are strictly based on power output and ensuring that the dams remain in good condition. More broadly, the Zambian Government and various donor agencies (USAID, World Bank) and NGOs (e.g. GiZ of Germany) monitor the energy in Zambia and publish frequent reports on the state of the energy sector in Zambia (ZMF 2011). Their metrics for monitoring the energy sector include overall output in MW, projected future needs, and what percentage of the country has been electrified (ZDA, 2015). This monitoring approach is limited in its scope because there are few power plants in the entire country (less than 20) and civil groups have been largely excluded from the project development process.

6.5.2 Suggested Monitoring

Monitoring should include project impact monitoring and evaluation (M&E), but this needs to be an integral part of *ongoing dynamic baseline monitoring and assessment*: there needs to be strong feedbacks between the monitoring of impacts post-implementation and ongoing assessment and planning activities for future projects or changes to existing projects. Criteria indicators of impact used to compare project alternatives during assessment (see 6.2) and planning are a primary focus of monitoring to track outcomes, but the larger set of baseline assessment indicators also need to be monitored over time to track changes in conditions. Appropriate temporal and spatial scales for monitoring will be in-line with assessment and planning stages. Monitoring data should populate the *shared information resource* that stakeholders co-create, which sits at the core of the socio-technical enterprise and any capacity building network (see 7).

The use of certain tools like surveys and reports from the government and third party organizations will be the basis of much of the social monitoring, supplemented by data inputs from civil society using the growing cell phone network, with gatekeeping and QC/QA provided by academic researchers. The monitoring tools need to cover the wide range of impacts based on the assessment criteria. To convey information to the public on the progress of the project, timely reports should be used, and online maps and reports issued.

The monitoring stage will include stakeholder engagement from all sectors. Civil society groups and chiefs will be utilized to collect data needed for this project, to answer key questions like: What are the rates of electrification in rural and urban areas? What is the cost of electricity? Do people have access to electricity? This information can be passed along to planners and managers who can use it to evaluate the effectiveness of the project and make changes as needed. Universities can engage in this process by monitoring the data collection and evaluation done by civil society, government, and private business. They can act as a check to ensure that corruption is not taking place in the monitoring process. Working with NGOs, universities can also assist by training civil society groups in data collection.

7. Capacity Building Networks

The scaling-up of localized SD success, and the scaling down of regional efforts, is one of the most persistent challenges for SD work, and is central to the *varying temporal/spatial scales conundrum*: *How can SD practice operate on a large scale, without losing its capability for responding to particular local circumstances?* The suggested process of integrative SD practice is framed as a *socio-technical capacity-building enterprise* (Downs et al. 2017), and the underpinning domain of the ICP framework is Domain 6) socio-technical capacities and networks. The capacity building model we employ builds from earlier work (Downs 2001, 2007) that considers six levels of capacity for each target sector: a) seed financial and political capital; b) education, training and human resources; c) information resources; d) policy making; e) appropriate technology (hardware); and f) enterprise development. By re-configuring the six levels such that *information resources* become the central activity to which all other levels both contribute to, and are served by (Figure 3), desirable economies of scale and communication are achieved by connecting interdependent sectors via the information resources core.

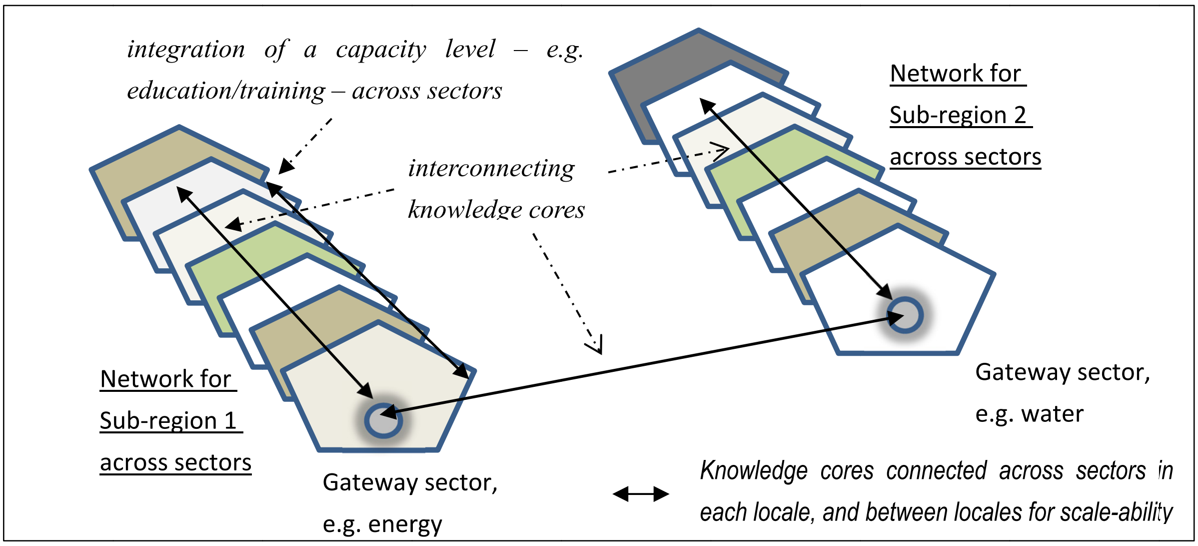

Figure 3. Capacity-building enterprise as a distributed socio-technical network. There are six levels of capacity for each sector, with information resources at the core of each (forming pentagons). Sectors integrate capacities at each level (e.g. Level 2: *education and training* across energy, water, food etc.), and connect via Level 3: the *information resources* core. Local and sub-region scale networks can be linked and scaled-up to regional and national scales.

Thus, we collectively build capacities that serve multiple sectors and stakeholders, offsetting transaction costs. Pivotally, such a design in theory also lends itself to the development of networks that can operate at the local scale to address local SD needs, then be interconnected via their information cores such that they grow into regional, national, and multi-national networks: the smaller networks feed the larger ones, and vice versa, creating a *distributed, socio-technical capacity building network* (Figure 3). Recognizing the primary importance of integrative knowledge is not new: the topic of knowledge systems for SD work has been receiving attention for some time (Cash et al. 2003), and this can be leveraged.

8. Conclusion

Zambia's response to its energy challenges offers a good example of BAU practice, and illustrates the advantages of using an integrative collaborative project model to critique it, and improve it. Energy is an excellent "gateway sector" because it connects with so many others – water, food, industry, health, climate change – and because there are major Zambian and Southern African efforts underway to tackle the persistent and growing energy deficit. Development challenges can be reframed as opportunities for the creation of socio-technical capacity building enterprises that emerge locally and are place-based, but also interconnect and scale-up via knowledge networks.

Our preliminary technological recommendation for a sustainable energy program in Zambia – subject to a full stakeholder process - is for an integrated approach including: 1) Deploying medium-size (10 MW - 20 MW) solar farms at the district levels in Zambia to connect to the grid; 2) Deploying community scale off-grid solar for remote areas by leveraging micro loans from local banks and NGOs; 3) Increasing the efficiency of current hydro; and 4) Optimizing thermal generation plants to ensure stable base load power is provided.

Stakeholder partnerships need to adopt creative, large-scale, long-term views and practical models of complex problems, and cultivate a capacity-building ethos. Such partnerships are better able to craft integrative responses, with a higher likelihood of enduring success. In terms of the economy and poverty reduction, Zambia has high potential to better support its existing industries and its society with sustainable energy. Furthermore, it is also poised to stimulate energy enterprises that provide employment to many, and to become a leader in the provision of products, services and integrative capacity to other African nations, including the 15 other nations of the Southern Africa Development Community.

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