South-South technology transfer: who benefits? A case study of the Chinese-built Bui dam in Ghana[1]

Oliver Hensengerth

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Abstract

The literature on technology transfer has focussed on North-South transfer and has analysed transfer as a largely technical process. This is despite the increasing influence of rising powers in technology transfer, specifically in the area of energy generation. China is an important player in this field. This article has two aims: firstly, it adds to the small but emerging literature on South-South technology transfer by exploring the role of Chinese actors, using the Bui dam in Ghana as a case study. Secondly, the article develops an expanded notion of technology transfer by arguing that technology transfer is not only a technical process, but it is inherently political as it includes crucial issues on decision-making regarding the type of technology that is transferred, who is granted access to the decision-making process, and who benefits from the new technology. In examining technology transfer from this perspective, the article draws on the sociology of technologies approach and the sustainable transitions literature arguing that technology transfer is a contested process that takes place within complex political, economic, social and cultural settings and actor networks. This determines the technology that is transferred, who benefits most, and who is marginalized in the process.

Keywords: China; South-South technology transfer; hydropower; sustainability transitions; socio-technical systems

1. Introduction

[1] Abbreviations used in the article: BPA (Bui Power Authority); CDM (Clean Development Mechanism); CSR (corporate social responsibility); EPC (Engineering, Procurement and Construction contract); ERM (Environmental Resources Management); ESIA (Environmental and Social Impact Assessment); GIZ (German Agency for International Cooperation); IPCC (Intergovernmental Panel on Climate Change); RPF (Resettlement Planning Framework); IPCC (Intergovernmental Panel on Climate Change)

The technology transfer literature has focused on North-South technology transfer. This is despite the prominence of South-South cooperation. In the energy sector, Chinese companies are not only the world's most prolific dam-builders; but China is also increasingly important in South-South climate finance, making it an important player in sustainability transitions. Evidence of this is China's foray into the field of rural electrification, but also the sums mobilized and institutions created to enable this. It includes a three-year programme launched in 2011 to support small island nations and African countries (China Daily 2015). More recently, it includes the US$3.1 billion South-South Climate Cooperation Fund, although little is known how this will operate (Lema and Lema 2012; Gallagher 2014; China Daily 2015; Arkin 2017).

Large hydropower is key for renewable energy technology transfer, although its sustainability merits are contested. Not only do large hydropower dams contribute a significant part of the Kyoto Protocol's Clean Development Mechanism (CDM) Pipeline; but also, 'in the renewables sector, *with the exception of large scale hydropower*, technology transfer has been constrained by the lack of investment and high costs' (Moreira 2000: 243-244, emphasis added).

In addition to focussing on North-South transfer, the technology transfer literature styles transfer as largely technical. Hard and soft aspects of transfer are debated, including the process of transferring hardware, and then the ways in which transfer leads to local technological innovation. The literature, however, lacks systematic explorations of the wider setting in which transfer occurs, including the politics of decision-making and the political, social, economic and cultural ramifications of introducing a new technology into a specific environment.

This article develops an expanded notion of technology transfer by employing the argument of the literature on the sociology of technologies that technology is not simply an artefact but a social institution. In doing to so the article bring the technology transfer literature into a conversation with

the sociology of technologies and sustainability transitions. The focus on South-South transfer is achieved by using the Bui dam as a case study. This allows both an examination of a Chinese project within South-South technology transfer, and it allows recasting technology transfer as a political process rather than as a technical and non-political process.

It is beyond the scope of the article to examine differences between North-South and South-South technology transfer. Rather, the article has two aims: firstly, it contributes empirical material to the small but growing literature on Chinese involvement in South-South technology transfer by examining the actors and processes that are involved in such transfer. Secondly, it develops an expanded notion of technology transfer by arguing that transfer is not simply a technical process but inherently political, starting from the decision on the technology to be transferred to the engagement with people in whose environment the technology is introduced. Thus, technology transfer does not end with the transfer of hardware and the raising of domestic innovation. Instead, it continues by creating new power dynamics between government, users and other affected groups that require domestic institution-building and multi-actor engagement for equitable access to its benefits and for inclusive development.

The article first surveying the literature on technology transfer. It then introduces the literature on sustainability transitions and the sociology of technology. It then outlines methods, after which it examines the case of the Bui dam.

2. Technology transfer

The literature on technology transfer has explored transfer mechanisms (including foreign direct investment, trade and joint ventures), barriers to transfer (including investment policies, infrastructure, and cultural differences), distribution of technologies (including reach amongst the population in the host country), and the quality of technology transfer. The latter includes the extent

to which technology transfer raises domestic knowhow and increases the ability to innovate (Maskus 2004; Schneider et al. 2008; Hammar et al. 2012; Lema and Lema 2013; Ohimain 2013). The quality of transfer is in turn dependent on the quality of domestic institutions, which includes corruption and the presence and enforcement of environmental policies. The literature generally acknowledges that technology transfer includes both hard and soft aspects (de Coninck et al. 2007: 445) or in Lema and Lema's (2013) words narrow and a broad views of transfer. The narrow view comprises physical aspects (the technology itself, cross-border movements, and transaction agreements); the broad view includes the creation of domestic skills and capabilities for innovation to drive technological change. The broad view is key and could be seen as the ultimate goal of technology transfer. In other words, technology transfer can be judged based on the extent to which physical or hard aspects serve the realization of soft aspects. This addresses the importance of domestic absorption of a new technology.

Despite arguments on quality and domestic absorption, Phillips et al. (2013: 1595) maintain that the literature has ignored how domestic politics and power relations influence 'what types of technology get transferred and on whose terms.' Indeed, stakeholders in technology transfer include a range of actors on multiple scales, including international institutions, private and state-owned companies, domestic governments, and – especially in the case of large hydropower dams – local communities who face the environmental, cultural, social, and economic impacts of the technology. Some of these issues have been articulated by the literature on technology transfer the Kyoto Protocol's CDM. Exploring the environmental sustainability of CDM-sponsored technology transfer, several authors have argued that the sustainability results of CDM technology transfer are questionable (Cosbey et al. 2005). This is partly because the CDM's market mechanism distorts the original environmental and social sustainability goals (Pearson 2006). Another reason is the presence of technologies that are of doubtful sustainability, in particular large hydropower dams, which make up a significant portion of the CDM Pipeline. Given the centrality of environmentally and socially sustainable economic growth to the legitimacy of the CDM (Schreuder 2009; Olsen 2007), the high number of large dams funded

through the CDM is problematic, with often deleterious impacts on the livelihoods of local communities (Rousseau 2017).

2.1 Technologies as social institutions

The mainstream definitions of technology transfer are inherently technical, despite the importance of soft aspects. The debates on soft aspects, however, revolve around capacity-building such as through training and education to raise a new generation of engineers capable of devising, operating and maintaining new technologies. The debate therefore does not probe into the political and social settings within which technology transfer occurs.

In contrast to the mainstream definitions Cromwell (1992: 979) applies a more encompassing notion of technology transfer. He argues that sustainable transfer goes 'beyond information sharing and training' and requires 'extended periods of local development, risk sharing and institution building' with the 'involvement of project partners and beneficiaries in continual reassessment and response.' As a consequence, '[t]ransfer is not exclusively concerned with adapting technology to given socioeconomic and technical environments. It is also the development of suitable mechanisms within the destination environment whereby a technology can be successfully adopted and exploited – adaptation of the destination environment itself' (p. 979). This includes equitable access to the benefits of the technology for poor communities (p. 984).

Adaptation, thus, becomes a key part of technology transfer. The issue of power, marginalization and equitable access in technology transfer processes has been highlighted by the Intergovernmental Panel on Climate Change (IPCC) (2000: 113). Arguing that the needs of local communities are often ignored in technology transfer, the IPCC drew attention to the importance of local knowledge systems and the inclusion of local stakeholder perceptions of technologies and technological solutions to development questions: 'Participation of the main stakeholders in the assessment stages can help

establish a process that will produce a technology selection better matched to local needs' (p. 115). However, as the report continues, 'current processes of technology selection often work against involvement and consultation of local communities' (p. 115).

In a similar vein, Urban et al. (2015a) pointed to a lack of social sustainability policies in technology transfer, resulting in continued marginalization of the rural poor who suffer from the economic and social impacts of a transferred technology but receive few or none of the benefits. Phillips et al. (2013: 1595) argued that technology transfer processes are laden with power relationships that influence 'what types of technology get transferred and on whose terms.' Not only does this apply to the decision-making process itself; but the introduction of a technology into a specific social, economic and cultural setting engenders social change in destination environments. It is in this context that Fahim (1981: 4) – a trained anthropologist – argues in his analysis of the Aswan High Dam that large dams 'are not just engineering works but also constitute social institutions.' In the process of their creation they give rise to new power configurations, redrawing rules for access to water, land, food and energy (Siciliano and Urban 2017).

The literature on sustainable transitions and sociology of technologies has captured these processes with the notion of socio-technical systems, a term describing the complexity of human-technology interactions during transition processes (Pfaffenberger 1992; Malerba 2002; Verbong and Geels 2007; Geels and Schot 2010). For Geels (2004) a socio-technical system incorporates innovation and development of knowledge; but it also includes the diffusion, use, *impacts* and *societal transformations* initiated by the technology. As a consequence, sustainable technological transitions need to emphasise both innovation *and* users (p. 898). They not only include people interacting in the direct context of a technology, but also temporally and spatially remote agents, supply chains, hardware and software, and the wider social, financial and political setting (Wilson 2000). In this view, technologies are more than mere artefacts. They are 'formed by, and embedded within, particular

economic, social, cultural and institutional structures and systems of beliefs' (Berkhout et al. 2004: 51).

This means that socio-technical systems are affected by complex processes of power and decision-making. This raises issues of the politics of transition and questions of who wins and who loses from transitions, and who decides which technologies to implement and which to ignore (Shove and Walker 2007: 765). As a consequence, socio-technical systems are not static. They are dynamic systems that see diverging or converging socio-cultural, policy, technological, science, market and user dynamics. They are therefore multi-level, multi-factor and multi-actor arrangements containing diverse actors with diverse knowledges (Shove and Walker 2007: 764; Geels et al. 2016).

Exploring electrification in the context of energy transitions, Ahlborg and Sjöstedt (2015: 21) see electrification as a 'dynamic process of formation of a new socio-technical system, which brings people, technology, institutions and resources into specific relationships.' Electrification is therefore a new socio-technical configuration of energy supply that destabilizes some power relations while stabilizing others (Ahlborg 2017). As a consequence, while energy transitions are generally conceived as beneficial for all, they can lead to ambiguous outcomes, increasing social inequality for some and creating social mobility for others (ibid: 2). As a result, transitions to new energy supply systems bring with them significant socio-economic change; but they also create and recreate mutually beneficial or adversarial relationships within and between communities, local and central government, as well as domestic and multinational infrastructure companies and banks.

In large hydropower dams, technologies include facilities for energy generation and transmission; resources include water, energy, food and land; people and institutions include local communities directly affected by dams (including their economic, social and cultural institution and systems), urban dwellers who are likely to receive most of the new electricity, government ministries and individual

politicians, domestic and foreign banks acting as financiers, domestic and multinational construction companies, and domestic and transnational NGOs. These actors operate in various stages of the technology transfer process where they engage in competitive pro and anti-hydropower discourses.

Smits and Middleton (2014: 564-565) point out that these pro and anti-hydropower discourses are created by actors who come together in different arenas, and these configurations generate specific power relations and decision-making processes. They argue that these arenas can be simultaneously multi-scale and multi-place. Looking at the CDM as an incentive structure for private investment into large hydropower stations, the authors list global (CDM Executive Board), national (Designated National Authorities, international and national consultants), and local (project developers, local authorities, affected people) arenas or scales (p. 565, Table 1). The actor configurations emerging in this process determine who in these multi-actor and multi-scale networks makes decisions, what actors have access to the decision-making process, and who gains and who loses (Bulkeley et al. 2014; Bulkeley 2013; Forsyth 2014; Suhardiman et al. 2014; Men et al. 2014). Schlosberg (2004) articulated these conflicts through the concept of environmental justice, which incorporates the following three elements:

> equity in the distribution of environmental risk [and goods], recognition of the diversity of the participants and experiences in affected communities, and participation in the political processes which create and manage environmental policy (Schlosberg 2004: 517).

Schlosberg points out that social justice needs to simultaneously address 'institutionalised exclusion, a social culture of misrecognition, and current distributional patterns' (p. 519). Going beyond distributional, recognitional and procedural justice, Schlosberg and Carruthers (2010) add justice as capabilities to the conceptualization of environmental justice by drawing on the work of Amartya Sen. This specifically adds the perspective of empowerment and voice to the notion of justice.

However, Martin et al. (2014) point out that environmental justice discourses cut across different scales are often in competition, with globally set environmental protection goals frequently ignoring discourses within local communities. Scheumann (2008) articulated this by arguing that in hydropower investment different environmental protection goals – global climate change versus local protection of social-ecological systems – compete with each other as different discourses are championed by different interests, which are styled as mutually exclusive. This means that justice perceptions can also differ dramatically between actors across scales, from a global climate change adaptation and mitigation discourse to national energy security to the security of local livelihoods and local notions of wellbeing (Hensengerth 2017).

In a similar vein, and looking specifically at climate justice, Bulkeley et al. (2014: 32) pointed out 'how notions of justice (variously referred to as fairness, equity, inequality, participation, legitimacy and so on) are being deployed and contested in the politics and day-to-day practices of […] responses to climate change.' Similarly, Movik (2014) argued that during policy formulation processes understandings and assumptions of justice shape the ways in which water access policies are formulated and implemented.

The article examines these processes for the planning and implementation of the Bui hydroelectric project in Ghana. It explores the creation of the Bui dam from the vantage point of a social institution and socio-technical system, and analyses the role of Chinese actors and their interplay with the Ghanaian governance landscape in this process. The next section describes the methods used to gather the relevant data for this analysis.

3. Methods

Data for this study is drawn from interviews carried out in Ghana in the capital Accra and with communities at the Bui dam site. A first round of interviews was held during two weeks from late June to early July 2010, and follow up conversations were held via email especially with the Environmental Protection Agency and engineers at the Volta River Authority. This material was updated during a one-week stay in Accra in July 2015, again followed by email conversations where additional material or clarifications were requested. The main purpose of this field work was to explore the role of Chinese actors in the construction and financing of large hydropower projects, modes of contractual arrangements under which technology transfer occurs, the interaction of Chinese agencies with local Ghanaian actors, the distribution of responsibilities between Chinese and Ghanaian actors, and the extent to which Chinese actors engage with local communities. The purpose was therefore to gain an in depth picture of Chinese engagement in the creation of a new energy facility in the context of South-South cooperation.

In Accra, interviews were held with relevant government agencies, most of them facilitated through the Section for Development Cooperation in the German embassy in Accra. Agencies interviewed included the Bui Power Authority, the Volta River Authority, the Ministry of Finance and Economic Planning, the Ministry of Energy, the Environmental Protection Agency, the Energy Commission, and the Water Resources Commission. Government interviewees were chosen for their knowledge of the planning, implementation and monitoring processes for large dams in general and Bui in particular, their knowledge of the environmental impact assessment and resettlement processes, their familiarity with the financing arrangements, and their knowledge of the content of relevant planning documents. Key planning documents relevant to this analysis comprise the Environmental and Social Impact Assessment (ESIA) and the Resettlement Planning Framework (RPF). Both documents are publicly available, and the analysis in the article is partly based of the suggestions made therein, particularly in the RPF.

Further interviews were held with the Ghana Dams Dialogue, a multi-stakeholder platform composed of government representatives and representatives initially from the Akosombo dam resettlement communities – the first dam built in Ghana. The purpose of the Ghana Dams Dialogue is to establish channels of communication between government and local communities to avoid a repetition of the mistakes made during resettlement for the Akosombo dam, which caused widespread poverty in resettled communities. The Ghana Dams Dialogue had been set up and had for a number of years been financially supported by the German Agency for International Cooperation (GIZ), and relevant contacts to the Ghana Dams Dialogue as well as to a number of civil society organizations were initially facilitated by GIZ. Additional interviews were held with research organizations, national OECD donor agencies, civil society organizations and researchers conducting work on hydropower dams in Ghana. During both stays in Ghana, attempts were made to contact Sinohydro and the Economic and Commercial Counsellor's Office in the Chinese embassy, but this was unsuccessful. At the dam site, interviews were held with community members in Bui Village (including the Bui Chief), with representatives of the Jama (often also spelled Gyama) host community (including the Jama chief), and with community representatives in what was then the temporary Jama resettlement site. The table below provides further details on the interviews, organised by date of interview.

Table: List of interviews (the table is provided in a separate file)

Organisation, or description of the organisation	**Role description of interviewee**	**Date of interview**
Environmental Protection Agency	Senior manager (2 interviews)	21 June 2010 and 1 July 2010
OECD national development agency	Country director	21 June 2010

OECD embassy	Senior diplomat	21 June 2010
Ghana Dams Dialogue	Local community leader	22 June 2010
Domestic NGO	Activist	22 June 2010
National Association of VRA Resettlement Townships	Community leader	22 June 2010
International Water Management Institute	Group of researchers	22 June 2010
Volta River Authority	Senior manager	23 June 2010
Bui Power Authority	Senior manager (2 interviews)	23 June 2010 and 28 June 2010
Water Resources Commission	Senior engineer (2 interviews)	23 June 2010 and 29 June 2010
Energy Commission	Senior manager	23 June 2010
Energy Commission	Senior manager	24 June 2010
Ghana Irrigation Development Authority	Senior director	24 June 2010
Water Research Institute	Engineer	25 June 2010
Forestry Commission	Senior manager	25 June 2010
Volta River Authority	Group of engineers	26 June 2010 (via email)
Forestry Commission	Department director	28 June 2010
Ministry of Finance	Officer	30 June 2010
Ministry of Finance	Economist, China Desk	30 June 2010
Bui village	Local community leader	1 July 2010
Jama village	Local community leader	1 July 2010

Jama resettlement township	Group of community leaders	1 July 2010
National Development Planning Commission	Senior analyst	2 July 2010
Centre for International Migration and Development / National House of Chiefs	Traditional authorities advisor	2 July 2010
OECD national development agency	Project member on land management	8 July 2010 (via telephone)
Independent researcher conducting research on the health effects of the Bui dam on local communities	Independent researcher	25 August 2010 (the meeting took place in London)
Environmental Protection Agency	Senior manager	31 July 2015
U.S. university	Researcher	1 August 2010

4. Results

The Bui dam is a key part of Ghana's electricity supply strategy with the aim to diversify economic growth away from the South to the North. It is controversially located on the Black Volta River where it flooded 21 percent of Bui National Park and required the relocation of the hippopotamus population. Bui was commissioned in December 2013. With an installed capacity of 400MW the dam produced 730GWh in 2014 (Energy Commission of Ghana 2015). The output of the dam was meant to increase as the reservoir reaches full capacity, with annual average energy production calculated at 969GWh (International Energy Agency 2016: 36).

The history of planning for Bui dates back to 1925, when Albert Kitson discovered the Bui Gorge and found it suitable for a hydroelectric dam. However, although by 1978 plans for Bui had reached an advanced planning stage, the plans suffered from coups d'état, the relative cost of thermal power, and a lack of interest by companies. In 2002, in a renewed attempt to build Bui but still facing a lack of interest by companies, President Kufuor turned to China and Russia for help. In 2005, the government announced that the Chinese government had expressed willingness to assist, with financing from China Exim Bank and construction by Sinohydro. The government tasked UK-based Environmental Resources Management (ERM) to conduct the ESIA and the RPF, which the firm submitted in 2007 (for a detailed history see Fink 2005: 69-72). In 2007, Ghana's parliament passed Act 740 establishing the Bui Power Authority (BPA) as project owner with full responsibility for planning, implementation and management (Zigah 2009: 25).

4.1 Modes of hydropower technology transfer and financing procedures

The transfer of hydropower technology occurs under a variety of contractual arrangements, and Chinese companies operate under all of these. They range from the supply of materials (as in the case of Ethiopia's Gibe 3 dam) to turnkey projects or Engineering, Procurement and Construction (EPC) contracts (like Ghana's Bui dam) and build-operate-transfer (BOT) projects (such as all of Cambodia's dams). Under material supply arrangements, the company merely delivers materials or machinery used to construct the dam. Under turnkey and EPC arrangements, the company builds the dam and immediately hands it over to the recipient government. This occurs for example in countries where there is no domestic expertise in building dams, but expertise in operating and maintaining them. This is case in Ghana. In BOT cases, the company builds and operates the dam for a fixed period – in the case of Cambodia's Kamchay dam, for example, this period is 44 years and includes the construction period. This allows the company to recover its investment costs through electricity sales. BOT is common in contexts where host countries have neither domestic expertise in construction nor in operation and maintenance.

Regarding financing, Chinese projects often come in a packaged approach with concessional and commercial loans, disbursed through China Exim Bank. Concessional loans are subsidised from the foreign aid budget of the Ministry of Commerce. Within the Ministry, the Department of Aid to Foreign Countries is in charge of aid and so negotiates concessional loans with foreign governments. Exim Bank then executes the terms of the agreement (Brautigam 2009: 174; Hubbard 2007: 4). Quoting a China Exim Bank official, Brautigam explains that the Bank lends money in a mixed package mode consisting of 'concessional loans, seller's and buyer's credits in support of large overseas engineering projects, particularly in developing countries' (Brautigam 2009: 174). In contrast to concessional loans, buyer's credits are extended at 'competitive' rates based on the OECD's Commercial Interest Reference Rates (CIRRs) or the London Inter-Bank Offered Rate (LIBOR) (Brautigam 2009: 176). Bui is financed by a concessional loan and a buyer's credit disbursed through Exim Bank.

During the loan negotiations between Exim Bank and Ghana's Ministry of Finance and Economic Planning, Exim Bank requested the ESIA report (interview at the Ministry of Finance and Economic Planning, 30 June 2010), in line with the 2007 *Guidelines for Environmental and Social Impact Assessments of the China Export Import Bank's Loan Projects*. Article 13 requires the project owner or borrower to submit the ESIA study during loan negotiations so that the environmental and social impact may be evaluated and the construction proposal amended if necessary (China Exim Bank 2007). Article 14 stipulates that the Exim Bank 'if necessary, can require the inclusion of environmental and social responsibilities in the loan contract, in order to monitor and restrain the behaviour of borrowers' (China Exim Bank 2007). While the government did submit the ESIA study, it is not clear if Exim Bank required Article 13 amendments or Article 14 measures.

The loan agreement was submitted to the Ghanaian Cabinet for approval, from where it was sent to Parliament for its consent. The concessional loan agreement was signed in 2007 and the buyer's credit

facility in 2008 (interview at the Ministry of Finance and Economic Planning, 30 June 2010). Articles 15 to 19 of the Exim Bank's environmental guidelines make Exim monitoring of its projects mandatory, although to date information on if and how monitoring was carried out could not be obtained as this information has been refused by the BPA. In June 2010 an Exim Bank team reportedly visited the Bui dam site (interview at the Ministry of Finance and Economic Planning, 30 June 2010). In the same month an International Review Board of Consultants (RBC) inspected the Bui Dam and briefed the BPA's Chief Executive Officer (CEO) of the outcomes. However, the BPA did not want to disclose any information on the outcome of the review, stating only that inviting an RBC is 'standard international practice.' The CEO also visited China on 30 June 2010 for project meetings and manufacturing inspections regarding Bui, but he did not give further details about the visit (interview at the Bui Power Authority, 28 June 2010).

Sinohydro built Bui under an EPC contract. While in charge only of dam construction, it had to comply with the conditions set out in the ESIA. Resettlement was the responsibility of the BPA. Nevertheless, it was Chinese initiative that eventually brought the project off the ground (Kirchherr et al. 2016). Bui is a roller-compacted concrete gravity dam with three Francis turbines, built by Alstom Hydro in China, each with a capacity of 133MW. Two rock-fill saddle dams contain the reservoir. The dam has a height of 108m, with crest elevation at 185m above sea level. The reservoir area at Full Supply Level is 444km2, with reservoir level at 183m. The Minimum Operating Level is 168m. Power transmission occurs from the Bui Switchyard through 161kV transmission lines of a total length of 240km. A bridge across the Black Volta River connects the Brong Ahafo and Northern Regions (International Energy Agency 2016: 37; Bui Power Authority 2012).

During construction Sinohydro employed 3000 Ghanaian unskilled and semi-skilled workers, without further training provided to find employment on the site following the end of construction. High-skilled jobs were mainly occupied by Chinese staff, of which there were around 700 (interview at the

Ministry of Finance and Economic Planning, 30 June 2010; Mohan and Tan-Mullins 2009: 595). Nevertheless, despite the total absence of skills training, operation and maintenance is carried out solely by Ghanaian staff. Ghana has a solid skills basis in hydraulic engineering for the operation and maintenance of hydropower plants but is lacking domestic companies with expertise in hydropower dam construction, making Ghana a good case for EPC contracts. Hydraulic engineering has a long tradition in Ghana. Hydropower has been a key form of electricity since the establishment of the Volta River Authority in 1961. The Volta River Authority today runs the Akosombo and Kpong dams (with installed capacities of 1020WM and 160MW respectively) and a number thermal plants. It maintains an Engineering and Operations department staffed by domestic engineers, including those with expertise in hydropower (interviews with Volta River Authority personnel, June 2010). The Volta River Authority is currently carrying out feasibility studies for two 140MW hydropower dams at Pwalugu and Juale, which are to be built by Chinese companies, thus further expanding Ghana's hydropower capacity.

4.2 Local institution-building, power and access to resources

Resettlement proceeded in three phases and included seven villages plus the personnel of the Game and Wildlife Division at Bui National Park, who lived at Bui Camp – in total 1216 people or 219 households. Phase A began in May 2008 and saw the resettlement of Brewohodi, Agbegikuro, Dam Site and Lucene to the Jama resettlement site, located next to Jama Village, which functioned as host community. Resettlement to Jama was complete in June 2012, but before relocation to this permanent site resettlers were housed in a temporary resettlement site, making the process stressful and filled with uncertainties (interviews with resettlers at Jama resettlement township, 1 July 2010; a member of the Ghana Dams Dialogue, 22 June 2010; a domestic NGO activist, 22 June 2010; and a member of a OECD development agency, 8 July 2010). Phase B started in June 2010 and saw the resettlement of Bui Village, Bator-Akanyakrom and Dokokyina to Bui Resettlement Township. Phase B

was completed in June 2011. During Phase C, the national park employees were relocated (Bui Power Authority, no date_a; Bui Power Authority, no date_b).

The RPF uses World Bank and Ghanaian regulations as basis for expropriation and resettlement: the World Bank Operational Policy on Involuntary Resettlement (Operational Policy 4.12), the World Bank Involuntary Resettlement Sourcebook, Ghana's 1992 Constitution, the 1986 Land Title Registration Act, the 1962 State Lands Act, the 1962 Administration of Lands Act, the 1960 State Property and Contracts Act and the 1965 Public Conveyancing Act. Ghanaian regulations for resettlement and expropriation do not require public participation, but domestic ESIA as well as World Bank regulations do. ERM therefore suggested creating mechanisms for public participation and advertising these widely to the public (ERM 2007b: 78). In addition, resettlement sites must be able to support the economic well-being and social and cultural values of communities, must be incorporated into local government jurisdiction, must be acceptable to resettlers, support living standards and provide services and infrastructure at least similar to the original settlements (ERM 2007b: 101 and Box 10.1).

To monitor resettlement the RPF suggested the creation of a Steering Committee composed of representatives of the BPA, district officials, chiefs, the Land Valuation Board and NGOs. The Steering Committee would have cooperated with a Working Group made up of a Resettlement Coordinator, village representatives, NGOs and technical personnel in charge of host site preparation (including architects and agricultural experts). The Working Group would have been responsible for implementing resettlement, including pre-resettlement consultation and overseeing the process of relocation – which would have involved regular coordination with the construction contractor Sinohydro. After resettlement, the Working Group would have been responsible for implementing and monitoring rehabilitation and responding to grievances. External monitoring would have taken place by an independent agency in regular intervals until thirty-six months after resettlement (ERM 2007b: 122-133, 141-146).

None of this, however, happened. Sutcliffe (2009: 2-3) reported that RPF recommendations for addressing villagers' concerns[2] were not taken up. Villagers were also not given a timeframe for resettlement or for compensation payments, and they were not informed of appropriate channels of communication 'to make their grievances known.' The BPA simply appointed a Resettlement Officer to coordinate the process, ignoring the complex structure suggested by the RPF. Some consultation did take place, although villagers' views were not substantively considered (Miine 2014: 64-66, 72-74). Furthermore, the BPA did not discuss all relevant issues with affected communities, in particular the selection of resettlement sites (Urban et al. 2015b: 583).

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In addition to recommending an institutional structure for resettlement, the RPF advocated the implementation of a Livelihood Enhancement Programme to restore livelihoods to at least the same level as before resettlement. The Livelihood Enhancement Programme adopted a two-pronged approach: the targeting of vulnerable households, and the enhancement of livelihoods in resettled communities in general. The focus was on the major livelihood activities of the villages: agriculture, fishing, trading, livestock rearing, hunting and collection of forest products.

The LEP also refers specially to fishing communities, requiring the BPA to allocate new and equivalent fishing grounds, the development of fishing opportunities (establishment of fishing associations, business planning, micro-credit support, and facilities for storage, transport and refrigeration) and the development of alternative livelihoods (agriculture, small service enterprises and artisan workshops and training for other livelihoods to be identified and for which there is demand) (ERM 2007b: 98). In addition, to compensate for lost fishing grounds, the RPF suggests a 'transportation allowance for

[2] For details on issues raised by stakeholders and how they are addressed in the RPF see ERM (2007b: 115-116, Table 13.1).

fishing equipment (boats etc.)' and a 'transition allowance until fishing livelihood is restored' (ERM 2007b: 94, Table 9.6).

The focus on fishing is important. The area of the Bui dam comprises a number of indigenous and migrant communities engaged in fishing, notably the Ewe, who had migrated to the region after having been displaced by the Akosombo Dam in the 1960s. The Ewe made up the majority population of Agbegikuro, Bator-Akanyakrom and the entire population of Dam Site (ERM 2007a: 52; ERM 2007b: 19). Most villages have a mixed economy consisting on farming (food and cash crops), fishing, trading, hunting, raising livestock, and collecting forest products; but fishing was the key activity for Agbegikuro, Bator-Akanyakrom and Dam Site (ERM2007b: 29-30, 33), making these communities particularly vulnerable to resettlement away from the river.

Indeed, during interviews conducted in the temporary Jama resettlement site, community members previously engaged in fishing said that fishing activities had now collapsed as they were resettled on dry land, too far away from potential fishing grounds. In addition, community members argued that the land allocated to them by the Jama chief was not very fertile, but in addition the community lacks farming skills and they did not received training to make the transition from fishing to farming (interviews with local leader at Jama village and interviews at Jama resettlement township, 1 July 2010). As a local community leader complained:

> We haven't received any training for farming, nor tools or seeds, and the land is not very fertile. The Bui Power Authority does not allow us to go back to the river arguing that there is a security issue while construction is ongoing. But we know when during the day construction is happening, and so we went back to the river to fish after working hours. But we were still arrested and sent back.

Obour et al. (2016: 291) found that before resettlement the seasonal flooding between June and November would lead to an increase in fish stock between November and March, allowing fishermen to generate enough income to meet social, economic and health needs of family members. Some of the catch was also exchanged for food from neighbouring farming communities. After resettlement was completed and the reservoir filled, new fishing opportunities arose on the reservoir, but these are mostly exploited by new migrants with large boats from Yeji and Bamboi who are attracted by the new opportunities. Traditional fishermen from Agbegikuro only know how to fish in the narrow river channel but are not skilled to fish in the large reservoir. Indeed, traditional fishermen claimed that fishing in the reservoir is quite different to fishing in the narrow river channel and poses risks to live (Twene 2016: 93).

As fishing in the reservoir is difficult for the local fishermen, some have explored fishing downstream in the river. This, however, is made difficult by two factors, as fishermen from Bator-Akanyakrom pointed out: downstream flow has strongly reduced since dam construction, and the BPA tends to open the spillways without prior warning, leading fishing nets and boats to drift away (Obour et al. 2016: 291). Indeed, a community leader said:

> The authorities prevent us from going to our fishing grounds under the pretense of security. We have been told to fish further downstream, but the water flows much faster there, which makes fishing dangerous and we don't have the right equipment to fish there. But the Bui Power Authority does not appreciate this problem (interviews at Jama resettlement township, 1 July 2010).

Fishermen from the two communities are now unemployed. This has knock-on effects on women fishmongers who used to sell fish caught by the men on local markets. 42 percent of the fishermen and 28 percent of women fishmongers have now shifted to farming, but often without having received

skills training or adequate land. Other women have moved to sell food when the dam was under construction while others have branched out into selling groceries, trying to make use of the improved transportation network, the influx of immigrant labour, and new tourism opportunities. As a consequence, households from Agbegikuro and Bator-Akanyakrom no longer eat traditional meals made mainly from fish (Obour et al. 2016: 292-293).

As they faced resettlement, the community of Agebegikuro requested the BPA to be resettled at the river to allow them to continue fishing. The BPA however ignored the request arguing that the villagers 'lacked technical expertise to assess and assist site selection' (Miine 2014: 66) – directly ignoring the RPF. Resettlement also affected cultural life: Agbegikuro used to celebrate a festival involving communal fishing, during which the catch was distributed within and outside of the community. Given the lack of fishing opportunities after resettlement, the festival can no longer be celebrated (Obour et al. 2016: 292). Resettlement did produce some improvements: improved housing, access to electricity (but now also the need to pay for electricity, which increased economic burdens), improved roads, a new school in Bui resettlement camp and an extension of the existing school in the Jama host community, upgraded health centres in Jama and Bungase, and financial support. However, fishermen from Agbegikuro and Bator-Akanyakrom pointed out that they would have been better off if the BPA had provided them with new fishing equipment instead of the financial support for the start of new farms, which forced them to move into non-traditional economic activity without having requisite skills (Obour et al. 2016: 294-295). Indeed, a strong focus during the interviews was placed by fishermen on the lack of training for farming (interviews with community leader at Jama and with communities at Jama resettlement township, 1 July 2010).

The problems, however, reach beyond fishing communities. An overall decline in livelihoods has resulted from constraints on agricultural production owing to low soil quality, lack of fertilizer and lack of experience of resettled communities whose main economic activity was not agriculture; long

distance to markets to sell agricultural produce; long distance to rivers for fishermen and disappearance of some fish species; and absence of off-farm income generation. This has resulted in lack of adequate food supply with adverse impacts on health. To supplement income, some resettlers have opened illegal mining sites in the forest reserve, which in turn led to destruction of parts of the forest (Miine 2014: 75-77). At the same time, some farmers at Jama resettlement site reported that their crop yields have remained the same, having changed to planting more maize, squash and gourd instead of yam and cassava as they had done in the old villages (Obour et al. 2016: 292). This suggests that livelihoods in the resettled communities are highly uneven depending on a range of factors including, but not limited to, occupational groups, existing skills (such as where farming-to-farming resettlement has taken place) and skills support.

Otu-Tei (2009: 110-112) also argued that the Jama resettlement occurred 'immediately after the main season for planting maize and yam, the main staple foods in the area, because the resettlement was determined by the pace of the dam construction.' Further, in the words of a community leader:

> We were told that our mango trees would not be affected by construction. But now that construction has started we are not allowed to go back to harvest the mangos (interviews at Jama resettlement township, 1 July 2010).

This was a violation of the ESIA, which required Sinohydro to adhere to a Construction Management Plan that would avoid negative consequences for local livelihoods. This plan was to be enforced by the BPA (ERM 2007a: 163). A more careful scheduling of construction, along with Sinoydro's adherence to its own emerging social safeguard policy, could have avoided some of the social fallout. Indeed, sentiment against the Chinese presence seemed to run high. A member of the Ghana Dams Dialogue, a multi-stakeholder platform set up to deal with longstanding issues of the Akosomobo dam resettlement and to prevent failures of Bui resettlement, argued:

> Relations with the Chinese are not cordial. In order to prepare for construction of Bui, they burnt the bushes without consulting the community. For the first meeting of the Ghana Dams Dialogue, a member of the Chinese embassy attended, but he said nothing during the meeting. The Chinese were also invited to further meetings of the Ghana Dams Dialogue, but they didn't come (interview with member of the Ghana Dams Dialogue, 22 June 2010).

Out-Tei therefore concluded that 'critical issues' in resettlement implementation, such as 'compensation, preparation of resettlement site, relocation, implementation of livelihood programs, and monitoring were ignored […]. Completion of the dam was prioritized at the expense of sustainably restoring or improving the living conditions of the affected people' (Otu-Tei 2009: 116). This lack of local institution-building 'robs [… resettlers] of their freedom, causes social disarticulation, reduction in right to resources and powerlessness' (Mettle 2011: 93).

5. Discussion

From a mainstream technology transfer position, Bui exhibited all aspects of Lema and Lema's (2013) narrow view: a transferred technology, cross-border movements but also the involvement of transnational actors and transnational funding streams as well as the conclusion of relevant agreements between Ghanaian government agencies and Chinese actors. It largely failed, however, in terms of the broader view: Ghana already has experienced hydraulic engineers, and the process of planning and construction did not raise the capacity of local firms in hydropower construction or provided provide training for low skilled workers to find employment in higher-skilled sectors following the end of construction. It is therefore questionable that the transfer has benefited Ghana in skills terms, although it may certainly do so in terms of clean energy production and growth diversification from the South to the North and therefore fulfil the government's principal aims.

The dam, however, had other far reaching consequences. The complex and multi-year process of institution-building suggested by the RPF was ignored, and thus the call of the IPCC for community engagement to ensure equitable access to the benefits of a transferred technology was not heeded. Bui produced considerable change in community access to resources, including land, water, food and energy: former fishing grounds were blocked off, and the new opportunities of reservoir fishing attracted fishermen from outside with requisite skills and equipment. Local fishermen have since been unable to compete. In addition, allocated land was not as fertile as the original land. Food security has since become a problem. This is intertwined with cultural identification such as that of the Ewe centred on traditional livelihoods, associated festivals and community cohesion. Electricity supply for local villages also did not come forward, at least initially during accommodation in temporary resettlement sites, and thus local communities did not participate in the immediate benefits that Bui was designed to create. To date, a so-called Bui City, which had been touted as the new, modern home for resettled communities including an airport and a university (interview with member of the Ghana Dams Dialogue, 22 June 2010), has not been realized.

These wider problems and the disruptions that new technologies can cause are captured by the view of large dams as social institutions (Fahim 1981). In a similar vein, the literature on sustainability transitions sees energy systems as more than artefacts. Energy systems are socio-technical systems that engender new power configurations and social dynamics with ambivalent outcomes – positive for some, negative for others (Ahlborg and Sjöstedt 2015; Ahlborg 2017). Energy technology transfer introduces not only new technologies but also new domestic and transnational actors, making technology transfer a multi-scale and multi-actor process. Institution-building in lockstep with introducing a new technology is therefore key to avoid negative outcomes. Implementing the suggestions made in the Bui dam RPF would have led to such local institution-building. Furthermore, despite its environmental guideline, Exim Bank does not appear to have monitored the Bui dam

particularly closely. Sinohydro, meanwhile, at the time the Bui project was implemented, was in the process of developing an environmental policy, which would have required it to apply stricter company-internal monitoring mechanisms.

Scheumann (2008) pointed out that different notions of justice compete with each other, reaching from global notions, to national and local ones. Movik (2014) and Bulkeley et al. (2014) argue that such different notions of justice play out in the everyday politics of resource access and allocation in the process of which rules for resource access are produced and reproduced. It is these interests and ideas of which development goals are just that underpin decision-making in technology transfer and the choice of the technology that is to be transferred. For the Ghanaian government, electrification of the country's North to diversify growth away from the South is paramount in the view of macro-economic development. It also ties in with global climate change and green energy discourses and is therefore relevant in the context of low carbon energy transitions. Chinese banks and construction companies largely see access to new markets to diversify their investment and to remain internationally competitive, but their actions are at least on paper restricted by national Ghanaian law, the norms laid out in the ESIA and the RPF, and their internal environmental and social policies.

This means that technology transfer does not occur in a normative vacuum. Instead, the decision-making process for technology transfer and its implementation are governed by networks of actors cutting across multiple scales, with specific interests, objectives and ideas of development that benefit society, framed by a range of rules and norms. This makes technology transfer an inherently political process, rather than merely a technical one that would see the transfer of a piece of technology and that ends with the raising of domestic innovation capacity. Technology transfer takes place in a complex political, cultural, economic and social environment. Once introduced, technology engenders changes to these environments from which some benefit and others do not. Those who do not benefit include those directly affected by the introduced technology. Displacement, food shortages and

restricted access to land and water are particularly difficult issues for the local population in the case of Bui.

To alleviate this, the IPCC (2000) suggested to make public consultation with local communities a part of technology transfer processes. This indicates awareness of the multi-scale impacts and far-reaching social, economic and cultural changes that technology transfer can produce. It also shows that the IPCC is aware of the power relations in technology transfer and the problem of marginalization that technology transfer processes can produce or maintain. Thus, Ahlborg's (2017) notion that in the process of energy transitions some power relations are stabilized while others are destabilized is important here to understand the ways in which technology transfer has implications beyond the mere creation of a piece of technology. A consideration of the wider context is important to address issues of equitable outcomes of technological change and transitions to energy sustainability.

6. Conclusion and policy recommendations

The Bui dam shows failures on all sides: the Ghanaian government did not follow the requirements for institution-building in the RPF; Sinohydro violated the Construction Management Plan laid out in the ESIA to time activities so to avoid harming local communities; and China Exim Bank appears to have followed its own environmental guidelines in form only. Looking at this from the perspective of technology transfer, the Bui dam case shows that technology transfer should not just be seen as a technical process that ends with the creation of domestic innovation capacity. Instead, it needs to be seen as a wider process that creates new political, social, cultural and economic dynamics and redefines access rights to land, water and energy. It thus creates new opportunities for some, and new forms of marginalization for others.

Entrenched poverty and disempowerment of resettled communities counteracts the positive impacts of investment into potentially green technologies and produces uneven development. As a

consequence, in order to realize the development potential of hydropower technology transfer, institution-building specifically around engagement with local communities is important to take into local livelihood circumstances and needs, the ways in which the technology affects these, and options for mitigating these impact. This would be in line with the IPCC recommendation to make participation of local communities a key component of international technology transfer.

The focus on China here is relevant because companies from the global North are mostly bystanders in the hydropower expansion in the global South as they fear large-scale protests, a negative press, and law suits (prominent examples are the Narmada and the Xayaburi dams); in addition, many Northern countries have export credit regimes that apply – more or less strictly – environmental guidelines, which makes hydropower investment difficult and costly (a prominent example is the Ilisu dam in Turkey).

Chinese companies as global leaders in the hydropower sector have a key role to play here. Not only could they ensure better social and environmental policies in their investments by enhancing CSR policies; but in collaboration with governments – who in turn have an obligation to enforce existing policies – hydropower dams could have the capacity of creating more inclusive growth. However, this needs long term financial investment into livelihood restoration programmes and may also include the consideration of alternative energy generation mechanism.

Chinese hydropower technology transfer to the global South follows clear business interests of market access. This meets the development interests of governments. What is frequently absent in this are the development and application of complex social and environmental protection policies and rights-based development discourses. Southern governments often complain about cumbersome and bureaucratic North-South aid policies and too strong an emphasis on environmental and social safeguards, which results in long and complex planning processes. The hydropower sector is a key

example of this development, which has affected hydropower planning in a number of Southern river basins, including the Senegal, Zambezi and Mekong River basins.

In contrast, South-South transfer – at least in the hydropower sector investigated here – often lacks such safeguards. Chinese actors would do well in heeding the IPCC call for more community participation to strike a balance between national economic interests and the needs of rural communities who depend on local social-ecological systems for their livelihoods.

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