Sustainable Management of Hydropower in Lao PDR

Seumkham Thoummavongsa and Xayphone Bounsou

Abstract— *Laos has potential for new hydropower plants with total installed capacity of 28,000 MW. Today, Laos has hydropower plants with a capacity of 3,200 MW. Hydropower projects involve a number of multiple stakeholders with various interests. Effective management and environment considerations are important to ensure sustainable development within the sector. Even though substantial improvements in policy procedures, legal requirements and assessment guidelines have been made there is still room for improvements. A major problem is related to benefit sharing, capacity building and institutional aspects. Development of hydropower needs to be sustainable, with minimal adverse social and environmental impacts. Hydropower should, as renewable source, also be a viable and profitable energy solution contributing to a positive economic development. Hydropower development should respond to realities of the country and to the energy market. Hydropower must be developed in the context of broader goals, including environmental management, poverty alleviation institutional and social development along with integrated water and energy management. Sustainable development of hydropower requires the integration of economic and social development as well as environmental protection. In planning of hydropower projects the following parameters are important: efficiency, participatory decision-making, sustainability, and accountability along with precautionary approach to ensue an environmentally sound development.*

***Keywords*— Hydropower, sustainable, planning, development, management and benefit sharing.**

1. INTRODUCTION

The economic development in the Lao People's Democratic Republic (Lao PDR) has been firmly rooted in developing its abundant natural resources, including water, minerals, forests, wetlands and biodiversity. Although a relatively small percentage of 2.8 of the national water resources are developed for storage or abstraction, water is the fundamental resource for hydropower generation which has been identified as the major national development opportunity [1].

The Lao PDR has the potential to build more than 70 hydropower plants (Dams) with a total installed capacity of about 28,000 MW. So far, the Lao PDR has built only 14 hydropower plants or power dams with an installed capacity of 3,200 MW (year 2012) [2]

There is a need to develop new, more sustainable environmental planning and policy approaches that integrate social and ecological concerns in hydropower projects in the country. These social ecological approaches should go hand in hand with present long term rehabilitation efforts carried out by the rural societies to restore damaged aquatic environments from previous hydropower projects. Hydropower is not just a means of combating GHG emissions; water storage also supports adaptation to climate changes. Water and energy are essential to the alleviation of poverty. Climate changes make this more urgent and for many countries the development of hydropower can be a vital and important part of the answer. Due to the increased demands of reliable supplies of electric power, irrigation, and drinking water the number of new small and medium sized hydropower reservoirs is increasing dramatically in the world.

In the Lao National Energy Policy it is important to maintain and expand affordable, reliable and sustainable electricity production and supply in order to support a positive economic and social development in the country. Also improvements and expansion of transmission networks to support the rapidly growing industrialization and modernization process and the intergradations of the power sector in the ASEAN community through its power exchange programs will require extra power capacity. To use or tap the country's large hydropower potentials will however require participation of private developers;

Hydropower energy is a key element of sustainable energy production. Hydropower energy contributes holistically to our combined goals of having economic growth, a positive social development, increased energy security, and a good environmental protection. All factors promising a brighter, safer, and cleaner future for the Lao people and for the coming generations. Some initial progress has already been made. Putting renewable energy solutions into practice on a national scale, in a world that has organized its institutional, industrial, financial, and governmental systems principally around the supply and use of fossil fuels is a very challenging task [3].

On a regional scale, power supply is the most capital

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intensive sector of all. The industrial and commercial sector and every aspect of social progress are heavily dependent on reliable energy supply. At the same time there are significant scopes for the development of hydropower on the existing power production structure and the modernization of the existing hydropower plants to improve efficiency and development of hydropower plants to provide energy to rural, remote and under-supplied regions. The development, renovation, and rehabilitation of these existing hydro power plants will together with new hydropower projects, lead to a situation where significant additional clean and renewable energy capacity can be achieved.

The purpose of this paper is to analyze socio-economic and environmental sustainability considerations to be developed in the Lao PDR. The paper discusses the existing environment aspects associated with hydropower planning, development, and other challenges related to that sector in the Lao PDR. The paper aims to highlight the problems and constraints in the hydropower sector and suggest some opportunities to meet the emerging challenges, the implementation of policies and institutional strengthening processes that will lead to an improved and sustainable development of the hydropower sector in the country. Furthermore, the paper can be considered a discussion paper which can help and give some guidance of how to integrate sustainable development and management considerations into hydropower planning, development and management. It also provides policy makers related to Theun Hinboun Hydropower Expansion with the kind of information they need in order to achieve a better understanding of the environmental, social and economical implications of hydropower developments and management.

2. HYDROPOWER DEVELOPMENT AND MANAGEMENT CONTEXT

The Lao PDR is in the midst of relatively rapid economic growth and natural resource development. Hydropower, mining and agriculture are major sectors. Urban areas are also growing as the population reallocate as a result of the commercial and industrial development in the major towns in Lao. As a result, there are increasing pressures on the environment and an increasing need to manage natural resources in a sustainable manner. The Hydropower generation has been expanded from 33 MW in 1975 (independent power production) to 1,937 MW in 2010. 99.8% of the power production is based on hydropower, 0.07% (1.51MW) from diesel generators and 0.02% (0.47MW) from Solar Power installations [7]. Currently, the electrification ratio in the country is approximately 80% or 1,060,413 households in 2012 and is expected to increase to 90% in 2020.

Hydropower has been perceived and promoted as a comparatively clean, low cost renewable source of energy that relies on proven technology [11]. Except for the reservoir development, which gives the hydropower a big water footprint, [4] it is a non-consumptive use of water. At the same time, the hydropower can also be viewed as a large ‘ecological footprint’ as it has substantial impacts on the natural environment because of its use and reliance upon the existing natural resources [5].Further, classified as a clean, renewable energy resource, hydropower can reduce the net production of greenhouse gasses by moving economies to a lower-carbon future by replacing other forms of power generation [6].

There are risks inherent with the development and operation of hydropower. These risks cover a range of financial, engineering, hydrologic, geological, and market concerns with particular attention to environmental protection, social aspects, resettlement and relocation of people. Hydropower reservoirs have a large number of potential cross-sectional impacts including changes of downstream flows and water quality, dam safety, reservoir fishing, resettlement, ecological impacts, and flood control [10, 11]. As a consequence of a wide variety of impacts and risks, the definition of acceptable hydropower development has changed into a situation where it is needed to ensure the core principles and parameters of sustainable development [8, 9].

2.1 Sustainable Development

The Brundtland Commission's report defined sustainable development as "a development which meets the needs of current generations without compromising the ability of future generations to meet their own needs". The concept supports strong economic and social development, in particular for the low income people. At the same time it underlines the importance of protecting the natural resource base and the environment. Economic and social well-being cannot be improved with measures that destroy the environment. Intergenerational solidarity is also crucial: any development has to take into account its impact on the opportunities for future generations [12].

Sustainable development requires the integration of three components – economic development, social development and environmental protection – as independent, mutually reinforcing pillars. Eradicating poverty, changing unsustainable patterns of production and consumption, and protecting and managing the natural resource base stressing the economic and social development are overarching objectives of, and essential requirements for sustainable development [12].

International organizations like the International Hydropower Association (IHA) [13] and the World Commission on Power Dams are among the international financiers [14] who have produced guidelines for how to promote greater consideration of environmental, social and economic aspects in the sustainability assessment of hydropower projects. This also accounts for the guidelines for the management and operation of existing hydropower schemes.

While there are disagreements on some aspects relating to WCD’s detailed recommendations, there is a clear acceptance of the core values listed in the report, which are equity, efficiency, participatory decision-making, sustainability, and accountability [13].

Also the values of precautionary approach and eco-efficiency to environmental management have been used in developing sustainable hydropower. The

precautionary principle and the principle that preventive action should be taken can guide the decision makers in the hydropower sector and eliminate some of the risks and uncertainties in the sector. [15].

Some of the precautionary principles are made in the Rio Declaration on Environment and Development, 1992, where it is stated that: Where there are threats of serious or irreversible environmental damage, the lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental damages. This statement may be extended to include any risk, such as economic, ecological or social risks [16]. IHA [13] believes that the evaluation of the hydropower generation options should be based upon life-cycle analysis of alternative technologies,, the scientific and technical uncertainties taken into account.

Eco-efficiency is based upon the idea that doing more with less – is the core of the business case for sustainable development. Combining environmental and economic operational excellence to deliver goods and services with lower external impacts and higher quality-of-life benefits is a key factor in pursuing sustainable development strategy for the hydropower business [17].

At the domestic level, good governance with sound environmental, social and economic policy, together with democratic institutions responsible to fulfil the needs of people, following the prevailing laws and taking the necessary anticorruption measures are carried out on the basis of sustainable development [17]. Sustainability is based on due considerations given to interrelationships and integration of competing needs. Therefore, it is of prime importance that the national and/or regional policy context takes into account all cross-sectional issues, for example through Integrated Water Resources management (IWRM) [17].

Hydropower development must adopt the dual perspective of integrated water resources management and sustainable energy development. [14]. Integrated water resources management is about strengthening frameworks for water governance to foster a good decision-making in response to changing needs. Here, the rather universal definition of IWRM "as a process that promotes the coordinated development and management of water, land and related resources in order to maximize the economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" is important [18]. Such decision support systems as IWRM are particularly appropriate and useful in hydropower development during the implementation process with a participatory, transparent multi-stakeholder approach [16].

Certain forms of benefit sharing (national-to local) should be used in order to achieve poverty reduction targets. This is important when poverty levels in hydropower project areas often are much higher than the provincial or national averages. This benefit sharing approach should be done for a period of time until poverty levels are reduced to acceptable levels. Only then it is possible to focus on other socio-economic issues that the authorities consider important [36].

The following figure shows the evolution in the view and treatment of power dam affected communities

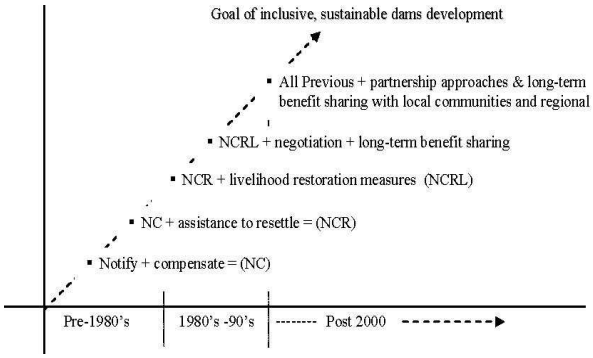

Fig. 1. Era of Typical Practice

The above figure illustrates the development in the hydro power sector the last three decades.

The Lao National Sustainable Hydropower Policy (NHSP) is founded on three important principles: (a) *economic sustainability* relies upon the maintenance of the renewable resource base, and the use of non-renewable resources to support the development of other factors of production; (b) *social sustainability* is based upon the principles of public involvement and participation, including, mutual understanding and consensus; (c) *ecological sustainability*, which relies upon the avoidance if irreversible environmental impacts such as the loss of biodiversity loss, accumulation of persistent pollutants, or disruption of ecological cycles [19].

3. METHODOLOGY

The paper is based on an empirical analysis of primary and secondary data and information; official government documents and relevant literature, a series of workshops of the Future Resource and Economy Policies in Lao PDR until 2020 as well as interviews with government officials and power sector and environmental experts.

4. SUSTAINABLE MANAGEMENT OF HYDROPOWER IN LAO PDR

4.1 Social and Environmental Sustainability

Hydropower development in Lao PDR needs to be sustainable with minimal adverse social and environmental impacts, while remaining a viable and profitable energy solution supporting the economic development in the country. When planning new hydropower projects, site selection, design, construction and operation of hydropower projects there is a need to consider the environmental and social impacts in a manner suitable to the environment and to the society. The Government is currently committed to reduce the existing dependence on fuel wood and imported fossil fuels by promoting to the extent possible to use renewable resources for production of electrical energy [20]. The rural Lao remains an essentially agrarian society, and the livelihoods of its people are strengthened

by the presence of healthy and diversified ecosystems that provide them with living sustenance and additional income. Therefore the issue of sustainability is an important one [21].

The Lao Government has developed and improved the domestic legislation related to the hydro power sector; the Law on Water and Water Resources (1996), Forestry Law (2007 updated), Land Law (1997, amended in 2003), Agriculture Law (1998), and Environmental Protection Law (1999) to deal with sustainability and environmental conservation issues. The present legislation together with various regulations ensures sustainable development within the hydropower sector.

According to the Environmental Protection Law (1999), and Decree on Environment and Social Impact Assessment No. 112 (2010), the hydropower projects with an installed capacity of more than 15 MW must produce an Environment and Social Impact Assessment (ESIA) Report and an Environmental Management Plan (EMP) [22]. The Electricity Law (2011) furthermore stipulates that investors in electricity production have an obligation to protect the environment; take the necessary social, environmental considerations. The assessment consists of the following main contents or sections: 1. Assessment of environmental impact in each case, together with proposals of methods and measures for solving or mitigating any adverse impacts on the environment, water resources, land surface or underground, ecology, biodiversity and aquatic and wildlife animals habitats; 2. an estimate of the damage and resettlement issues of people affected by the electricity project; 3. Means to mitigate the impacts of water volume, including the accumulated impacts of the downstream reservoir of the dam; 4. Cover the expenses for restoration of the impacts mentioned in section 1, 2 and 3 of this Article. These extra costs shall be incorporated into the total project cost [23]. Moreover, the recently enacted Lao Technical Electric Standards provides all the necessary guidelines to maximize power dam safety during construction, operation and management. The Lao ESIA process is largely compatible with international standards and guidelines for conducting ESIAs, and the bottom line is that construction activities cannot start before an approval from the Ministry of Natural Resources and Environment has been granted. [10]. The social and environmental safeguards used by the International Development Banks have enhanced the implementation processes of many hydropower developmental projects in Lao PDR, which in general lacks the necessary human and technical skills, and financial resources.

Concerning the Nam Theun 2 Hydropower Project, a lot of lessons has been learnt from previous experiences. Now, issues like environmental impact and resettlement have been addressed and have resulted in revised project preparation and implementation [25]. The aim of the National Policy on Environmental and Social Sustainability of the Hydropower Sector in Lao PDR now makes it possible to ensure that the principles of social and ecological sustainability are fully integrated into all large scale hydropower developments. Thus, it is now possible to replicate some of the experiences obtained from the Nam Theun 2 Project in other hydropower investment projects even though it is not possible to use the Nam Theum project as a standard [27].

It should here be mentioned that hydropower projects in the past did not allocate budget to secure for social and environmental sound sustainability solutions while the newer projects such as Nam Ngum 1 Hydropower Dam, allocated up to 8 % (62 USD million) of the project cost on the matter as an influence of the government policy and law on social and environmental management.

Several studies have been carried out on the economic environment of the relocated households and local communities around the hydropower sites. Most of the surveys indicate that the annual family income has increased approximately by 50%. Besides, the local communities changed their livelihood based on agricultural cultivation to other activities such as fishery, tourism, retail, and other commercial activities. As a result, not only family income has improved, natural environment and livelihood have also positively been influenced.

The following figure shows the average income by zones (2008-2011) for the Theum Hinboun Expansion Project (THXP) [39]

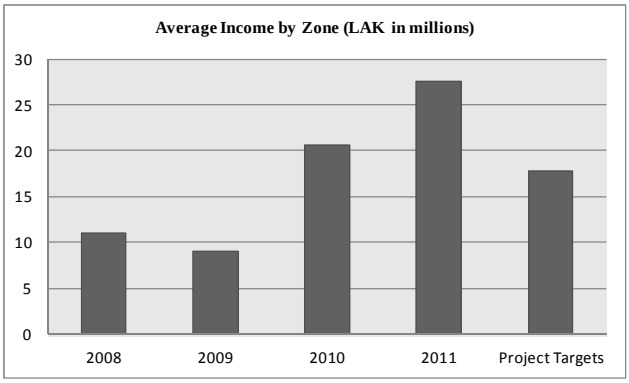

Fig. 2. Average income in all zones covered by the THXP region

Lessons Learnt from resettlement of Theun Hinboun Expansion Project

The planning for large Nam Theun 2 Hydro Power Project was a key factor in terms of introducing a resettlement policy in the Lao PDR. Prior to Nam Theun 2 Project no specific reallocation or resettlement policy was in place. Furthermore, the implementation of hydropower projects was not consistent with donor-funded project requirements for a wide range of studies and standards conditional to financing. Many projects were implemented with low levels of compensation and limited follow-ups. With regard to resettlement, the physical relocation of villages and people has primarily been based on providing the basic essential infrastructure, such as roads, with little long-term support for positive livelihood development. The Nam Theun 2 Project's resettlement Action Plan involved the draft of a Resettlement policy for the whole country. The WB and ADB, as well as other lenders, insisted that the project is prepared and implemented according to their

requirements.

A clear policy and institutional structure was required and the legislation needed for this was developed in 2003. The Theun-Hinboun Expansion Project's (THXP) feasibility phase started in 2003 and was prepared in accordance with the new resettlement policy and regulations.

The Theun Hinboun Expansion Project (THXP) is an expansion on the existing Theun - Hinboun Power project (THPP), which was the first private sector Build-Own-Operate-Transfer (BOOT) hydropower development in the county. It is located on the Nam Theun, a major river in the central Lao PDR, approximately 100 kilometres upstream of the confluence of the Mekong and the Nam Theun/Kading. From the Nam Theun basin water flows at a rate of 110m^3/sec and is diverted through a tunnel to a powerhouse (with a generating capacity of 220 MW) and then discharged through a tailrace canal and regulating pond into the Nam Hai, a tributary of the Nam Hinboun. The dam has a height of 25m and a 197m long overflow weir, creating a head pond which allows 15-million m^3 storage volume). This result is higher water levels along a 24-kilometre stretch of the Nam Theun, but not higher than the natural flood levels. As the dam has no flood zone due to the "run-of-the-river" design no resettlement of the population was required.

Resettlement Planning for THXP

The preparation of the RAP was carried out by consultants in accordance with ADB safeguard policies and requirements and Lao resettlement policy (2003). People involved in this project had the advantage of the completed studies and lessons learnt in preparing such documents from the NT2 project. The Company, THPC, was committed at the start to follow the prescribed guidelines and managed to develop high standards of social and environmental mitigation and sustainable development. The owners (20% Statkraft from Norway, 20% GMS of Thailand and 60% Electricite du Laos) provided funds for early preparation and even prepared the ESIAs before the final financing aspects were in place.

The entitlements for the Resettlement Action plan such as compensation for all forest and crops and other non-removable assets are now important elements A disturbance allowance was also provided together the transportation costs related all goods and commodities when reallocating to new locations. New houses were constructed in close consultation with resettles and communities. Houses between 60m2 and 70m^2 houses were constructed, and for each family a l800m2 housing plot was provided for vegetable production, fruit trees and small livestock, as well as one hectare for rice production land (potentially irrigated) and ½ hectare for upland crops.

Improved services (schools and health centres) were provided with 3 year health coverage, improved infrastructure - roads, water supply, electricity and community buildings, Technical Assistance for livelihood development. All commitments which resulted in an approximately 50% increase of average income compared to the pre-project incomes.

At Financial Close in October 2008, the Social and Environmental Division (SED) of the THXP had over 100 fulltime and seconded government staff work on consultations, health, social management, infrastructure, agriculture and environmental monitoring programs. Resettlement of the first group of 156 households from the two villages closest to the dam construction site was undertaken from March to May 2009, less than six months after the financial agreements was signed. All the necessary planning had been done well in advance, and many social programs were started and partly implemented before the construction activities for the power plant started and there were other serious commitments to improving lives and livelihood for the involved and affected people. In general, the following parameters were used:

- Flexibility in implementation details based on sound principles and legal requirements;
- Lengthy and detailed consultations with resettlers and host villagers;
- Additional measures for addressing vulnerable groups and small ethnic minorities;
- Livelihood activities started-up immediately after relocation to the new location;
- Completion of compensations and other payments were done as promptly as possible;
- Implementation of a monitoring system of key indicators to show changes and progress each year.

Successful Aspects of Resettlement Implementation

A number of actions were carried out during preparation and implementation that turned out to be successful in achieving goals and positive results. Examples to be explained in this paper will be limited to:

- Preventative measures - Setting up programs prior to construction start up activities can be broadly classified as "preventive measure" as their aim is to avoid potential negative impacts.
- Staffing up – the THXP has the advantage of using existing staff from the first project;
- Participatory approaches - Site Selection Participatory and public approaches take more time and are open-ended by nature, potentially posing and challenge to project development and implementation.
- Establishing procedures and formats. During implementation phase , managers focused on carrying out programs and are applying on system to be in place to enable them to work efficiently and effectively;
- Monitoring approach. THXP was planned with one very important goal in mind: to show that a large hydropower project with resettlement and other impacts can be successfully mitigated and project affected persons could indeed become project beneficiaries [38].

The policy promotes an integrated approach to river basin management with multiple projects on a single

river. Cumulative impacts are to be recognized and measures required for their mitigation. Some of the main elements of the policy are a broad definition of project affected people and their right to sustainable development options, free prior and informed consultation, disclosure of project consultation reports, compliance with oversight from third-party agencies, and project revenues to cover the costs of environmental and social safeguards through the Environmental Protection Fund (EPF) established in June 2005 [28].

The Environmental Protection Law stipulates an EPF (2011), which has specialized funding "windows" for the collection, management and distribution of funds from large-scale water developers such as hydropower. Hydropower projects are supposed to contribute a percentage of the revenues to the Environment Protection Fund, which would then distribute the funding to ensure institutional capacity building, environmental and biodiversity conservation programs. Some of revenue from Nam Theun 2 Hydropower Project now flows to the EPF [27]. The fund, however, has not been functioning properly, but the mechanism could potentially serve as a model for direct benefit sharing with affected and involved communities [27]. The establishment of the first Watershed Management Protection Authority in Lao PDR is also a result of the accomplishment of the Nam Theun 2 project. This Authority is responsible for the management and protection of the watershed of the Nam Theun 2 above the reservoir formed by the Nam Theun 2 hydro-electric dam [25].

The Lao EIA process is largely compatible with international guidelines for conducting EIAs. However, there is some unclear division or split of responsibility among various agencies, inadequate human and financial resources and inconsistency of legislation and regulations. In response to these deficiencies the Government has recently promulgated the binding approval of the environmental and social impact assessment (ESIA) and the related Compliance Certificate, as part of the concession acquisition process [27].

The key legal institutions and frameworks are in place in the hydropower sector in Lao PDR, they tend to be constrained by low institutional capacity. Shortage of human resources at key sector regulatory agencies including Water and Resources Environment Administration, Ministry of Energy and Mines and provinces have been a bottleneck for preparing environmental studies and social sustainability surveys in cost-effectiveness way and in compliance with relevant government policies and decrees [27]. There is a need to conduct thorough capacity assessments and prepare capacity building plans and to ensure proper funding for these activities. Comprehensive training activities and implementation of operational practices will be required. There is also a need to develop capacity for operation and maintenance after the concession period ends.

Major gaps remain between the formulation and implementation of legal instruments, and between the establishment and enforcement of rules and regulations. Important issues to be raised are the implementation and enforcement of the existing environmental regulations and building of enforcement and monitoring capacity related to the hydropower sector. Implementation capacity for ESIA procedures needs to be strengthened within Ministry of Natural Resources and Environment and other relevant ministries. Especially, capacity building to monitor the implementation of environmental management and mitigation processes is highly required as well as awareness building of all actors at all levels to protect the environment.

ESIA still frequently fails to influence decision making, like for example, the case of Theun-Hinboun power dam shows [14, 21, 29, and 30]. There is a need to improve environmental governance at the same pace as current trends in foreign direct investments in the hydropower sector. There is also a need to encourage companies and other investors to commit to a high standard of investment policy and socio-environmental performance. By the approval and the use of the new ESIA Decree, ESIA procedures and process will become more transparent, including clear responsibilities of key agencies and project owners; (who is doing what and when?). Also the role of MONRE as the third-party regulating agency for all stages of approval and monitoring need to be strengthened, so it is possible to have clear requirement for social impact assessments, public involvement, and disclosure [27].

What is Lao PDR's energy roll-out strategy for the next ten years, and why does hydropower play such an important part in the strategy?

The 2 main objectives of power sector development in Lao are: (1) to supply reliable and affordable power to all sectors of the domestic demand. Electrification ratio reached 73% or 756,604 households in 2010, increased by 15% compared to year 1995; The power ratio is expected to reach 80% in 2015 and 90% in 2020; (2) to export excess electricity to provide a source of revenues to fund the economic and social development in country and alleviate poverty.

Installed capacity was 200 MW in 1995 and would be 3,200 MW in 2012, and about 75% of this capacity is devoted for export. Furthermore, it is goal to export 12,500 MW or more than 85% of total installed capacity by 2020, substantially all from new hydropower plants;

Lao PDR chooses hydropower because we have large hydro potentials; hydropower is clean, zero carbon emission and because hydro power is a renewable energy source; hydropower offers more than power generation: No other method of generating electricity can create opportunities for providing water for human consumption and flood control, while generating clean and inexpensive electricity; hydropower is also a non-consumptive use of water solution. Furthermore, the hydropower sector makes contribution of 33% of the GDP in Lao PDR (Wealth and Sustainability – Background Paper on Lao PDR Development Report 2009 by World Bank Group); nobody wants to stay an LDC, and if Laos wants to leave the Least Developed Country list by 2020, what other choices do we have? The only concern is to develop hydropower responsibly, conformed to sustainability criteria and with the Water, Food and Energy nexus approach [34].

If Lao PDR wants to become the battery of SE Asia, what is the biggest challenge it faces in the next decade? And how do we plan to overcome this challenge?

Along with the development of large hydro power projects, we need to expand interconnections to the neighbouring countries to facilitate the present export of power, first on project-by-project basis and, ultimately, realizing the goals of integrated development and operations within Greater Mekong sub-region (GMS) and ASEAN.

The challenges: Interconnected High Voltage transmission infrastructures (network) are required to enable flexibility and reliability in dispatching the energy; in addition to the regulated environment, huge amount of investments are needed – substations and transmission lines – are necessary requiring equally huge amounts of financing resources. Large initial investments are required while long pay-back periods are expected.

Lao Government strategy: Grants and concessionary loans would be preferable to facilitate the development of the power transmission system, but investments by private sectors are also welcome and may also be needed at the initial stages of the interconnections, by individual independent power producers (IPP's) due to the different timeframe of generation projects.

We are furthermore convinced that the GMS/ASEAN power grids would be successful implemented because increased energy interdependence improves the relationship between countries and decreases risk, again improving the general investment climate in the country. The establishment of GMS/ASEAN grids will further support the optimum use of energy resources. Presently, 80% of all power generation in the region is non-renewable, causing many environmental problems such as increased emission of greenhouse gasses, acid rain, toxic wastes, etc. There is a great deal of complementarities in the energy sector in South East Asia; for example, Lao PDR, Vietnam and Thailand could develop and utilize a combination of thermal and hydropower more efficiently through regional agreements. The 12,500 MW or 60,000 GWh of electricity generated using clean and renewable hydropower from Lao PDR will furthermore make an contribution to the reduction of 30-60 mil tons of CO2 emission every year, and the saving of 5 mil toe/y of fossil fuels in this region [34].

Institutional structures for oversight and monitoring include multiple government agencies have to be developed, yet there are evidently major gaps in implementation, some due to unclear and/or overlapping institutional responsibility mandates. There is a need for stronger vertical and horizontal institutional coordination across the government agencies and for building capacity to improve and enhance environmental and social monitoring activities. To develop financially sound hydro projects those are both socially and environmentally sound and will improve the living standards of Lao people.

4.2 Economic Sustainability

There can be no sustainable development and good management without the demonstration of sound and equitable distribution of the economic benefits. For this reason economic considerations are essential in the decision-making processes associated with hydropower projects. The efficient use of economic resources requires that the best options are selected, that the alternatives have been carefully evaluated, and that there are no hidden and unforeseen costs that could emerge in the future.

Currently, energy demand growth has been rapid and the availability of confessional funds and grants of international development banks is not keeping pace with the increasing capital requirements of the power sector. Restructuring and reform of the energy and water sector in many countries including Lao PDR has changed the role of government in decision-making and planning, allowing private investors and corporations taking both financing and ownership roles in these projects [14].

The existing problems and weaknesses in private financing models (planning and procurement) can a negative impact to economic sustainability and effectiveness in Lao PDR. Promotion of independent power producer (IPP) projects in Lao PDR begins with an unsolicited proposal from a sponsor and, from this, a memorandum of understanding is drawn up and a concession ultimately negotiated. Concessions are awarded in the absence of competition after the sponsor has completed technical and environmental studies of the proposed project [31].

The private sector involvement on a significant scale however introduces problems for power planners in managing the uncertainty of IPP commercial operation date (COD) and a means of countering this risk must be found in order to ensure the private sector's role in domestic generation development to be dependable and constructive [31]. Delays in CODs lead to increases in interest accumulated on funds borrowed for construction activities and to delays in revenues accruing to the owner from the completed project [14].

Overall, the failure of project delivery (IPP) can be seen as one of problems related to the practice of awarding mandates for IPP projects as an unsolicited, negotiated transaction based on a BOT modality. Problems related to this approach include the lack of transparency and competition, the failure to filter out projects inconsistent with IPP program objectives, insufficient government control of project development, lack of government's capacity to assess competing development proposals and evaluate associated opportunity costs, a high degree of uncertainty on project outcomes, and unnecessary time commitments for all parties in Lao PDR [27, 31].

Developing new financial models require strong independent regulation and integrated resource planning [32]. There might be a need to establish a regulator to set domestic retail tariffs and negotiate wholesale export tariffs. Currently import tariffs are higher than export tariffs. The establishment of a regulator would mean tariffs could be pre-set before bidding power generation

concessions and bidding would therefore be on some other criteria's, perhaps the highest royalty payments. Also, a creation of a centralized Lao power purchasing agency or cooperative that could competitively bid power concessions within Lao PDR and could sell the off-take from some or all Lao power generation projects to domestic and/or foreign power purchasers is needed [31].

For Lao PDR it is important to develop a policy that defines the standard method for determining the fiscal benefits from hydropower projects. The Government needs to ensure that the less direct and longer-term benefits of hydropower projects are not overlooked in the planning process or penalized by short-term financing or tax regime requirements. With new developments, capital and operating costs should be taken into account over the lifetime of a project with a life-cycle assessment of project alternatives forming an integral component of assessment processes. Direct and indirect costs and benefits should be identified, and where possible quantified in monetary terms [33].

The Nam Theun 2 project cost US$1.29 billion, of which US$733 million was used for construction, US$383 million was for the combined financial and advisory costs, another US$94 million for NTPC management, and the remaining US$80 million was for environmental and social cost.

The project development followed the World Bank's guidelines regarding environmental and social practice. Project development regarding the care of the environment and local communities will serve as an example for future projects of a similar nature. The Lao Government will earn annual revenue of US$2 billion throughout the 25 year concession period. The projects assets such as the power plants will be handed over to the Government after the concession ends, under the build operate transfer basis.

In 2012 Nam Theun 2 expects to provide revenue of US$27 million in royalties and dividend to the Lao government. Last fiscal year the company paid US$19 million in resource use charges and dividend. The previous year, the company paid US$5.4 million to the government.

With a strong commitment to the World Bank and the Asian Development Bank, the Lao Government will spend money on poverty reduction, education and healthcare services so that is can achieve the millennium development goals in 2015.

Lao PDR has seen progress in poverty reduction in the country over the past five years. This fiscal year, Laos expects to see a 2% drop in poverty to 22 percent thanks to the booming growth of the mining and hydropower sectors, which have created conditions for people to earn a better living.

Despite the strong economic growth over the past several years, Laos in one of the least developed countries in the world and still relies on foreign assistance.

The country needs about US$700 million as Official Development Assistance (ODA) per year so that it can achieve UN millennium development goals in 2015. The ODA accounts for about 30 to 40 percent of the total investment. The Government highly values the foreign assistance and contribution of development partners in the past but it want to build its own economy and strength. Today, the world economy is volatile, posing challenges for the least developed nations to survive [35].

5. CONCLUSIONS

The Lao country's abundant water resources and mountainous terrain have allowed the Government of Lao to set up a master plan to develop hydropower and export large quantities of hydroelectric energy. Quick growth and steep forecasted size of the energy sector with respect to the economy and Government's revenues will put a lot of pressure to develop institutional environment, policies and fiscal framework to properly use natural resources in Lao PDR's development strategy. When planning and developing hydropower sector investment, ongoing development of the legal, institutional and regulatory environment and strengthening of the institutional capacity and improvements in the commercial position of EDL are issues to be considered in Lao PDR (FREPLA2020, 2009a).

Major problems of Lao hydropower sector relate to lack of capacity and poor institutional environment, such as insufficient quality of environmental and social assessments, ineffective regulatory framework, a lack of transparency, and the failure to conduct comprehensive consultations with all stakeholders. The opportunities and challenges of hydropower development are complex, and ultimately dependent on the resources, skills, and will to invest responsibly, with due regard to economic, environmental and social aspects of sustainable development and management. The governance gap remains a crucial challenge that will increase over time if the government does not take strategic and continued actions to enhance governance and institutional capacity. There is a need to better assess strategically the hydropower development options for Lao PDR and the use of hydropower development generated revenues to poverty reduction activities. The collective benefits to the country can be maximized if individual hydropower investments are assessed as part of a river basin approach (to understand cumulative hydrological, environmental and social impacts, as well as to increase the economic potential for any given level of impacts) as well as the energy sector development strategy (The World Bank, 2010c, p. 11).

Also there is a need for integrated planning approach which takes into account mining sector development as these sectors are closely interwoven mining sector being dependent on energy sector for its production. The mechanisms for accountability and democratic control and the needs for participatory approaches to hydropower planning and management need to be well recognized and to be strengthened in Lao PDR. Processes and activities related to risk assessment and management need to be established and developed in the energy sector. Currently the risk management lies on private sectors/investors shoulders and as for the risk

management the Government has been relying on the multilateral development banks (H.E Somboun Rasasombath, 2010). There is need to conduct research related to this issue and to designate and define clear responsibilities of the risk assessment and management activities to the hydropower sector organizations.

The Lao Government has, during the recent years, put utmost efforts to enhance the integration of social, environmental, and economic benefits to all beneficiaries. It is evidenced that several laws and regulation have been issued, with close monitoring on implementation. The outcome is continuously being improved.

Obviously, sustainable management of hydropower can be achieved by balanced consideration of environmental, economical and social factors. The main goal of sustainable management of hydropower is to maintain adequate renewable hydro resources for sustainable electric power generation, and hence, to ensure sustainable revenue for the country. Besides, public involvement and participation, benefit sharing, setup workable institutional support and mechanism are also among the crucial factors for sustainable management of hydropower.

Lao PDR can and should definitely use its large hydropower advantages but should also learn a lot from other countries in relation to development of hydropower and from past mistakes. The country can draw on the lessons that are emerging from the Nam Theun 2 Project and Theun Hinboun Expansion Project which can generally provide a best practice example in socio-economic and environmental management of hydropower projects

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APPENDIX

Table A1. The existing and planning hydropower projects for EdL

No	Name of Project	Installed Capacity MW	Status	
			Progress	Commercial Operation
1	Nam Dong	1	In Operation	1970
2	Selabam	5	In Operation	1970
4	Se Xet	45	In Operation	1990
5	Nam Ko	1.5	In Operation	1996
3	Nam Ngum 1	155	In Operation	1997
6	Nam Leuk	60	In Operation	2000
7	Nam Mang 3	40	In Operation	2004
8	Se Xet 2	76	In Operation	2009
9	Nam Xong (Expansion)	6	Plan	
10	Selabam (Expansion)	7.7	Plan	
11	Se Xet 3	23.96	Plan	
12	Nam Ngum 1 (Expansion)	40	Under Constn.	
13	Nam Boun 2	15	Plan	
14	Viengphouka (Fire coal)	150	Plan	
15	Houay Lamphan Gnai	88	Under Constn.	
16	Kangsuaten	45	Plan	
17	Se Xet 4	8	Plan	
18	Nam Hinboun 1	40	Plan	
19	Nam Khan 2	60	Under Constn.	
20	Nam Khan 3	60	Plan	
21	Nam Chainh	100	Plan	
22	Nam Phark	30	Plan	

Table A2. Existing and planning IPPs in Lao PDR

No	Name of Project	Installed capacity (MW)	Annual Average Energy (GWh/y)	Status	
				Progress	Commercial Operation
1	Theun-Hinboun	220	1560	In Operation	1998
2	Houay Ho	152	450	In Operation	1999
3	Nam Lik 1-2	100	435	In Operation	2010
4	Nam Theun 2	1080	6000	In Operation	2010
6	Nam Ngum 2	615	2300	In Operation	IOD 2011 COD 2012
7	Xekaman 3	250	982.88	• CA Signed 4/1/2006	2012
8	Nam Ngum 5	120	507	• CA Signed 10/4/2007	2012

9	Theun Hinboun Expansion	280	4563	• CA Signed 27/8/2008	2012
10	Tad Salen	3.2	17	• CA Signed 3/2/2009	2012
11	Hongsa Coal-Fired	1878	12582	• CA Signed 3/11/2009	2015
12	Xayaburi	1285	5990	• CA Signed 29/10/2010	2019
13	Xekaman 1	322	1098	• CA Signed 10/2/2011	2015
14	Nam Long	5	37	• CA Signed 21/3/2011	2013
15	Nam Sim	8	34	• CA Signed 13/06/2011	2015
16	Nam Ngiep 2	180	723	• CA Signed 18/8/2011	2015
17	Nam Ngum 3	460	2047	• PDA Signed 15/11/1997	2018
18	Nam Theun 1	523	2016	• PDA Signed 28/11/2004	
19	Nam Ngiep 1	290	1507	• PDA Signed 27/4/2004	2018
20	Xe Katam	61	380	• PDA Signed 20/12/2007	2016
21	Nam Ou 1-7 (Cascade)	1156	5064	• PDA Signed 15/10/2007	2016
22	Donsahong (Mekong)	240	1756	• PDA Signed 13/2/2008	
23	Nam Mo	120	516	• PDA Signed 30/3/2008	2015
24	Nam Lik 1	60	256	• PDA Signed 8/4/2008	
25	Nam Sane 3	65	440	• PDA Signed 19/6/2008	
26	Nam Kong 1	75-150	469-563	• PDA Signed 23/6/2008	
27	Sekong 4	300-600	1901-2119	• PDA Signed 23/6/2008	
28	Xepian-Xenamnoy	390	1788	• PDA Signed 14/11/2008	2018
29	Se Kong 5	330	1613	• PDA Signed 19/6/2009	
30	Nam Phak	45	307	• PDA Signed 6/11/2009	
31	Nam Beng	34	137	• PDA Signed 10/3/2010	
32	Nam Mang 1	57	201	• PDA Signed 20/5/2010	2015
33	Nam Tha 1	168	721	• PDA Signed 16/6/2010	
34	Nam Seuang 1	63	320	• PDA Signed 11/8/2010	
35	Nam Seuang 2	141	718	• PDA Signed 11/8/2010	
36	Nam Pha	130	594	• PDA Signed 20/8/2010	
37	Phou Ngoy (Mekong)	651	3278	• PDA Signed 7/12/2010	
38	Sanakham (Mekong)	660		• PDA Signed 27/12/2010	
39	Pakbeng (Mekong)	855	4846	• PDA Signed 27/12/2010	
40	Xenamnoy 1	15	100	• PDA Signed 28/1/2011	
41	Nam Kong 2	66	263	• PDA Signed 16/03/2011	2014
42	Nam Sum 1	102	1015	• PDA Signed 19/09/2011	2016
43	Nam Sum 3	186	244	• PDA Signed 19/09/2011	2016
44	Nam Phay	60	429	• PDA Signed 20/12/2011	
45	Nam Ham	3.5	14	• MOU Signed 6/4/2005	
46	Xe Neua	53	209	• MOU Signed 16/5/2006	
47	Xekaman 4	80	315	• MOU Signed 19/12/2006	
48	Nam Feuang	28	113	• MOU Signed 3/4/2007	
49	Nam Bak 1	160	744	• MOU Signed 11/4/2007	
50	Nam Bak 2	40	205	• MOU Signed 11/4/2007	
51	Pak Lay (Mekong)	1320	5948	• MOU Signed 11/6/2007	

52	Louangprabang (Mekong)	1410	7380	• MOU Signed 13/10/2007	
53	Dak Emeule	130	525	• MOU Signed 8/1/2008	
54	Se kong 3 (3 A)	105	410	• MOU Signed 29/1/2008	
55	Se kong 3(3 B)	100	393	• MOU Signed 29/1/2008	
56	Ban Koum (Mekong)	1872	8433	• MOU Signed 25/3/2008	
57	Nam Ngum 4	220	822	• MOU Signed 30/3/2008	
58	Xebanghieng 1	50	197	• MOU Signed 25/11/2008	
59	Xebanghieng 2	52	198	• MOU Signed 25/11/2008	
60	Nam Phoun	74		• MOU Signed 5/12/2008	
61	Nam Ma (1, 1A, 2, 2A, 3)	149	605.1	• MOU Signed 30/12/2008	
62	Thakho	50	360	• MOU Signed 17/3/2009	
63	Houay Champy	5		• MOU Signed 26/5/2009	
64	Nam Kong 3	45	170	• MOU Signed 31/8/2009	
65	Nam Neun	65		• MOU Signed 8/10/2009	
66	Nam Pot	15	70.5	• MOU Signed 26/11/2009	
67	Nam Ngiep Muang Mai	38		• MOU Signed 25/2/2010	
68	Nam Mouan	124	524	• MOU Signed 26/2/2010	
69	Nam Mo 1	60-80		• MOU Signed 4/3/2010	
70	Xepian-Houay Soy	100	250	• MOU Signed 30/3/2008	
71	Se Kong Downstream	80		• MOU Signed 26/8/2010	
72	Nam Phouan	60		• MOU Signed 24/9/2010	
73	Nam Poui	60	294	• MOU Signed 6/10/2010	
74	Nam Ang Thabeng	30		• MOU Signed 15/03/2011	
75	Xelanong 1	80		• MOU Signed 28/06/2011	
76	Nam Et 1,2,3	420		• MOU Signed /2011	
77	Nam Nga	80		• MOU Signed 11/11/2011	