Maintaining the Productivity of the Mekong River by Improving Sediment Passage and Fish Passage through Hydropower Dams:

Issues in Economic & Financial Analysis

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Contents

Abbreviations

ADB	Asia Development Bank
CBA	Cost-benefit analysis
cumecs	cubic metres per second
EGAT	Electricity Generating Authority of Thailand
ERR	Economic rate of return
EU	European Union
EVN	Electricity of Vietnam
FRL	full reservoir level
FS	Feasibility Study
HFO	heavy fuel oil
IBRD	International Bank for Reconstruction and Development (World Bank)
IDC	Interest during construction
IFI	International Financial Institution
LLO	Low level outlet
MCM	million cubic metres
MDB	Multilateral Development Banks (ADB, IBRD)
MIGA	Multilateral Investment Guarantee Agency (member of the World Bank Group)
PPP	Public-private partnership
WTP	Willingness-to-pay

Economic and Financial Analysis

1. Background

1. To play a credible role in the dam development dialogue, it is necessary to have the ability to assess how alternatives alter costs and benefits and their distribution among actors and stakeholders compared to the current plans and existing operations. Modifying the site, design or operation of a hydropower dam to facilitate sediment and fish passage will entail larger capital costs for low level gates, for instance, larger O&M costs throughout, and reduced power output during sediment flushing operations. These economic costs will be offset by the extended lifetime of the asset, perhaps by decades. In other words, short term costs are offset by long-term power generation and fishery production benefits. Whether the ledger will provide a net-benefit over the life cycle of the facility, and the time value of the costs and benefits, are the issues that require analysis. These need to be quantified to understand the tradeoffs and their distribution among the various stakeholder interests.

Stakeholders

2. The first task is to indentify the stakeholders, whose income and expenditures will be affected:

- The ***developer*** of the hydro project: which may be a private entity, a public-private partnership (PPP), or a government owned company (perhaps a subsidiary of the main state-owned utility)
- The ***government***: which, depending on circumstances, may need disaggregation into the central, provincial and local government, or even a government–owned intermediary who buys power from the producer, and sells it to the foreign buyer (with the difference accruing to the government as the resource rent)
- The ***buyer*** (which may be EGAT or EVN in the case of export projects, or the local utility)
- To the extent that incremental costs (or benefits) are passed through to consumers of the hydro electricity produced, electricity ***consumers***.
- In the case of export projects requiring a dedicated transmission line, synchronised with the grid of the importer, the owner and operator of the ***Transmission*** link (who may or may not be the importer himself).
- ***Project affected persons (PAFs)***: those immediately affected by the project, whose livelihood or residence may be affected (those who must be resettled, or who lose land from inundation).
- ***Downstream stakeholders***: such as Mekong delta fishermen, whose livelihoods may be altered as a consequence of changes in flow regime.
- The ***International financial institutions*** – that include the multi-lateral banks (ADB, IBRD), bilateral export-import banks (such China EXIM bank, JBIC), or other donors who provide debt finance at concessionary rate (or who provide other credit enhancements (such as MIGA and IBRD) that provide political risk insurance and partial risk guarantees (PRG).
- The ***global community*** because hydro projects typically displace thermal generation and therefore benefit the global community through lower GHG emissions (and who may provide revenue from the sale of carbon credits)

3. In some cases these identifications are not as clear as this list suggests. The multi-lateral banks have private sector arms (such as IFC in the case of the World Bank, or the ADB private sector operation) that may provide equity, and whose interests are therefore aligned to that of the developer rather than to that of the debt provider.

Basic concepts

4. Several basic concepts require clarification at the outset:

- **Concessionary finance**: is any finance that is provided to government under terms and conditions that are more favourable than the risk-adjusted market rates through the private sector. "More favourable" means longer loan tenors and lower interest rates than would be available in the marketplace. Several ASEAN countries have active domestic bond markets which set the yardstick for the cost of Government borrowing:[1] middle income countries may even raise bonds in foreign countries.[2] One of the main motivation for PPPs involving the international financial institutions is the access to lower-cost debt that this provides – albeit offset by the transaction costs of dealing with IFIs.
- **Opportunity cost:** best illustrated by example. When a hydro project hires otherwise unemployed rural labourers to work on a construction site for unskilled tasks, the financial analysis would book this transaction at whatever is the rate of pay provided. But the economic analysis would book this cost at zero – because society has not given up any other economic benefit (given that these workers are otherwise unemployed). In other words the opportunity cost of a good is that which must be given up to use a resource in some other action.
- **Economic v. financial analysis:** these are often thought to be separate areas of analysis, but in reality they are not.[3] In economic analysis, resources are priced at their economic opportunity cost, in financial analysis at their market price. For example, in *economic* analysis, the price of gas (relevant here because hydro in Laos and Cambodia will largely replace gas-generation in Thailand and Vietnam) will be set at the international price (set in the Mekong region by the Asia-Pacific LNG trade,[4] but in financial analysis at the actual price (which may be highly subsidised). The difference between the two represents a subsidy. Thus economic and financial analysis are linked by so-called transfer payments (e.g. when a developer pays import duty on imported equipment, there is a flow of cash from developer to the government), but no real resources (labor, capital, natural resources etc.), have been consumed.[5]

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1 See, e.g., www.asianbondsonline.adb.org. Neither Laos and Cambodia has a developed domestic bond market. However, at the time of writing (may 2014), the Thai 10-year Government bond trades at 3.6%, the Vietnam government 10-year bond at 8.75%.

2 For example, the Indonesian utility PLN raised US$2billion in medium term bonds (rated BB by S&P, Baa3 by Moody's) at 8%.

3 One of the reasons why one might think this is the case is that financial analysis is usually conducted at nominal costs (i.e. with explicit assumptions about future inflation and changes in exchanger rates), whereas economic analysis in usually presented at constant costs (assuming no inflation). But there is no intrinsic reason why economic analysis cannot also be done at nominal prices; or indeed financial analysis at constant prices. Indeed ADB prepares so-called project financial return (at constant prices), which add back in transfer prices to the economic flows, ignore the precise financial structure, and then compare the resulting financial rate of return with some estimate of the weighted average cost of capital (WACC). However, such analysis is of little interest to private developers, who are interested in the returns to their equity, given the actual financial package proposed for financing.

4 Or at the domestic production cost, adjusted for resource depletion premium

5 Nevertheless it is worth noting that there is disagreement as to whether some types of expenditure are, or are not, transfer payments. Some authorities state categorically that insurance is a transfer payment (since it simply involves payment from all those who are insured to the one that actually incur the loss). Others state categorically that it is not (and just reflects the average incremental cost of an asset that suffers some known rate of loss)

5. Private entities are of course mainly interested in financial analysis, but Governments (and the IFIs) are (or should be) motivated primarily by the economic analysis which takes the perspective of the national interest.

2. THE MAIN BUILDING BLOCKS OF THE PROPOSED MODEL

6. The financial model to be constructed for our project takes the form of a set of inter-linked sub-models, each of which provides a representation of the financial transactions of the main stakeholders.

Macroeconomic assumptions

7. Always the first block of any model. This will need to set out the main exogenous assumptions for the global economy and for each of the countries in the region.

- *International energy prices*. The best generally accepted fuel price forecasts are those provided in the International Energy Agency (IEA) annual Global Energy Outlook.
- *OECD Inflation*
- *Inflation and economic growth forecasts for each country*.
- *Exchange rate forecasts*: changes are most simply modelled as the differential between OECD and national inflation

The hydroproject

8. The first substantive building block is the analysis of cash flows from the perspective of the developer of the hydro project, which requires knowledge of

- The financial structure of the project - who provides equity (and their respective target equity returns), who provides debt, and under what terms and conditions (interest rate, loan tenor, commitment[6] and other financial fees)
- The costs of construction and operation - with explicit consideration of that part of cost accounted for by import duties, VAT etc, and with a breakdown of local and foreign currency (FOREX)
- In the case of hydro projects, the direct costs of relocation and resettlement of project-affected persons – the magnitude of which will depend upon the adequacy of Government compensation policies (or of the requirements stipulated in the safeguards policies if international financial institutions (IFIs) are involved).[7] The incremental costs of other environmental features (low level outlets for flushing, fish ladders etc) would also be recorded.
- The relevant rules of taxation (water royalties, corporate income taxes, restrictions of payments of dividends overseas, and any other payments required by the concession agreement, depreciation rules, tax holidays etc)
- The expected value of generation, disaggregated by hour of the day and season. This will be a function of the operating policy that may alter in

6 Commitment fees often levied bank banks (and the IFIs in particular) as a charge on undisbursed loan balances.

7 Such as are required by the World Bank or the ADB, or even by private banks in the OECD countries who subscribe to the so-called "equator principles", which is a credit risk management framework for determining, assessing and mitigating social and environmental risk in project finance transactions.

response to the expected structure of the power purchase agreement (PPA) which may provide incentives to maximise operation during peak hours.

9. The presumption is that the private investors, whether foreign or domestic, will seek to optimise the design in such a way as to maximise the financial return to equity, but in any event meet minimum target returns that are influenced by the investor's perception of risk.

10. The output of such a financial model will provide information on the tariff that is necessary to meet the revenue requirements of the project given the target equity return required by the investor and other constraints as may be imposed by lenders (debt service coverage ratios, escrow account requirements[8]).

11. As noted, such a financial model will be in nominal terms, hence the requirement for estimates of local and FOREX inflation and exchange rates. It would not be unusual for tariffs to have both a local currency and foreign currency component.[9]

The Government

12. The second sub-model records all of the transactions involving the Government (which mirror the transactions recorded in the books of the counter-party in standard double entry bookkeeping). These transactions include

- Equity contributions to the hydro IPP (or if entirely publicly financed, the entire amount of equity required).[10]
- Dividends from any equity investment
- Receipts of corporate income tax, royalties, concession fees
- Resource rents (see below)
- Operating costs and revenues for the hydro project once handed over to the Government at the end of the concession period

13. The presumption is that the Government desires to maximise its total revenue. But unlike the interest of the developer, where the rate of return – in effect the discount rate – is the variable to be maximised, and which provides the appropriate measure of how to weight cash flows occurring at different times, in the case of Government this is not straight-forward. Increased costs in the short run to manage reservoir sedimentation may bring distant benefits in the future, but what discount rate should be applied to evaluate the trade-off? This is discussed in Section 3.

The buyer

14. A detailed representation of the buyer's perspective is necessary in order to assess how much he is willing to pay for hydropower, as compared to the next best alternative. In Thailand this will be combined cycle gas, in Vietnam either combined cycle gas or a combination of imported coal or nuclear plus pumped storage. This model would have the same set of general features as the financial representation of a hydro project, but with the following additional components;

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8 Depending on lenders' conditions, a large hydro IPP may be required to fund escrow accounts for debt service and major maintenance (for major turbine runner overhauls) before paying out dividends.

9 For example in the NT2 project, the PPA with EGAT and the project company stipulates part of the tariff is in Thai Baht, part in US$.

10 The Government of Laos has a 20% equity share in the Houay Ho project, and 60% in the Theun Hinboun project. In the case of the NT2 project, the Government established the Lao Holding State Enterprise (LHSE) to hold its 25% equity share.

- Fuel costs, to be linked to a forecast of international energy prices or domestic fuel prices, as the case may be.
- Estimates of the externality costs of thermal projects – which involves calculations of GHG emissions and emissions of local air pollutants (NOx, PM_{10} and SOx)
- Calculations of implied subsidies (if any) associated with subsidised fossil fuels.

Transmission

15. The inability to synchronise the Laos and Cambodia grids with one or both the main potential customers (Thailand and Vietnam) remains a major hurdle for an efficient design of regional power trade in the region. All of the major export projects now being considered, such as the 1,285 MW Xayaburi project (mainstream Mekong in Laos, also serving EGAT), require dedicated transmission lines synchronised to the importing country.

16. Such transmission projects are easily modelled, together with the necessary adjustments to account for transmission losses: for example, power from a series of hydro projects in Laos will be evacuated by a 500kV line connected to the Vietnam 500kV grid at Pleiku.[11] In this case the transmission is to the account of the Government of Vietnam owned National Power Transmission company. It may be in the case of long export distances that HVDC transmission would be the best choice: where distances warrant, as little as 1,500MW can already justify HVDC.[12]

3. Issues

Assessing the impact of environmental safeguards

17. We here use the term "environmental safeguards" in the broadest sense as that package of incremental costs or changes in operating policy as may be desired (or required) to secure public policy objectives other than maximising hydro production (the developer interest) and Government revenues (the Government's main objective). The most immediate issue is to protect the interest of PAFs by an adequate policy of relocation and resettlement (R&R) compensation where homes and land is lost to a hydro project.

18. In this project we need to consider a much broader set of such safeguards. For example, there may be a requirement imposed by an Environmental agency that in order to prevent sudden changes in downstream water levels at daily peaking projects – at which in principle a dispatcher could order 500 MW of power to be added within a few minutes – ramping up and ramping down forced into longer duration, perhaps to several hours. This will significantly constrain the ability to concentrate power production during system peak hours.[13] Other examples include

- Cessation of power generation during periods when the reservoir is being operated for sediment flushing

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11 The project will evacuate power from the Sekong and Sekamen hydro projects in Laos first to a 230/500kV substation at Ban Sok, then by a 100 km line to the 500kV Pleiku substation in Vietnam (ADB, *Preparing the Ban Sok–Pleiku Power Transmission Project in the Greater Mekong Subregion*, Project 41450, 2008).

12 As in the case of the CASA1000 project that will bring 1300 MW of surplus hydropower from Tajikistan and Kyrgyzstan across Afghanistan to Peshawar in Pakistan- which involves 750 km of HVDC line.

13 This is a constraint ordered in the case of the 250 MW Trung Son hydro project in Vietnam.

- Operating rule constraints to allow storage for flood control
- Loss of generation due to environmental releases at low level outlets to provide minimum downstream flows

19. Such interventions may also involve incremental costs at construction

- construction of low level gates to discharge sediment and facilitate fish passage
- construction of fish ladders or other fish passage facilities
- increased construction costs for multiple dam sites if the sediment management approach involves downsizing and dispersing the dams

20. For each hydro project under study, the costs of these interventions will need to be separately identified and estimated by the engineering designers.

21. It is the first objective of the NHI project to examine the trade-offs between, on the one hand, these safeguards designed to minimise either short or long term impacts on other parties not directly involved in the immediate project financial transactions (such as downstream Mekong delta fishermen), and, on the other hand, the interests of developers and Governments in maximising short-term revenue.

22. The IFIs have their own set of safeguards that will apply to most hydro projects, each of which involves significant transaction costs to demonstrate compliance

- OP 4.01: Environmental Assessment
- OP 4.10: Indigenous peoples
- OP4.12: Involontary resettlement
- OP 4.36: Forests
- OP4.37: Dam safety
- OP 5.50: International waterways

23. It is one of the main problems in the Mekong region that dealing with the IFIs and their safeguards policies are seen as onerous, and the transaction costs high, in consequence of which projects have been awarded by the Lao and Cambodian governments to purely private entities (such as the Xayaburi project which is being financed by a consortium of Thai banks, or to projects awarded to Chinese developers supported by China EXIM bank) – whose general approach is to minimise expenditure on safeguards to the absolute minimum as may be imposed on them by their respective Governments (interested solely in maximising short-term revenue streams for taxes and fees). Indeed, any IBRD involvement in Mekong mainstream projects would trigger (among others) the safeguards requirements of OP5.50 on international waterways, which requires a no objection certification from downstream riparians. Given the opposition from Vietnam, for example, IBRD involvement in Xayaburi is inconceivable.[14]

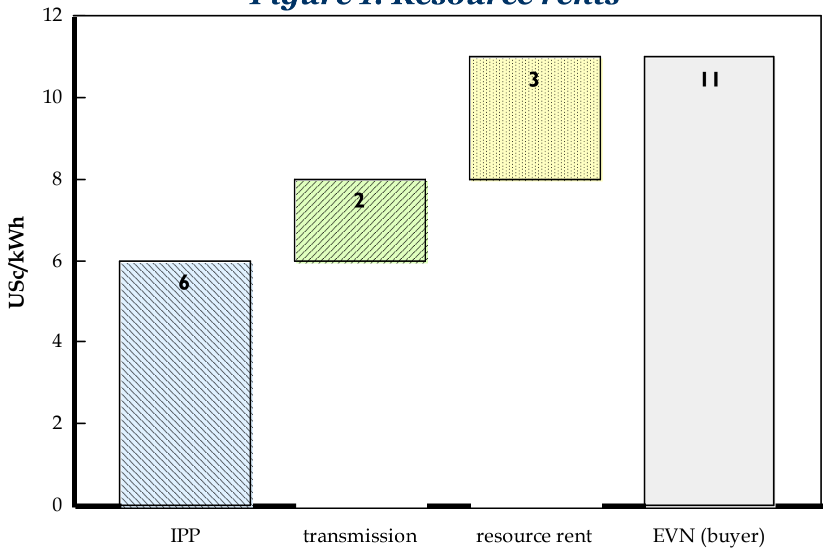
Resource rents

24. A *resource rent* in economics is the difference between the price at which an output from a natural resource can be sold and its respective extraction and production costs, including normal return. In the context of a hydro project, it is the

[14] The practical difficulty is not necessarily that the required no objection verification would *not* be given. A downstream riparian may not wish to upset the often finely balanced political relations with a neighbor by withholding consent. Rather, it is that from the perspective of a private developer, the process likely involves interminable delays – responses to any such uncomfortable requests will simply be postponed, in the hope that simple inaction kills an upstream project. Of course the Mekong River Agreement also has procedures for consultation for projects on the mainstream – but it appears that these procedures have often not been strictly observed.

difference between the most that a potential buyer (say Vietnam) is willing to pay for hydropower (which will be capped by the cost of the next best thermal alternative), and the developers production cost, adjusted for any transmission differential. For example, in the illustrative example of Figure 1, if EVN's willingness-to-pay (WTP) is 11 USc/kWh (say at the 500kV substation in Pleiku), the hydropower production cost (say in Laos) is 6 USc/kWh, and the transmission cost is 2 USc/kWh, then the resource rent is 3 USc/kWh.

Figure 1: Resource rents



25. In practice there are several claimants to this resource rent. The Government of Laos may claim the entire amount on grounds that the hydro resource is owned by them (as the representatives of the Lao people). But if it claims the entire rent, then there is no real incentive for the project to be built, since EVN can build the CCGT alternative in Vietnam if it gets no *better* price.

26. There is of course the further practical difficulty that it is difficult to determine what is a "normal return". 10% on equity? 15%? 20%? Each developer will have his own hurdle rate to make the investment, taking into account his perception of the risks involved. Moreover, the production cost itself may already include various elements of income taxes, water royalties and concession fees, which accrues to the Government of the host country. Therefore, the developer and the Government must agree (generally in the Concession Agreement) that the developer will provide the information necessary to calculate the rent. Then the Government can decide how the rent is to be shared.

27. In Laos, the current practice[15] is to levy a royalty based on a percentage of the gross revenue each year. One third of this royalty is allocated to the off-taker, the remaining two thirds allocated in a case-by-case basis between the Government and the developer. So in the example of the figure above, 1USc/kWh would be allocated to EVN (which means its purchase price is 10 USc/kWh), and if the balance is split 50/50, 1USc/kWh goes to the Government, and 1 USc/kWh to the developer.

28. Of course in practice this is all decided in a three-way negotiation (in the case of an export project). The off-taker EVN (or EGAT) has an interest in overstating its WTP by inflating the costs of the next best alternative. The developer has an interest in overstating the production cost. The Government has the exactly opposite motivation to understate production costs and overstate the buyer's potential WTP.

[15] Needs verification: this is taken from the 2010 World Bank report: Lao PDR Development report 2010: *Fiscal Regime in the Hydro Power Sector*.

But eventually it is in the interest all of three parties to find some mutually acceptable compromise that provides for an equitable sharing of rents.

29. Clearly, if the production costs are increased because of the environmental safeguards measures being proposed, then the resource rents available for distribution will diminish.

30. The modelling framework needs to be sufficiently flexible to be able to model alternative assumptions about how rents will be equitably shared. In an academic context this might be modelled as a problem in game theory, but for our project the necessary inputs will be determined with the help of our local counterparts.

The discount rate

31. In any analysis that seeks to assess the trade-offs between short term costs and benefits, and long-term costs and benefits, the choice of discount rate is the single most import decision to be taken. Not unexpectedly, it subject is highly controversial, since it is fundamental to the role of Government in making long-term policy decisions.

32. The economics literature on the discount rate is extensive and arcane, and much is incomprehensible to non-economists, much less to the likely government representatives on the study team.[16] The subject has perhaps been most fiercely debated in the climate change debate, which also deals with economic flows over very long time periods. [17]

33. In much of the development economics literature, one finds that the choice of discount rate to be used in economic analysis should be guided by the Government's "opportunity cost of capital". At the same time almost every (public sector) utility in Asia uses 10 or 12% as the discount rate in its formal models for capacity expansion planning – rates that have been unchanged often for 20-30 years (since the start of the use of these models in the 1970s and 1980s).[18] Yet the provenance of this 10-12% figure is often unclear, and we know of no IBRD or ADB appraisal report for a power sector project that actually goes to the trouble of a specific justification. Most economic analysis of power sector investment (and hydro projects) is done at constant prices, so this 10-12% is a *real* rate.

34. The World Bank Guidance Note for Economic Analysis[19] provides no guidance on the choice of discount rate (but simply points to the Bibliography of Annex III for discussions of the subject by others). Some other IFIs have issued more detailed discussions on the choice of discount rate:[20] for example, ADB states

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16 Some of the world's most prominent economists, and winners of the Nobel prize, have engaged in this debate, including Arrow, Stiglitz, and Amaritya Sen.

17 The most accessible discussions of discount rates in the climate change debate is K. Arrow, W. Cline, K Maler, M. Munsinghe and J. Stiglitz *Intertemporal Equity, Discounting and Economic Efficiency*; and M. Munasinghe, and P. Meier *Applicability of techniques of cost-benefit analysis to climate change*, both in Global Climate Change: Economic and Policy Issues, World Bank Environment Paper 12, 1995.

18 PLN (Indonesia) uses 10%; EVN (Vietnam) uses 12%.

19 World Bank, *Investment Project Financing: Economic Analysis Guidance Note*, OPSPQ, 9 April 2013.

20 ADB Economics and Research Department, *Theory and Practice in the choice of Social Discount Rate in Economic Analysis*, ERD Working Paper Series #94, May 2007.

categorically that 10-12% is to be used as the hurdle rate in assessing the economic rate of return (ERR).[21]

35. Thus in many cases the choice of discount rate is passed to the judgement of the assigned economist, who most often simply makes reference to past reports or to a Government Planning Department report. Only very recently has the World Bank provided a detailed project specific discussion of the question – only to find in some cases that 10-12% bears little relationship to any careful assessment of the Government's *actual* opportunity cost.[22]

36. The importance of the choice of discount rate has always been of interest to hydro, because as a capital intensive option (compared to thermal), the lower the discount rate, the more favourable does hydro become. The same is true for renewable energy (RE) technologies in general: advocates have long argued that high discount rates discriminate against RE. Indeed, when CBA was first used by the US Corps of Engineers after WW-II to justify water resource projects, critics complained that the 2% rate typically used provided (self) justification for building projects of doubtful value.

37. Rather than stipulate some particular value at the outset, to determine the discount rate for this NHI study the following approach is suggested:

- Review a sample of recent ABD and World Bank projects in sectors other than hydropower (such health, education, transportation, or other environmental and water resource projects) to identify the economic rate of return predicted for such projects. What this review may show is not known *ex ante*, and it may well be that this avenue yields little of value. However, if such social projects do bring returns significantly above the usual 10-12% hurdle rate, it will be hard to argue that hydro-project revenues (and downstream environmental impacts) should be evaluated at significantly lower discount rates.
- In the initial stages of analysis, use 10% as the starting point. If, say, a reservoir sedimentation control option is not economic (from the government perspective) at 10%, then use the backsolve option (of spreadsheet models) to ask the question: at what (presumably lower) discount rate does the given intervention become economic.
- The general rule should be to first ensure that all of the relevant externalities are included in the analysis, before arguing for a lower discount rate. For example, if indeed there are significant downstream fishery impacts, then these should be brought into the analysis to see how they would change the required discount rate.

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21 ADB, *Guidelines for the Economic Analysis of Projects*, Economics and Development Resource Centre, 1997: states as follows: *A project is considered economically viable if its ERR exceeds the opportunity cost of capital in the country concerned. Because it is difficult in practice to estimate precisely what this value should be for each country, 10 to 12% is used for all member countries as the minimum rate of return* (p.37). However, the guidelines do provide an Annex that illustrates the kind of calculations necessary (Annex 20: *Estimating the Economic Opportunity Cost of Capital*)

22 For example, in Morocco, the *nominal* rate of the most recent Eurodollar bond issuance is around 6%, so with 2% inflation the *real* opportunity cost of capital is 4%. Yet the Morocco state utility uses 10% real for its planning models.World Bank, *Noor II&III Concentrated Solar Power Project*, Project Appraisal Document, May 2014.