Sustainable hydropower and carbon finance

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Photo caption: Kaleta dam in Guinea.

Photo credit: Jamie Skinner/IIED.

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The Clean Development Mechanism (CDM) has helped finance more than 2000 hydropower projects, representing the largest source of OECD bilateral funding for hydropower. Europe, through its European Union Emissions Trading Scheme, has been the major supporter. However, environment and sustainability regulations intending to ensure 'respect' for the World Commission on Dams' guidelines are falling short, prompting calls to use the industry-led Hydropower Sustainability Assessment Protocol (HSAP). This Issue paper explores CDM project data and finds that, under a healthy carbon price, the cost of the HSAP would not be a barrier to accessing carbon finance, and could even strengthen the carbon market.

Contents

Summary

Hydropower offers a proven low carbon technology that can help transform global energy systems, supporting energy access for all while mitigating dangerous climate change. However, badly planned or sited dams can harm local communities and ecosystems, and have triggered long standing battles for social justice. In response to human rights and environmental pressures, OECD governments have increasingly scaled back bilateral support to large hydropower, often adopting a 'small hydro is good, large hydro is bad' approach. But this does not help mobilise the vast public and private finances needed to meet global energy needs sustainably. Meanwhile, 'business as usual' private sector financing often has only weak environmental and social (E&S) safeguarding, leading to concerns over hydropower's future role.

Carbon finance, through the European Union Emissions Trading Scheme (EU ETS) is to date the only mechanism which includes a legally binding environmental and social (E&S) safeguard requirement. Through the EU Linking Directive (2004), all project-based international carbon credits from large hydropower projects (above 20MW installed capacity) must demonstrate "respect" for the guidelines outlined within the World Commission on Dams (WCD) 2000 report *Dams and Development – a new framework for decision making*.

But although many recognise the WCD as a 'gold standard' for E&S safeguarding, it is a poor measuring stick for the sustainability of individual private sector projects as the WCD's strategic priorities and policy principles also require significant action by governments. Despite an effort to harmonise EU approaches by adopting a voluntary Compliance Report Template (from 2009), the EU regulation remains weak and poorly suited to delivering sustainable hydropower at scale.

Earlier work by IIED has supported using the industry-led Hydropower Sustainability Assessment Protocol (HSAP) as a way to ensure respect for WCD guidelines for individual projects. This *Issue paper* reviews the carbon market associated with hydropower and interrogates Clean Development Mechanism (CDM) project data from the CDM Pipeline and from specific European Designated National Authorities (DNAs), asking two main questions:

1. How has applying WCD guidelines as an E&S safeguard process in the EU Linking Directive affected hydropower investments within the CDM?
2. How significant is this carbon financing to large hydropower's revenue streams and are the costs of undertaking a HSAP a potential barrier to obtaining carbon finance?

Hydropower will become the leading CDM mitigation tool

Large hydropower projects have received the highest confirmed carbon offsets in the CDM pipeline, producing 48 per cent of renewable energy Certified Emissions Reductions (CERs). If emissions reductions continue as the CDM Pipeline implies, hydropower will overtake industrial gas projects as the largest mitigation tool under the CDM by 2020. Notably, investment trends have remained similar to foreign direct investment, with 78 per cent of confirmed hydropower CERs produced in China, whilst the Least Developed Countries (LDCs) have received only one per cent of this carbon finance.

Europe dominates CDM hydropower investment

The EU ETS is the world's largest carbon market, making it unsurprising that European States dominate investment, supporting 67 and 69 per cent of all CDM hydropower projects and subsequent confirmed CERs respectively. Seventeen EU ETS states have, at some point, been involved in CDM hydropower, but four countries are especially active: the Netherlands, the United Kingdom, Sweden, and Germany. Switzerland, despite not operating within the EU ETS, abides by the EU Linking Directive. These five European nations support the vast majority of hydropower projects and carbon finance flows in the CDM.

Out of 1384 European registered hydropower CDM projects, up to 573 projects were theoretically required to "respect" the WCD, and over 433 of these were subject to the voluntary Compliance Report Template. However, with no central registry, tracking the details of these carbon finance flows is challenging.

E&S safeguards have proved ineffective

Despite covering the vast majority of CDM hydropower projects, our reviews have found the EU ETS carbon project compliance procedures that require respect for WCD provisions are weak. The EU legislation allows the assessment to be at any point during the CDM project development cycle, even though WCD guidelines stipulate it should occur at the earliest possible point within the planning process. Furthermore, despite the introduction of the Compliance Report Template, European DNAs perform the assessment under varying timeframes.

Rather than weeding out 'bad' projects, research suggests the WCD assessment through the EU Linking Directive has created additional barriers for all, by increasing confusion in how to assess "respect". This is in addition to the extra regulatory hoops hydropower must jump through in providing reservoir monitoring to ensure greenhouse gas (GHG) emission reductions are real.

Whether or not Europe wants a leading role in project-based emissions reductions through hydropower, it is clear that better E&S safeguarding is required. The EU plans to partner with compatible emission trading systems around the world, linking the EU ETS with other cap-and-trade systems. As regional and sub-national emission trading schemes emerge, in particular within China, globally, plans to actively develop hydropower are substantial. China started trialling emissions trading in 2014 and plans a nationwide system by 2017. This is expected to be the world's second largest system. Unless E&S safeguarding is improved, hydropower may become locked out of such world leading carbon trading platforms. For example, Switzerland and New Zealand have already banned the use of large hydropower for carbon offsets within their compliance systems.

The HSAP is affordable under a healthy carbon price

Ineffective E&S assessments within the carbon market strengthen the case for considering the HSAP as the mandatory E&S safeguard for internationally funded hydropower. So would requiring the HSAP disincentivise private hydropower investment? Or can carbon finance cover the additional transaction costs of applying the protocol (each HSAP costs US$80,000–150,000)?

Our simple payback and carbon revenue analyses show that under current low carbon prices (~US$1/ tCO_2e), the HSAP would be unattractive to private investors, as carbon revenue would not recoup costs within three years. However, under a healthier carbon price of around US$9/$tCO_2e$, the average CDM large hydropower project would repay all E&S transaction costs within three years. Given that carbon markets have faltered under present carbon prices, such a rise is needed for the whole market to function, not just to finance sustainable hydropower. Furthermore, studies suggest that proven sustainable projects can attract price premiums amongst private investors, introducing the possibility that the HSAP could strengthen the market price for sustainable hydropower.

RECOMMENDATIONS

- The EU ETS and other carbon markets should adopt the HSAP as a better tool for measuring "respect" for the WCD guidelines than the voluntary Compliance Report Template for individual hydropower projects within LDCs or for any other bilaterally-supported hydropower.
- To assess carbon market mechanisms it is essential to harmonise data presentation and improve project transparency, including giving information on how offsets are distributed between investors, the date when supporting countries approve the project, and providing clarity on why projects fail to gain accreditation and/or approval.
- Emerging trading systems (for example within China) should also consider requiring the HSAP before financing hydropower projects.

Introduction

Clean energy sources are urgently needed. Carbon finance has helped to support hydropower — one of the most scalable short-medium term clean energy technologies available to many countries. But effectively addressing environmental and social concerns presents considerable hurdles, and current EU regulatory approaches ensuring sustainability are failing.

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Despite the growing seriousness of climate change, fossil fuels continue to dominate the global energy supply system. Alternative clean energy sources are urgently required, especially given the increasing energy needs in many countries. Transforming to low carbon energy will require substantial public and private finance to be mobilised, especially into developing countries where low carbon capital-intensive energy technologies often compete poorly with cheaper and presently-less-risky fossil fuels. Over the past decade, carbon finance has evolved into a new source of funding, representing over 13 per cent of renewable energy investment[1]. This has been spearheaded by the Clean Development Mechanism (CDM), which lets industrialised countries invest in sustainable low carbon projects in the developing world as a way to offset their own emissions. Overall, the CDM has been a significant market mechanism that has improved low carbon projects' financial viability in low income countries, providing additional resources and investment flows.

Eighty per cent of hydropower potential is yet to be exploited, mostly within emerging and less developed economies, and still represents one of the most scalable short-medium term renewable energy technologies for many countries. Hydropower also offers numerous additional benefits: by helping integrate other intermittent renewable technologies, by providing base load capacity that competes with fossil fuel generation, and as a climate change adaptation tool (for example reservoirs can provide a controllable water supply). Despite these potential benefits, there are concerns over the environmental and social (E&S) impacts of 'large' hydropower schemes. Failure to manage these impacts is often the primary reason for opposition from local communities and environmental organisations. This is particularly the case with hydropower within developing countries where 'business as usual' financing often relies on national E&S safeguards that seldom capture recent advances in standards, and where regulatory capacities are often weakest.

To be fully sustainable, all hydropower projects require inclusive and holistic engagement with best E&S processes from the start. The international public sector can play a key role in helping developing countries foster responsible private investment (for a fuller discussion see *The business case for bilateral support to improve sustainability of private sector hydropower*[2]). Multilateral support to hydropower includes extensive provision for avoiding, mitigating and managing E&S impacts through the multilateral banks' safeguarding policies. However, individual developed (OECD) countries do not yet appear comfortable in their ability to regulate such E&S concerns. Many are withdrawing from directly supporting public sector large-scale hydropower projects. Furthermore, there is little real incentive for E&S safeguards within private sector financing, which may include up to 40 per cent of the dams under construction today[3].

One exception is the European Union Emissions Trading Scheme (EU ETS), where Member States are required to assess E&S provision before accepting the use of large hydropower (>20 MW) CDM offsets for mandatory EU emissions compliance. The 2004 EU Directive governing this market requires large dam projects to "respect" criteria and guidelines set out by the World Commission on Dams (WCD) (see Box 1).

Although many recognise the WCD guidelines as the 'gold standard' of dam E&S safeguarding, their complex nature has often lengthened the decision making process and led to a varying degree of interpretation within the European community. The WCD guidelines do not lend themselves easily to standardised measurement, and attempts to harmonize the WCD procedure in Europe by introducing a Compliance Report Template (from 2009) has not resolved this satisfactorily. Carbon exchanges have responded to the confusion by banning or discounting large hydropower offsets, however proven sustainable credits have fetched price premiums. This highlights the importance of designing and implementing appropriate E&S safeguarding mechanisms if hydropower is to continue receiving support, not just through carbon finance, but from private investment in general.

Two previous IIED reports, *Watered Down? A review of social and environmental safeguards for large dam projects*[3], and *The business case for bilateral support to improve sustainability of private sector hydropower*[2], have recommended the international industry-led Hydropower Sustainability Assessment Protocol (HSAP) (see Box 2) as the main tool for measuring 'respect' for best practice E&S safeguards in individual projects. HSAP provides an independently certified assessment and monitoring tool for assessing a dam's sustainability, following many of the WCD recommendations. It could provide the necessary steps to de-risk OECD bilateral support for hydropower schemes.

Given the leading role Europe has played thus far in the global carbon markets (see below for a discussion), the EU could use the HSAP to assess large hydropower projects entering the EU ETS. The EU has actively helped to develop emerging carbon trading systems, and 39 national and 23 subnational carbon tax or trading systems were active as of August 2015[1]. In China, seven systems together have grown to over half the size of the EU ETS[4]. Although the CDM may not survive for much longer in its present form (as international climate agreements evolve), new market mechanisms are actively being developed, and to date international carbon offsets/credits have played a pivotal role in indirectly linking these schemes together.

This *Issue paper* gives an overview of the global carbon market and its links with the CDM from the perspective of hydropower. This provides an insight to those less familiar with these frameworks and interactions and a background to the subsequent analysis. We outline the factors within the carbon market's evolution that may have influenced hydropower investment within the CDM.

Following the overview, and building on the recommendations and findings of earlier IIED research[2,3], the paper takes up two main issues:

1. How has applying WCD guidelines as an E&S safeguard process in the EU Linking Directive affected hydropower investments within the CDM? Section 3 compares CDM project portfolios to document the flow of carbon finance towards hydropower within both the global and the European carbon markets. It identifies the major players and analyses the hydropower projects and financial flows captured by the EU's Compliance Report Template.
2. How significant is this carbon financing to large hydropower's revenue streams and are the costs of undertaking a HSAP a potential barrier to obtaining carbon finance? Section 4 provides a simple 'payback period' and carbon revenue analysis to determine what carbon prices are needed for carbon finance to create an incentive for the HSAP assessment and its additional monitoring.

BOX 1. THE WORLD COMMISSION ON DAMS (WCD)

Established in 1998, the 12 member-strong WCD aimed to review how effectively large dams contribute to development. Its 2000 report, *Dams and Development – a new framework for decision making* recommended seven strategic priorities:

1. Gaining public acceptance;
2. Comprehensive options assessment;
3. Addressing existing dams;
4. Sustaining rivers and livelihoods;
5. Recognising entitlements and sharing benefits;
6. Ensuring compliance; and
7. Sharing rivers for peace, development and security.

Importantly, the WCD recognised there can be no 'one size fits all' approach as every dam is different. The report was not intended as a blueprint for E&S safeguarding but a starting point for discussions, debates, internal reviews and reassessments.

BOX 2. HYDROPOWER SUSTAINABILITY ASSESSMENT PROTOCOL (HSAP)

The HSAP draws upon assessments of good and best practice in hydropower design, delivery and operation. This protocol has the significant advantage of using certified assessors to produce a set of clear scores on 23 sustainability indicators. These often cover similar ground to the WCD but in a measurable manner that can be applied to individual hydropower projects. It has the support of NGOs, multilateral banks, commercial banks and the hydropower industry and can be applied at four project stages:

1. Early stage;
2. Design stage;
3. Construction stage; and
4. Operation stage.

This offers a bespoke monitoring scheme that gives feedback on compliance and therefore confidence to investors that the project is sustainable and the best technical option. The cost of an HSAP varies from project to project but is in the order of US$100,000.

An overview of carbon markets and hydropower

This section briefly reviews carbon markets' structure and development from the perspective of hydropower investment. Many of the changes outlined influence the market as a whole, but there have also been specific hydropower developments. The focus is on the EU Emissions Trading Scheme (EU ETS) and the Clean Development Mechanism (CDM) although wider linkages are also discussed.

2

Despite being relatively new mechanisms, carbon markets have already been subject to a host of policy and regulatory changes, making them extremely complex systems[1]. They are composed of two main approaches: allowance and project-based systems.

Allowance-based systems work where greenhouse gas (GHG) emissions are regulated under a cap that determines how many carbon allowances each entity, region or country is allowed to emit. Those governed by the scheme are generally allowed to trade their allowances, to let them meet the cap in the most efficient way possible. Currently, the EU ETS is the largest allowance-based system in operation, covering $2GtCO_2e$. However, emerging schemes in China (covering over $1GtCO_2e$) and in other industrialising economies are becoming significant[1].

Project-based systems have, to date, acted through the Kyoto Protocol Flexibility Mechanisms and the voluntary carbon market, whereby GHG emissions abatement or sequestration projects are developed, receiving carbon offsets (credits) for what would have occurred under 'business as usual'. The two most prominent project-based mechanisms are the CDM, which generates Certified Emissions Reduction credits (CERs) within developing countries (non-Annex countries of the Kyoto Protocol); and Joint Implementation, which generates Emissions Reductions Units (ERUs). Both CERs and ERUs are equivalent to one tonne of carbon dioxide equivalent (tCO_2e) each. Project-based emissions reductions can be used for three purposes: towards meeting countries' agreed targets for their domestic GHG emissions under the Kyoto Protocol (for the Protocol's Annex B countries); towards an entity's voluntary carbon reductions, or towards an entity's domestic carbon allowance cap. As Joint Implementation projects do not have the principle aim of contributing towards sustainable development and because they take place within Annex B countries, such projects will not be discussed further here.

2.1 The European Union Emissions Trading Scheme and hydropower

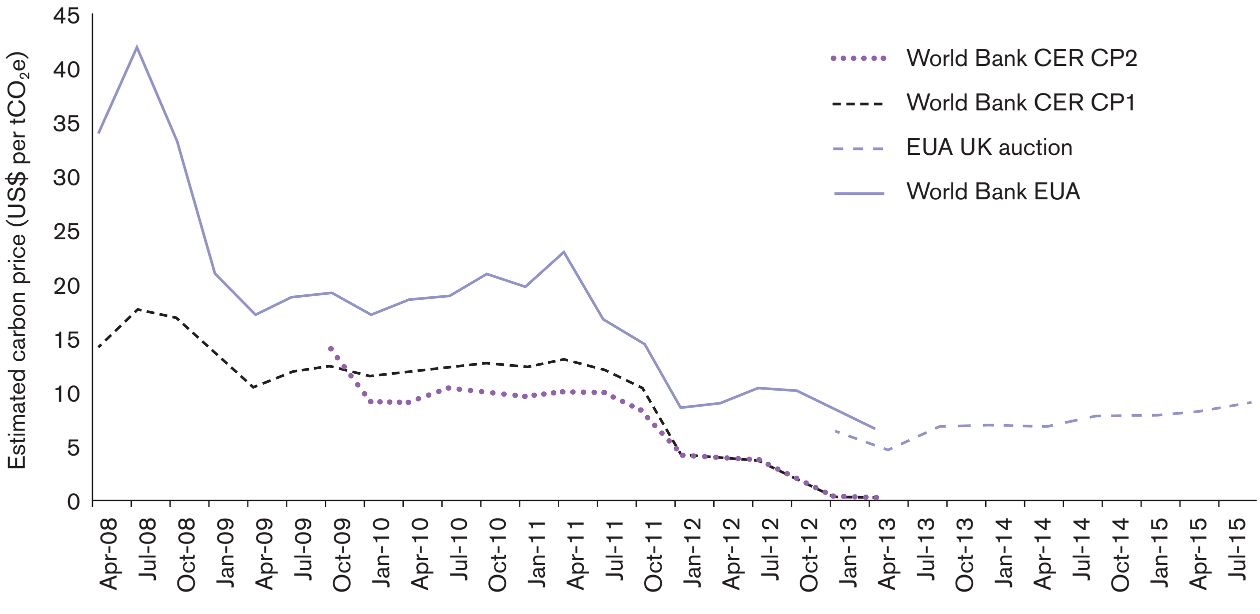
The EU ETS has been active since 2005, with the pilot Phase I running to 2007, Phase II to 2012 and now Phase III running from 2013 to 2020. All 28 EU states are included with Iceland, Liechtenstein and Norway (members of the European Economic Area, EEA) joining in 2008. Carbon allowances, on which overall and individual caps are based, are measured in European Union Allowances (EUAs), with each unit equal to one tCO_2e. Entities (businesses etc. governed by the scheme) are required to surrender a predetermined number of EUAs at the end of each phase. Within Phase III, allowances reduce annually by 1.7 per cent, providing an incentive to shift towards cleaner technologies and processes. However, in order to ensure efficiency, entities can trade EUAs on a secondary market. Those with surplus allowances can sell them on to those with a shortage. Many question the scheme's overall success, but it has forced participants, especially power producers, to integrate the price of carbon into their operations and investments[5].

Importantly, the EU ETS lets its entities buy international Kyoto Protocol carbon credits and use these to effectively raise their capped allowance. This system is governed through the EU Linking Directive of 2004. Again, the motivation behind this is to make carbon abatement efficient for developed countries, and to support sustainable development in developing countries. For hydropower investment, it means EU ETS entities can purchase offsets produced from hydropower projects in developing countries, providing carbon finance investment to the hydropower developers. This carbon revenue flow affects debt financers' and equity investors' decisions as it can improve project profitability and return on equity. Consequently, developers are more able to leverage project financing and guarantees. This is particularly important in limited resource financing models — the case for most private sector renewable energy projects within developing countries — where commercial loans are secured against project revenue streams, not assets.

2.2 Potential carbon finance

Entities operating under the EU ETS can invest in CDM hydropower projects (so contributing towards sustainable low carbon development) whilst receiving CERs equivalent to the fossil fuel power generation which such schemes offset. This produces a flow of carbon finance from EU ETS states towards the developing world that is very important in financing low carbon projects. Some CDM project participants have reported that this additional project revenue from carbon financing has made it easier to finance debt and raise capital, making projects more financially attractive[6,7]. These carbon transactions generally occur through contracts between the Kyoto Protocol Annex I investors and the host country on a commodity model basis, whereby payments are made on receipt of CERs with the price commonly agreed in advance. Given the dominance of the EU ETS in driving demand for CERs it is unsurprising that the price (Figure 1) has been coupled mostly with the price of EUAs, which itself is driven, among other things, by market, political and technology changes (Table 1).

Figure 1. Carbon prices 2008–15 in US dollars per tonne of carbon dioxide equivalent



Prices are estimated quarterly averages for European Union Allowances (EUAs) and Certified Emissions Reductions (CERs) (CP1 pre 2012 and CP2 post 2012).[4,9] Prices have been converted from euros to US dollars using annual exchange rates.

CERs prices have often been much lower than EUAs even though they both represent one tonne of carbon dioxide abated. There are two main reasons for this.

Firstly, rules restrict how CERs are imported into the EU ETS:

- In Phase I of the EU ETS there were limited import mechanisms and procedures for CERs (but these mechanisms are now developed through the International Transaction Log).
- During Phase II of the EU ETS, international carbon offsets were capped at 1,400MtCO_2e for the scheme as a whole.
- During Phase III of the EU ETS only CERs from CDM projects registered post-2012 within the 48 UN-defined Least Developed Countries are eligible. Additionally, importation of all international credits is capped at 1,600MtCO_2e for Phase II and III (2008–2020) combined. By August 2015 the EU ETS had used 90 per cent of this cap, and since the CDM alone will issue more than the remaining 10 per cent between 2015–2020, supply is likely to far exceed demand[1]. CERs from CDM projects registered before Phase II ended are only eligible for use within Phase III if surrendered before 31 March 2015.

Secondly, the price is affected by the inherent risk associated with delivering CERs from developing countries, compared to buying EUAs on the secondary market[7,8]. Prices are influenced by:

- Creditworthiness and the project developers' experience in implementing and continuing adequate monitoring that will ensure emissions reductions are delivered over the lifetime of the project.
- The year the CER is expected to be delivered — because of the compliance regulations mentioned previously.
- The host countries' willingness to support and cooperate with the market and projects (China's proactive involvement in the CDM market allowed them to set an unofficial CER price floor).
- Proven E&S benefits or impacts, which attract price premiums or discounts respectively.
- Projects' transaction costs and the time taken to become registered (see Figure 2).

Table 1. Timeline of the key events affecting trading and project finance in the EU ETS and the CDM

EU ETS	CDM	KEY EVENTS
		2003/04: Forward trading in EUAs and EU Linking Directive established.
Phase I	CP1	2005: EU ETS and CDM commence operations and trading.
		2006: EU ETS becomes the largest carbon market and CER price rises rapidly.
Phase I closes 31st Dec 2007		2007: EUA price crashes due to surplus and uncoordinated release of market information, major delay in CERs issuance due to CDM project pipeline overload, but CER price remains stable.
Phase II		2008: 2nd crash in EUA price due to economic downturn, EU emissions lower than expected and Swiss and NZ Emissions Trading Schemes open.
		2009: Move from multiple to single EUA registry, WCD voluntary compliance report template adopted by EU and EEA states, CDM industrial projects exhausted, economic downturn intensifies, reducing carbon project demand as CDM market becomes very risk averse, and re-entry of CERs into EU ETS now prevented.
		2010: EU ETS represents 84 per cent of the carbon market, CERs value falls as CP1 nears its end amidst uncertainty over commitment for continued use of CERs by EU post-2012.
		2011: Oversupply of EUAs becomes clear, creating rock bottom CERs price, CERs issuance rises due to backlog clean-up.
Phase II closes 31st Dec 2012		2012: Peak surge in CDM projects registration and CERs issuance as EU ETS Phase II and CP1 end.
Phase III	CP2	2013: Demand for CERs collapses due to uncertainty in international and EU climate and carbon market regulations (EU ETS now only accepts CERs from the Least Developed Countries, i.e. China no longer eligible), eight new carbon markets open worldwide (including in China) creating new demand for CERs but CDM market becomes saturated with little sign of recovery.
		2014: Major Designated Operational Entities (DOEs) and investors withdraw from the CDM.

Sources include the World Bank's series of reports on *State and Trends of the Carbon Market* from 2005 to 2014 (CP1 and CP2 refer to the first and second commitment periods of the Kyoto Protocol).

2.3 Emissions from reservoirs

For a hydropower project to take place under the CDM there must be an available project methodology that has been ratified by the CDM Executive Board (EB). Creating a new reservoir, or altering an existing one, can potentially increase reservoir GHG emissions as organic material decomposes, so CDM methodologies for hydropower projects are governed by the proxy of power density thresholds (installed power capacity divided by the reservoir surface area). Hydropower projects with power densities less than $4W/m^2$ cannot use present methodologies, meaning no carbon finance is available. Those above $4W/m^2$ but less than $10W/m^2$ can use all approved methodologies, using a reservoir emissions factor of $90gCO_2e/kWh$. Finally, for projects with power densities above $10W/m^2$ the reservoir emissions are assumed to be negligible.

Thus, many hydropower CDM projects require reservoir emission monitoring, adding an additional transaction cost compared to other renewable energy projects. Research suggests that these CDM methodological thresholds are steering carbon finance towards Run-of-River (RoR) hydropower projects[3] as these generally possess higher power densities (because they require smaller reservoirs). However, RoR schemes commonly divert large portions of downstream river flow, potentially having cumulative impacts within a watershed, and cannot always be considered to be more sustainable than large reservoir schemes[10].

2.4 Challenges arising from the EU Linking Directive

Large hydropower projects from eligible countries that wish to enter the EU ETS must comply not only with the CDM regulations, but also with the additional E&S

safeguards linked to "respect" for WCD guidelines, as required by the EU Linking Directive (2004).

The WCD guidance is primarily designed to filter out 'bad' projects early in the planning process before their political and financial investment becomes too large. Although the WCD may provide the best decision making framework, measuring individual dam projects against the guidelines is very problematic[11]. The WCD itself recognised that it is unable to provide a simple yes or no answer to a project's E&S performance. However, when the Linking Directive was being developed, the WCD framework was the only available tool for sustainable hydropower planning. EU governments were urged by the NGO community to adopt WCD provisions under the Directive for all 'large' hydropower projects (which were, fairly arbitrarily, decided to be those greater than 20MW).

Up until 2009, there was no standardised methodology for using WCD guidelines to decide the acceptability of an individual hydropower project's E&S impacts. Member states were free to decide how to measure "respect", leading to varying interpretations. The assessments were performed by project developers or certifiers, and checked by investing states' Designated National Authorities (DNAs) when providing the large hydropower project with a Letter of Approval (LoA) authorising participation in a CDM project activity.

In 2009, EU ETS member states adopted a Compliance Report Template in attempts to standardise measurement of respect for the WCD and to provide more clarity to the carbon market. However, using the template is voluntary and respect remains self-assessed by the project developers and DNAs. Once an EU ETS state provides a LoA, all member states agree to accept the large hydropower project's CERs. Yet trying to fit WCD guidelines to individual projects they were not specifically designed for is complex, and has led to delays in the CDM pipeline[12].

To ensure sustainability, it is also important to understand at what point in the project development cycle the WCD assessment is applied, and when the European DNA has provided the LoA. Although the WCD guidelines stipulate the E&S assessment should be performed early in the project planning process, the CDM Executive Board's regulations say the Annex I country LoA can be applied for at any point before CERs are being sold (Figure 2). Member States have varying practices on when and how they apply the guidelines. Thus, projects can be well developed before being reviewed against the Compliance Report Template and this is even stated as desirable by some DNAs[13].

The consequence of late assessment is that it leaves little scope for responding to any issues raised — early recognition of E&S challenges should help design appropriate avoidance and mitigation strategies.

Given that sustainable development is supposed to be the main driver of CDM participation, and that projects should be in line with countries' development priorities, it should be possible to assess hydropower as part of a country's wider needs, yet the CDM regulations provide only weak guidance on how a country's sustainable development needs should be assessed.

The additional transaction costs, time and uncertainty involved in the WCD assessments — which appear inadequate for addressing sustainability concerns — may also lead to a fall in the price of associated CERs, or even to them being banned by Parties or carbon exchanges (see Box 3). Transaction costs also affect the CER price[7], a significant consideration for the use of other E&S safeguarding approaces.

BOX 3. HYDROPOWER CERs BEYOND THE EU

Switzerland's cap and trade scheme accepts CERs. Possibly due to a desire to link up with the EU ETS, some of the system's regulatory structure is similar to the EUs, including using the WCD framework and Compliance Report Template. However, Switzerland has made large hydropower CERs ineligible for support within its system from 2013.

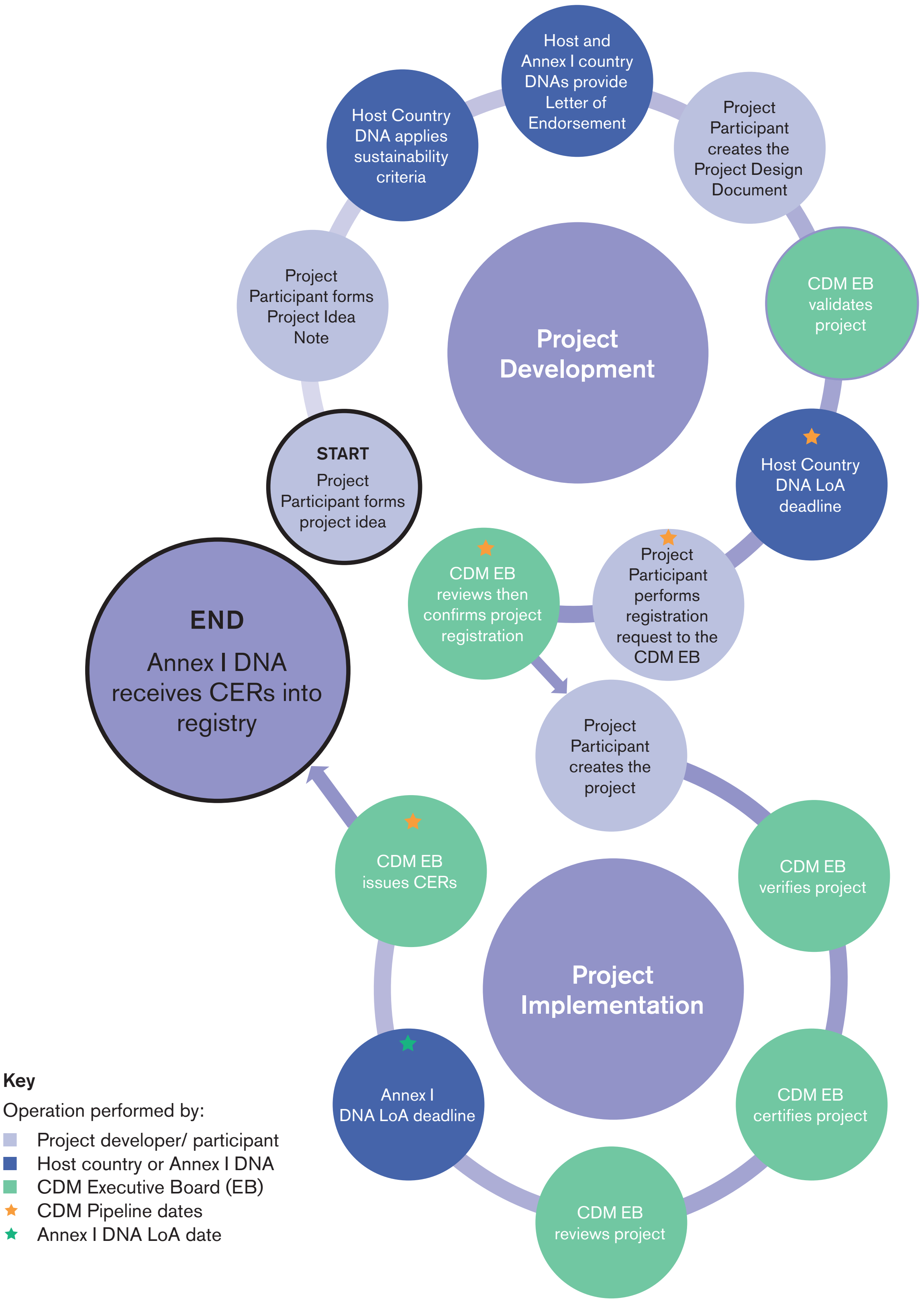
Before Norway entered the EU ETS in 2008 its cap and trade system also imported hydropower CERs that were understood to fall in line with the EU WCD compliance requirement.

New Zealand's Emissions Trading Scheme, which commenced in 2008, has imported international hydropower CERs in line with European WCD compliance requirements. However, it has suffered from numerous setbacks with uncertainty over national climate policy and has made large hydropower CERs ineligible for compliance since 18 December 2012.

The Australian Carbon Policy Mechanism, which also follows the EU ETS CERs importation policies, has been retracted due to a change in political direction.

Newly emerging national mandatory schemes, including the Korean and Kazakhstan cap and trade systems, have substantial potential but do not yet accept international carbon offsets as a way to meet entities' compliance obligations, although this is scheduled to change.

Figure 2. The main procedures in the CDM project pipeline



Showing the various stages at which the developed country (Annex I) is able to provide the Letter of Approval and therefore at what point the WCD compliance procedure is undertaken for large hydropower projects >20MW
Source: adapted from the UNFCCC's information for Designated National Authorities, see https://cdm.unfccc.int/DNA/index.html.

CDM portfolio analysis

This section compares CDM project portfolios to explore the flow of carbon finance for hydropower within both the global and the European carbon markets. It identifies the major players and asks how much hydropower carbon finance is covered by the EU Linking Directive for respect to the WCD.

3

Our research first explored the UNEP DTU (2015) CDM Pipeline database[14], extracting datasets on hydropower projects covering: a) the Kyoto Protocol Commitment Periods (CPs) I and II and b) Phases I, II and III of the EU ETS (2005 –2014/15). Since the Swiss cap and trade scheme is aligned with the EU ETS, including for hydropower E&S regulations, and the Norwegian system prior to 2008 is believed to conform to the same standards, both were included in the second dataset, making it European rather than EU ETS-based.

The trends in the European dataset confirmed European dominance in CDM hydropower and identified the most active supporting and host states that are developing hydropower projects which theoretically respect the WCD (under the EU Linking Directive of 2004). However, the CDM Pipeline database does not contain the date a Letter of Approval (LoA) is issued confirming 'respect', so the date of registration was used as a compromise.

For the top European supporting states we then looked at the Designated National Authority's (DNA's) own databases. These[15] date the LoA and therefore represent trends in WCD compliance more accurately (notably trends after the introduction of the WCD Compliance Report Template).

However, data quality in these DNA databases was inconsistent, including missing and duplicate projects, and highly variable dates for project activity (for more discussion see the Appendix). A sensitivity analysis suggests these inconsistencies are unlikely to have compromised the trends we uncovered, but they do mean the absolute values are not directly comparable between datasets.

3.1 Global CDM portfolio

Renewable energy technologies represented 72 per cent of registered CDM projects and 28 per cent of confirmed CERs up to May 2015, with 425 million issued CERs since 2005 (Figure 3A and B). Industrial gas projects mitigating hydrofluorocarbon and nitrous oxide emissions represented the 'low hanging fruit' of emission reductions and account for over half of all issued CERs so far. They offered the most cost-effective carbon finance tool for drawing investment into developing countries, but were mostly exhausted by 2006/07 and were excluded from the EU ETS in 2013. Hydropower, on the other hand, will continue to mitigate GHG emissions regardless of project operator's ability to monitor, verify and receive carbon offsets (presently inhibited by the low carbon price). If GHG emissions reductions continue as the CDM Pipeline projects, renewables will be responsible for over half (52 per cent) by 2020, with hydropower the largest mitigation tool under the CDM (Figure 4), as well as an important energy source in the developing world.

Figure 3. **A.** Percentage of project types in overall CDM portfolio (7630 registered projects) (A), and **B.** percentage of CERs issuance to date by project type in the overall CDM portfolio (1.55 billion issued CERs), between 2005–2015

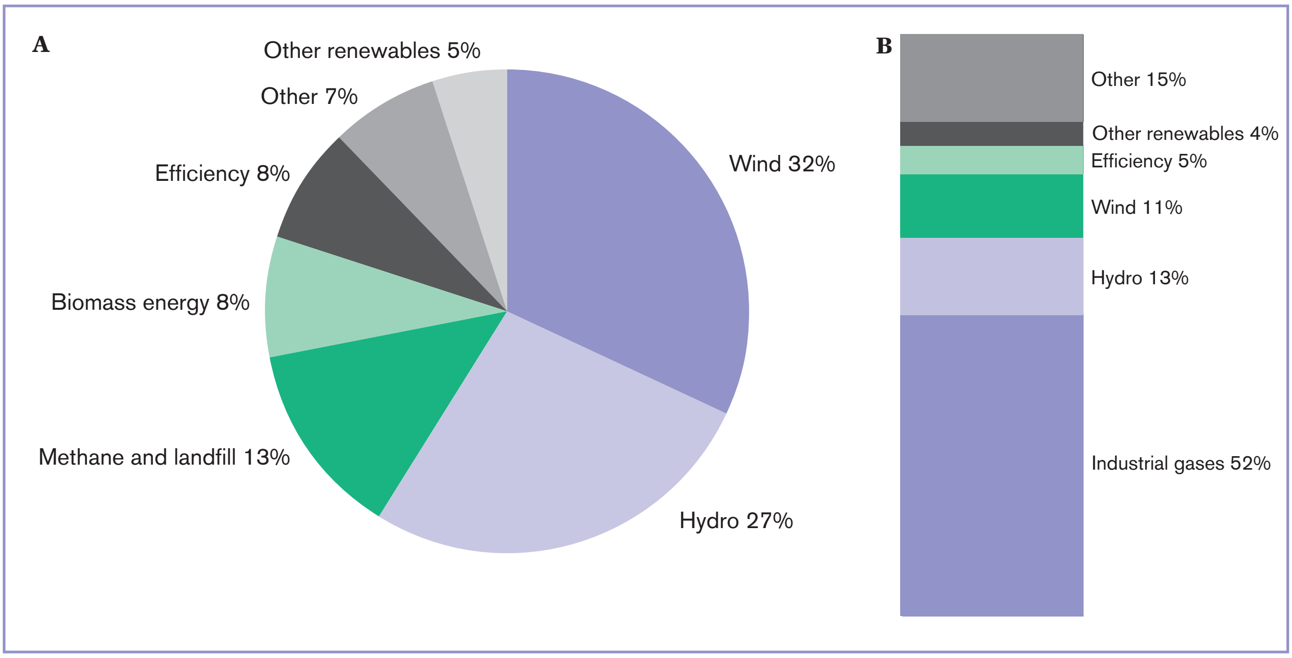


Figure 4. Projected accumulated emissions ($GtCO_2e$) reductions per CDM project technology for 2012, 2020 and 2030.

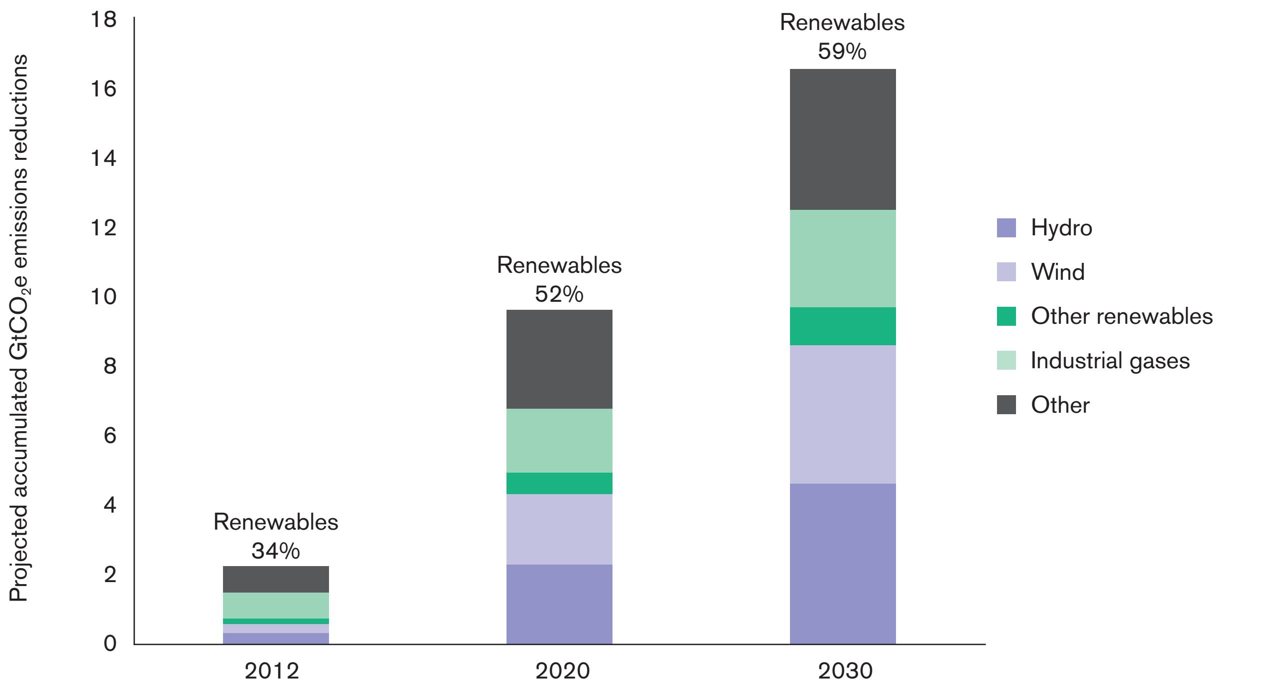


Figure 5. **A.** Percentage of host countries for registered CDM hydropower projects within the global CDM portfolio (2064 registered projects), and **B.** percentage of issued CERs per host country for hydropower projects within the global CDM portfolio (204.5 million issued CERs), between 2005–2015

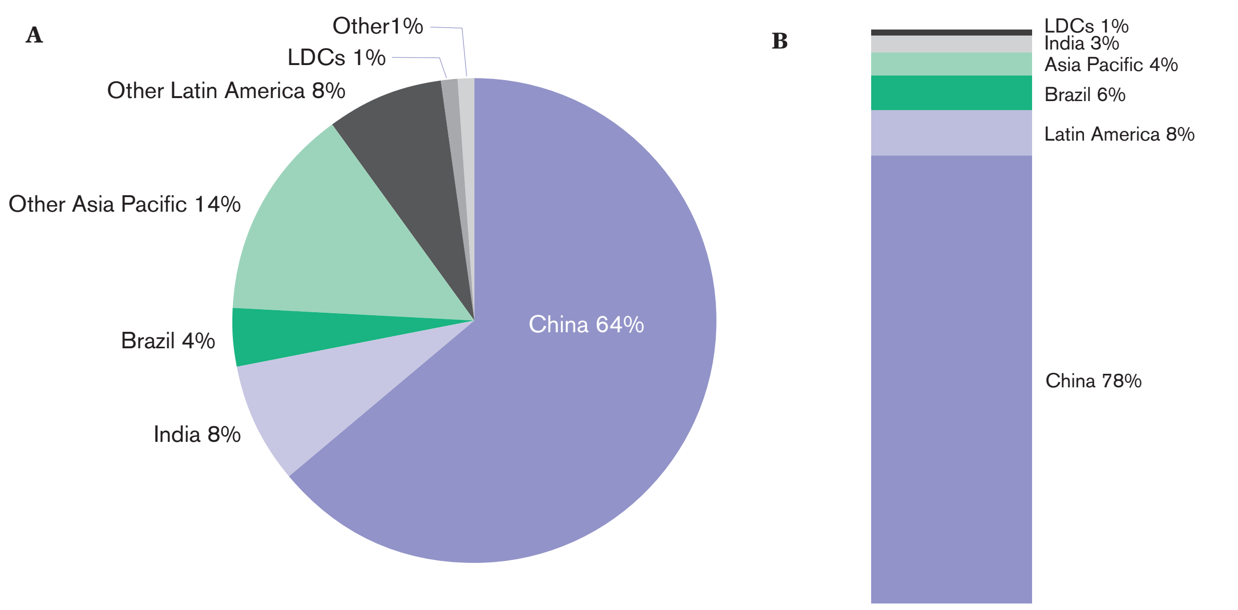
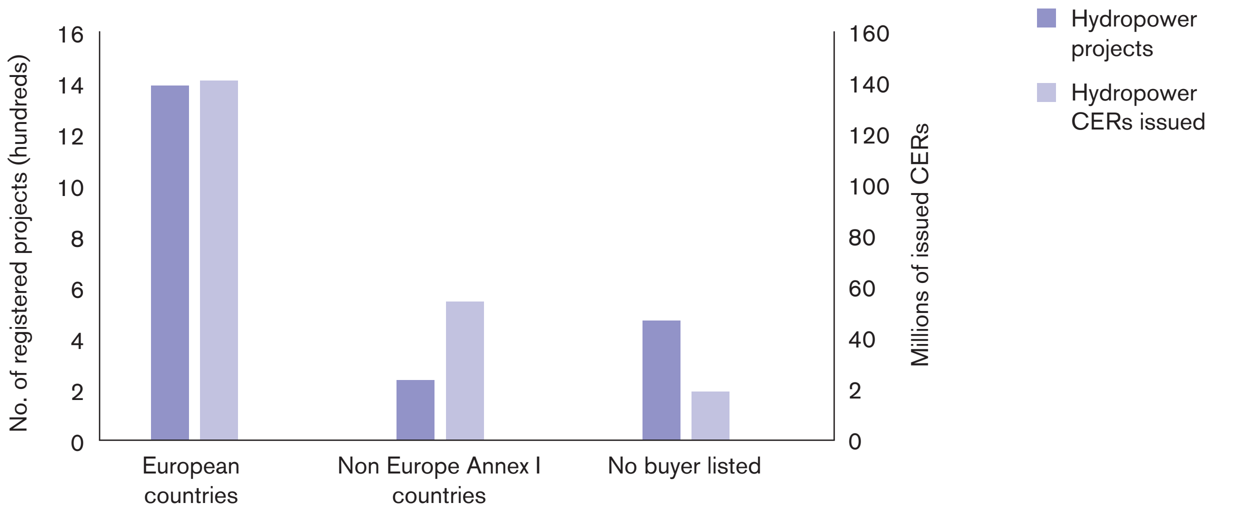


Figure 6. The total number of registered CDM hydropower projects provided with a LoA by European and Non-European supporting states, and the maximum number of CERs issued for these projects per supporting states, between 2005–2015



Global carbon finance for hydropower has flowed towards the emerging economies in a pattern dominated by China (Figure 5), which represents 78 per cent of the hydropower CERs to date. China's political shift towards support for renewables has created a very large market with a more favourable investment climate and high price expectations[16,17] than in the other BRICS countries.

Most of the investment in hydropower comes through European countries, supporting 1384 projects and 140 MtCO_2e reductions confirmed (Figure 6). But 470 hydropower CDM projects are yet to receive approval from any Annex I country, meaning their US$18.9 million worth of CERs can only be used towards the host countries' Kyoto Protocol targets. These projects are concentrated in 2012/13, and may reflect a rush for registration before the first Kyoto Protocol Commitment Period and Phase II of the EU ETS closed. They may have missed the deadline, or may be yet to receive their Annex I LoA. Of the non-European CDM support in hydropower, Japan has supported 70 per cent of projects, dominating the early years of CDM hydropower investment but has now reduced its activity considerably[1,7].

3.2 Focusing on European CDM contribution

European nations have supported 3,266 registered renewable energy projects, according to the CDM Pipeline database. All except those supported by Norway, Liechtenstein and Iceland pre 2008, and by Switzerland, are covered by the EU ETS, with hydropower and wind representing the vast majority (Figure 7). Large hydropower, with its economies of scale, has produced 37 per cent of renewable energy CERs whereas small hydropower accounts for only 8 per cent, further highlighting the significance of large hydropower schemes for greenhouse gas mitigation.

Wind and hydropower CDM projects show similar trends throughout the Kyoto Protocol Commitment Periods and EU ETS phases, with peak registrations for both during 2012. Both technologies have similar market forces[18] but the relatively greater number of wind projects registered at the 2012 peak (Figure 7) may suggest buyers were preferring wind projects, which seem able to pass more quickly through the CDM pipeline[12,19].

Figure 7. Timeline of CDM wind and hydropower projects, and hydropower projects technically subject to "respect" the WCD (>20 MW), and **A.** the percentage of CERs issued to date for all renewable energy projects with European support (310 million issued CERs), between 2005–2015

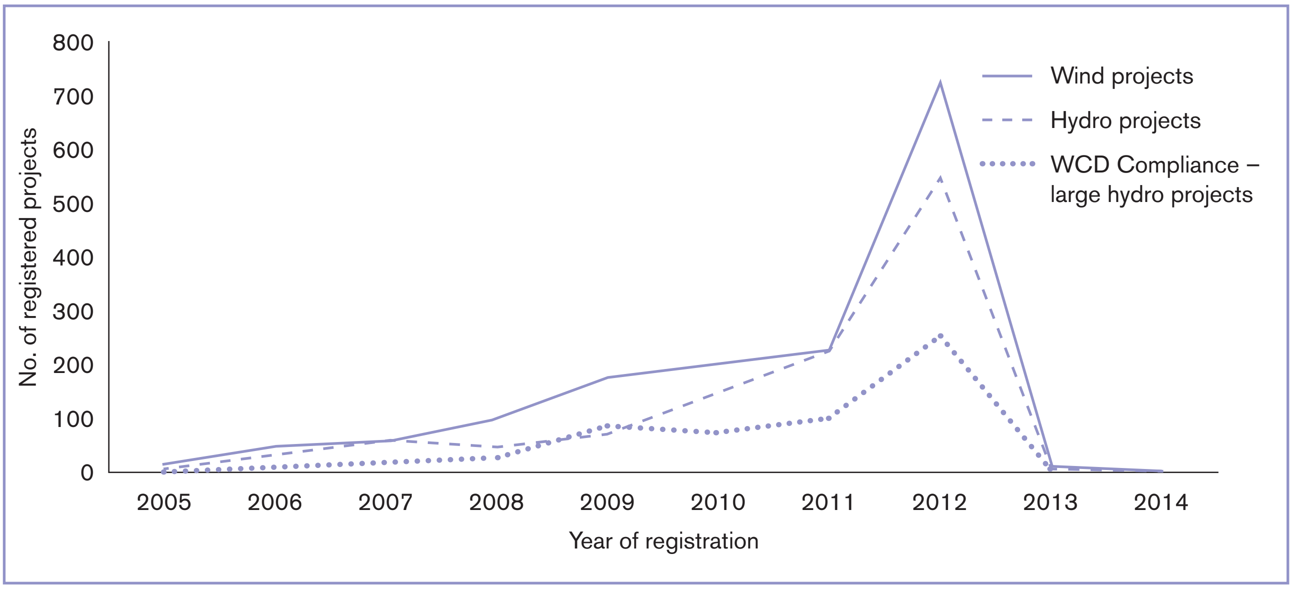
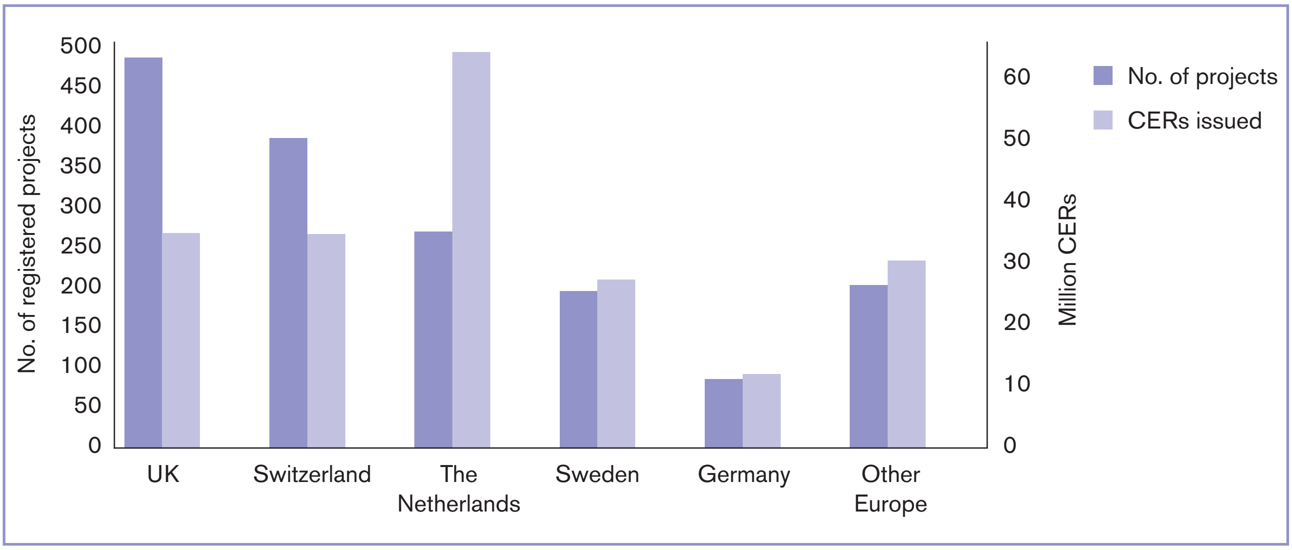
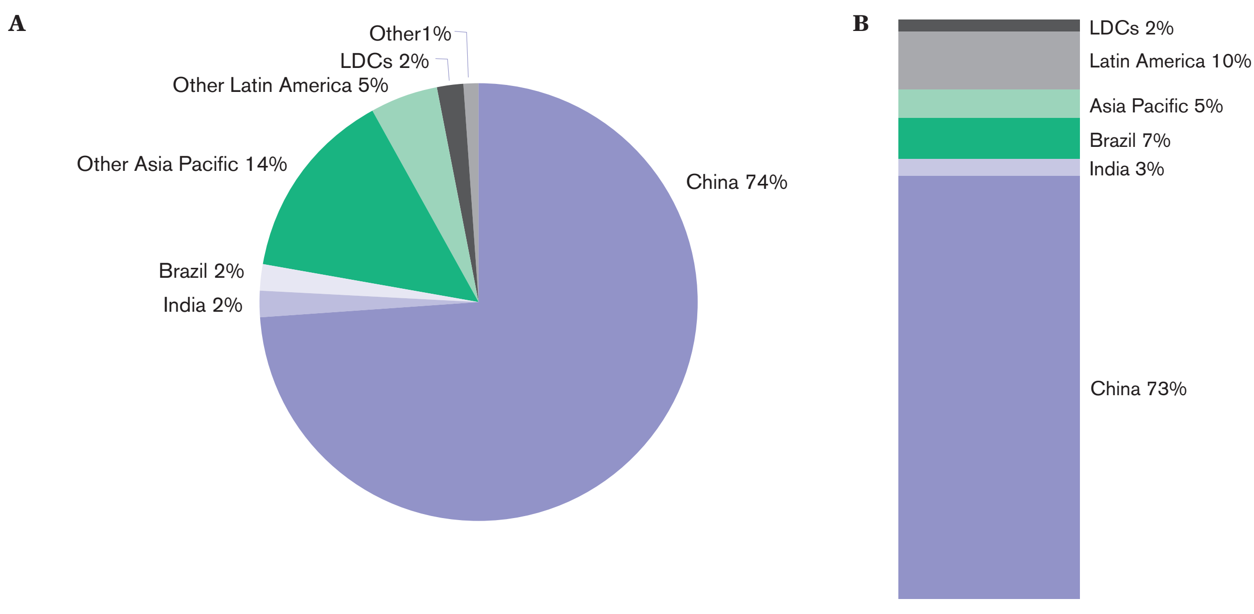


Figure 8. The number of registered CDM hydropower projects by main European supporting states through the provision of a LoA, and the maximum number of CERs issued for these projects per supporting states, between 2005–2015



Of the 31 EU ETS States, 17 have supported CDM hydropower. The Netherlands, the UK, Sweden and Germany are most actively involved, both in terms of projects and emissions reductions (Figure 8). Switzerland has also been a major player and, when included in the European dataset, is the second most active nation. Figure 9 shows how European-supported CDM hydropower projects are even more heavily focused in China than the overall global investment is (74 per cent, compared with 64 per cent in the global analysis). The UK and Swiss involvement follows the global distribution of projects because buyers purchase and then sell 'over the border', so are not necessarily used towards their own emissions reductions targets[20]. The CDM has registered 1384 hydropower projects with European support. Assuming all supporting

Figure 9 **A.** Percentage of host countries for registered CDM hydropower projects with European support (1384 registered projects), and **B.** subsequent CERs issued per host country to date (141.3 million issued CERs), between 2005–2015



European nations conform to the EU Linking Directive (see above), over 54 projects were required to "respect" the WCD guidelines pre-2009, and over 433 should have followed the WCD Compliance Report Template post-2009 (Figure 7). However, using the registration date produces uncertainty, given the range in possible dates for the European nation to provide a LoA. At its longest, registration can take two years[17]. So accurately determining trends in hydropower respect for the WCD requires further investigation.

3.3 Top European nations supporting CDM hydropower

Looking more closely at European countries financing both small (Figure 10) and large (Figure 11) CDM hydropower schemes, five nations emerge as most active. The United Kingdom, Switzerland, the Netherlands, Sweden and Germany collectively cover over 86 per cent of CERs issued that involve a WCD assessment. Project developers can apply through any of the EU ETS DNAs so the picture is perhaps influenced by the market's perceptions of the transaction costs and reliability or rapidity with which individual DNAs assess and decided upon proposals. Language considerations may also come into play.

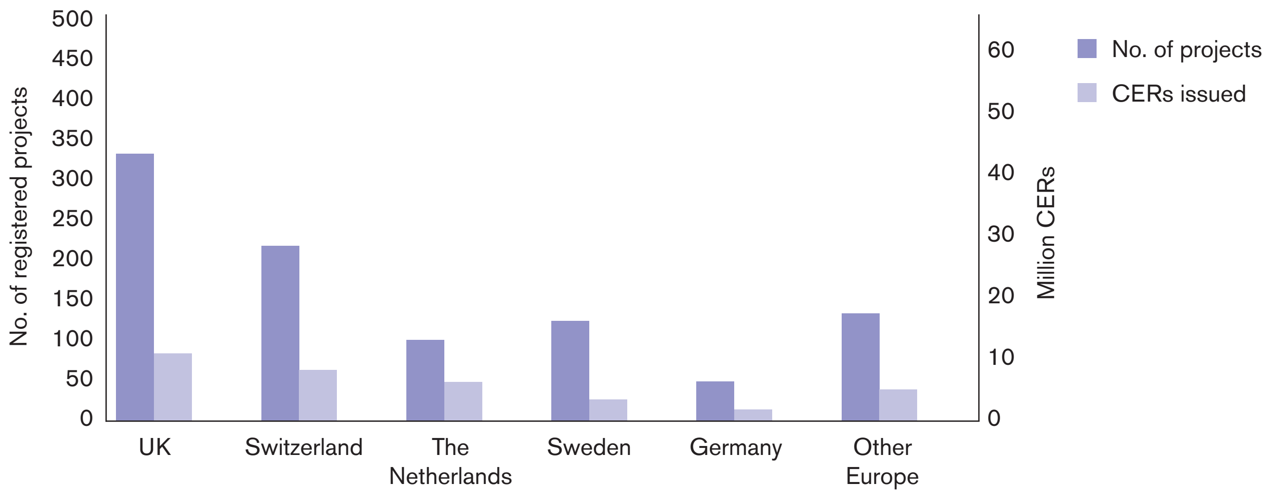
Addressing the effectiveness of the WCD framework in promoting better E&S outcomes remains very difficult because there is no publically available data on whether DNAs reject hydropower projects, and if so for what reason. However, some trends have been identified by analysing the top four[21] European DNA LoA records (Figure 12). Germany was not included as the date of LoA approval was not easily accessible.

The Dutch were the most active European DNA accepting large hydropower but support fell around the time of the introduction of the WCD Compliance Report Template. Swiss authorisations show a similar trend. It is known that significant uncertainty was created regarding the eligibility of large hydropower CERs around this time[5]. However, the UK and Swedish DNA profiles do not show a decline.

Notably, these top European DNAs (Figure 12) clearly show varying LoA procedures, such as on multiple LoAs. For example, 14–16 per cent of Swiss and UK LoAs were provided to hydropower projects that had already received a LoA, whereas the figure was just 5 per cent for the Netherlands.

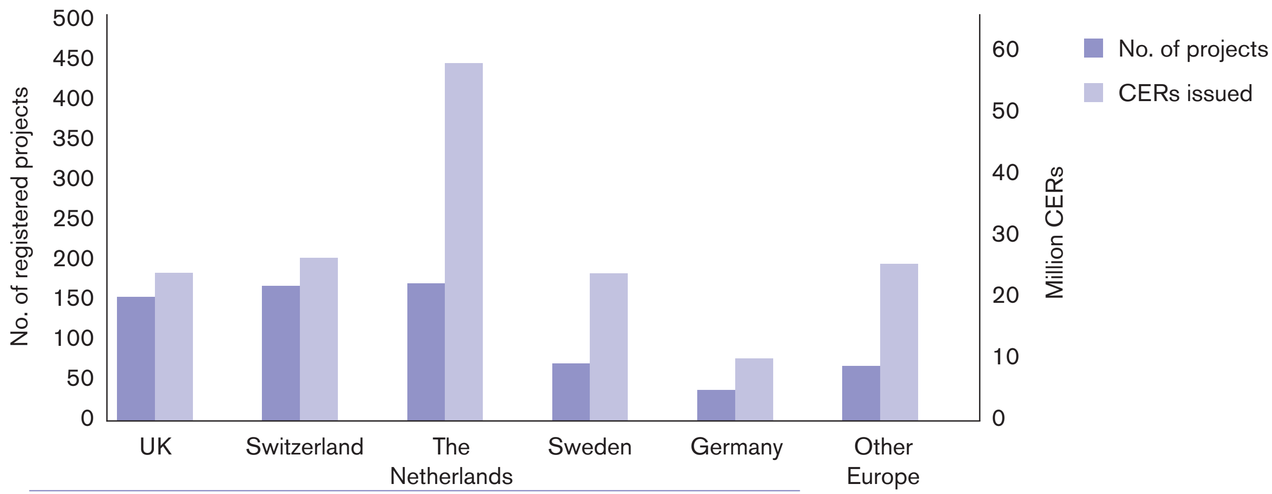
The Dutch DNA database is the only one to show the numbers of large hydropower projects demonstrating respect for WCD through the Compliance Report Template (the black line on Figure 12). But several large hydropower projects post-2009 show no mention of the Template or "respect" of the WCD guidelines. At best

Figure 10. The number of registered CDM small (<20MW) hydropower projects by main European supporting states through the provision of a LoA, and the maximum number of CERs issued for these projects per supporting states, between 2005–2015



Note: these do not provide cumulative figures as more than one country can provide a LoA.

Figure 11. The number of registered CDM large (>20MW) hydropower projects by main European supporting states through the provision of a LoA, and the maximum number of CERs issued for these projects per supporting states, between 2005–2015

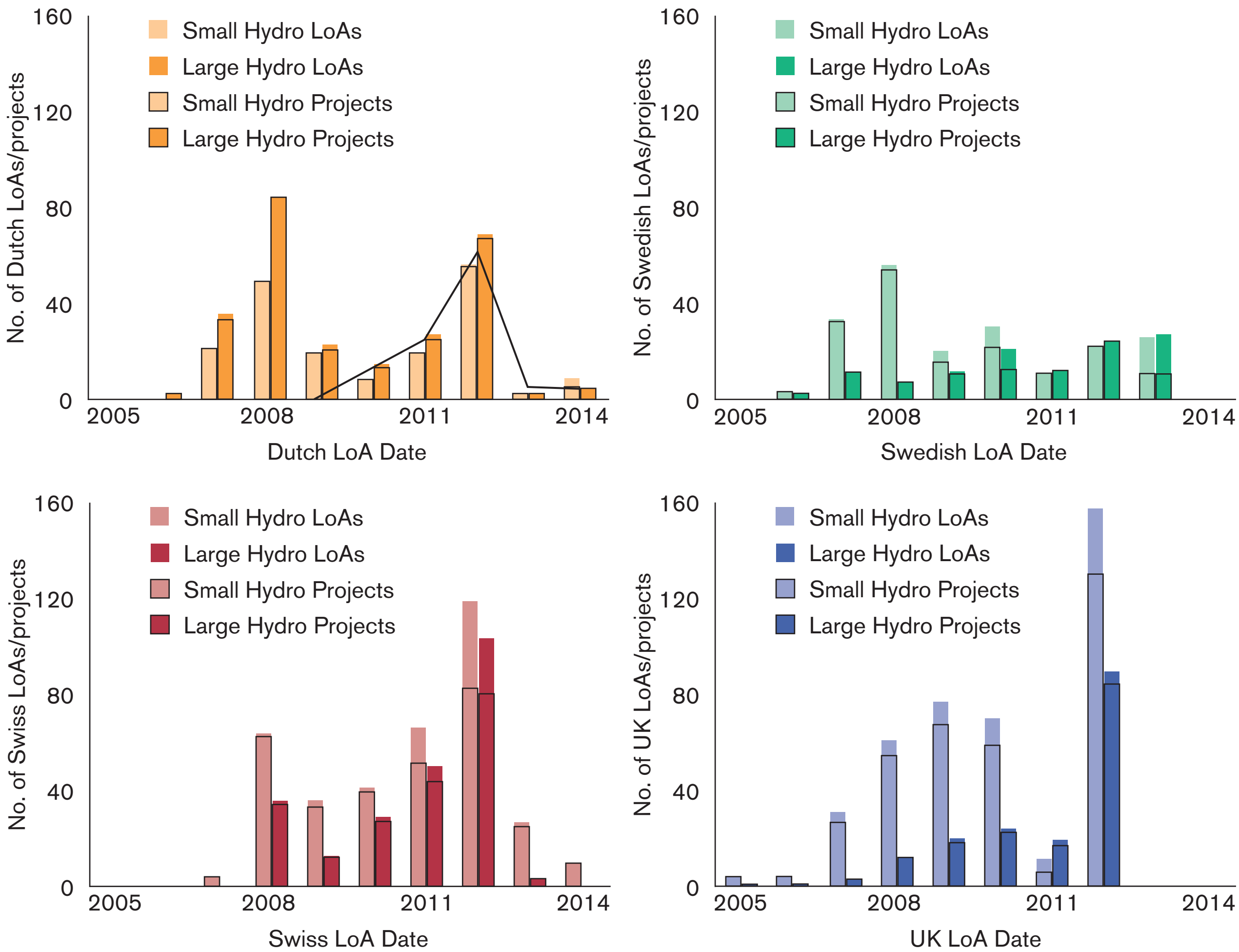


Note: these do not provide cumulative figures as more than one country can provide a LoA.

this provides further evidence of the poor E&S recording and reporting procedures for CDM projects. At worst, some hydropower projects may be escaping evidence based E&S performance review.

Overall, the trends in CDM large hydropower, along with the response of select DNAs and carbon exchanges to the Compliance Report[19], suggests the EU Linking Directive has not certainly reduced 'bad' hydropower projects, but may instead have limited carbon finance by creating additional interpretation problems and lengthened project acceptance[5,12].

Figure 12. LoAs issued per year for large and small CDM hydropower projects by the Dutch (orange), Swedish (green), Swiss (red) and the UK (blue) DNAs



The tables show total projects with LoAs and total cumulative LoAs. The black line shows the number of projects demonstrating a WCD Compliance Report Template for Dutch projects. Note I: there are no publically available LoA records for the UK post 2012 since the DNA changed to the Environment Agency. Note II: includes both registered and potentially non-registered projects (see Appendix).

Financial implications of improved E&S safeguards

This section provides a simple 'payback period' analysis examining what carbon prices are needed to make the Hydropower Sustainability Assessment Protocol (HSAP) (and other safeguards) viable if made a condition of attaining carbon finance. It also compares potential carbon revenue with power sales revenue to determine whether this can incentivise additional E&S safeguarding such as the HSAP.

4

Hydropower E&S safeguarding through the EU Linking Directive and “respect” for the WCD has been ineffective[3], and may even be preventing carbon finance flows[19]. With hope of an invigorated carbon market following COP21 and emerging allowance based systems in industrialising economies[1], a new policy position is needed on both large and small hydropower.

The best option available is the HSAP (see Box 2), however, adopting this as a mandatory requirement for assessing “respect” for the WCD, would cost US$80,000–150,000 per project[11,3], presenting a potential barrier to many investors. This section examines the financial viability of the HSAP, and whether the cost of such mandatory assessments could be covered by the carbon finance revenues they generate.

We have used a simple ‘payback period’ analysis to illustrate how carbon finance affects project revenue and the ability to cover additional transaction costs. Like other financial metrics for cash flow analysis, such as internal rate of return and return on investment, the payback period takes an ‘investment view’, comparing the costs of HSAP against the additional cash flow generated from carbon credits (see Appendix). The analysis is framed around three interrelated questions:

- What financial incentive does carbon financing offer to private and corporate investors contemplating hydropower projects in developing countries?
- Is this financial incentive enough for investors to voluntarily fund independent E&S assessments, such as the HSAP?
- To what extent are transaction costs and these financial incentives affected if access to carbon finance is made conditional on such E&S assessments at each stage of the project cycle?

We considered five E&S and monitoring assessment cases that can be related to CDM project development procedures (see Figure 2):

Case 1: Typical UNEP CDM transaction costs only (i.e. business as usual).

Case 2: Case 1 plus one HSAP assessment at the project preparation stage. This case also considers a US$1 million or US$2 million incremental Environmental and Social Impact Assessments (ESIA) as result of the HSAP for projects >20MW and <20MW respectively.

Case 3: Case 1 plus reservoir emissions monitoring on hydropower projects >20MW.

Case 4: Case 2 and 3 combined (typical UNEP CDM transaction costs plus reservoir emissions monitoring for projects >20MW).

Case 5: Case 4 plus four HSAP assessments, one at each stage of the project cycle from pre-planning to operation (see Box 2 and Figure 2).

The analysis concentrated on Commitment Period 2 in the CDM Pipeline database to maintain applicability to future hydropower projects. If the additional EU ETS scheme access and safeguard expenditure can be repaid in less than three years it is considered financially viable[22]. This payback was performed at CER prices of US$1 and US$9, representing a low and medium-high carbon price (see Figure 1). For more on the methods of our analysis, see the Appendix.

4.1 Simple payback analysis

The outcomes for all five transaction cases are outlined in Table 2, illustrating the relative commercial incentive provided by carbon finance for investors under a range of different E&S monitoring cases. The simple payback analysis produced several key trends:

- Payback periods are shorter for large hydropower projects compared to small hydropower due to economies of scale.
- As more transaction costs are included, such as HSAPs, improved ESIAs and reservoir emissions monitoring, the payback lengthens, most significantly with small hydropower projects.
- Including mandatory HSAPs and improving the ESIA sharply extends the payback period when the carbon price (CERs) is low, but less significantly when high. For instance, at a CER price of US$1 the payback period for typical CDM transaction costs rises from 1.1 years for ‘business as usual’ (Case 1) to four years for one HSAP and an ESIA (Case 2) for the average large CDM hydropower project, and from 5.4 to 18 years for the average small CDM hydropower project. Conversely, when a CER is worth US$9 the payback period for Case 2 rises only marginally above Case 1 (‘business as usual’) for large hydropower.
- On average, large hydropower schemes achieve payback in three years (the assumed acceptable period) for Case 2 when carbon prices are US$1.4. For small hydropower carbon prices must reach US$6 for a three year payback under Case 2.
- For Case 5, which includes all four HSAPs, improved ESIA (for large hydropower only) and reservoir emissions monitoring (see Table 2), carbon prices of US$4.4 and US$9 respectively are needed for large and small CDM hydropower projects to achieve payback in three years.

- When the CER price rises to US$9, in line with 2015 EUA prices (see Figure 1), payback takes under three years for both large and small hydropower under almost all situations: the single exception is small hydropower under Case 5.

Figure 13 displays the payback time with a varying CER price (US$1–15) for Case 4, and Figure 14 compares Cases 1 versus 5 over the same range in carbon prices. The flattening of the payback curve in Figure 13 as the CER price rises beyond US$6–7 shows that the payback time remains below the three year threshold and also becomes less sensitive to the transaction costs. Conversely, when the CER price falls below US$3 the payback curve steepens, and price sensitivity increases.

This confirms that carbon finance provides little incentive for implementing additional E&S safeguarding and monitoring procedures after the price collapse from mid-2011 onwards (see Figure 1). Indeed, even the present monitoring and verification costs for general CDM projects have been seen as a barrier for many investors[8] and reducing these costs have consistently been a priority with the CDM Executive Board and UNFCCC[17] . Conversely, if the CER price was to recover to that reached in 2008–11, in excess of US$9, investment in hydropower, even with additional E&S safeguarding procedures, would be highly attractive.

Table 2. Simple payback of carbon transaction costs by carbon revenue at a CER price of US$1 and US$9 for the five E&S and reservoir monitoring cases.

SIMPLE PAYBACK ILLUSTRATION (BALANCING CARBON TRANSACTION COSTS AND REVENUE WITH/WITHOUT HSAP(s) AND IMPROVED ESIAs		SIMPLE PAYBACK PERIOD (YEARS)			
		AVERAGE LARGE HYDROPOWER PROJECT >20 MW		AVERAGE SMALL HYDROPOWER PROJECT <20 MW	
		AT US$ 1/CER	AT US$ 9/CER	AT US$ 1/CER	AT US$ 9/CER
Case 1	Assuming typical UNEP CDM transaction costs only (i.e. no HSAP or reservoir emission monitoring requirement)	1.1	0.1	5.4	0.6
Case 2	Case 1 plus one HSAP at project preparation plus $US1/2 million increments for small/large hydropower in ESIAs	4.0	0.5	18.1	2.0
Case 3	Case 1 plus reservoir emission monitoring on the average project >20MW (no HSAP)	7.2	0.8	5.4	0.6
Case 4	Assuming Case 2 and 3 combined	10.1	1.1	18.1	2.0
Case 5	Case 4 plus four HSAPs (one at each stage of the project cycle from pre-planning to operation)	13.1	1.5	27.6	3.1

Figure 13. Simple payback of carbon transaction cost from carbon revenue versus market carbon price (US$/CER) for Case 4, for the average large and small CDM-CP2 hydropower project

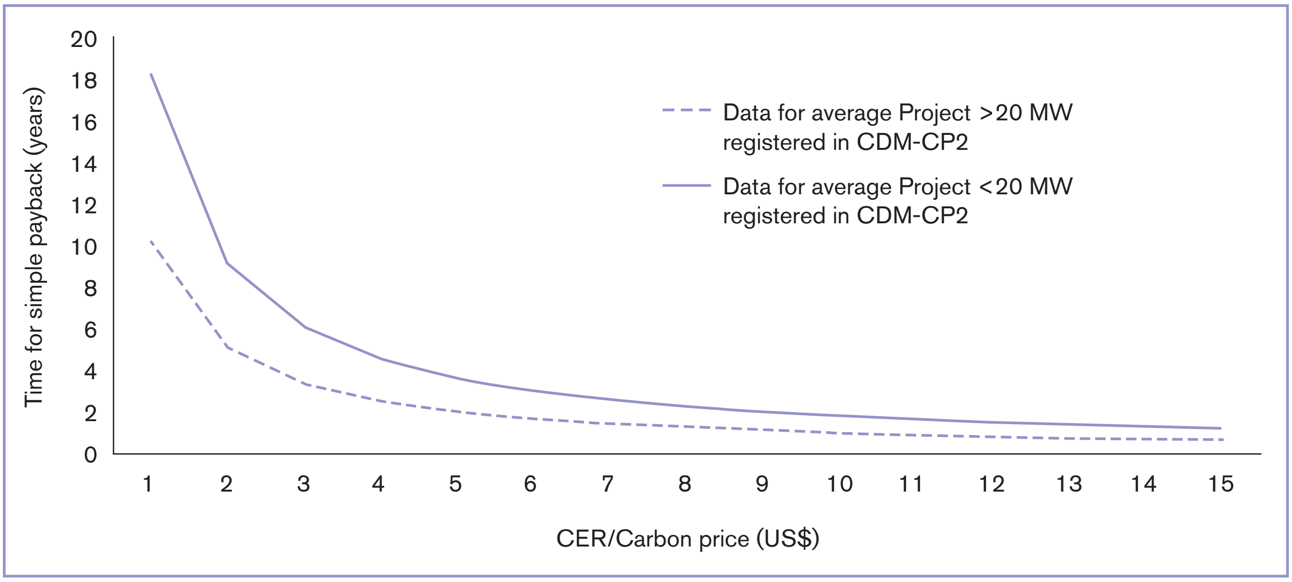
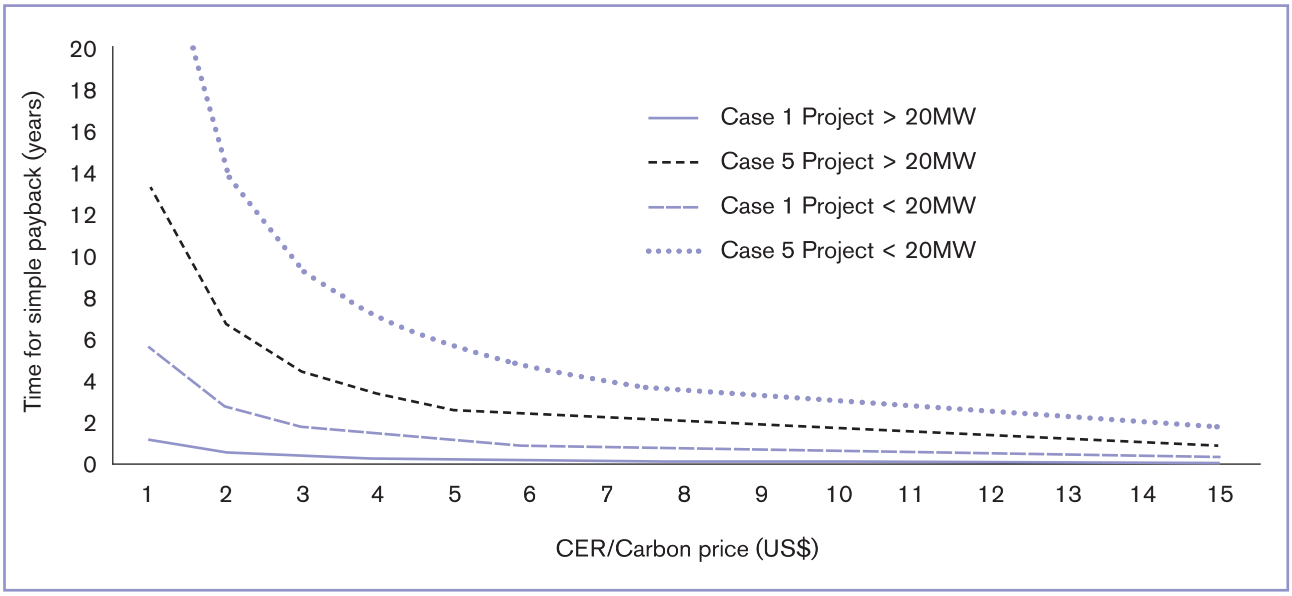


Figure 14. Comparison of Case 1 and Case 5 payback of carbon transaction costs from carbon revenue for the average large and small CDM-CP2 hydropower project



4.2 Carbon revenue

Although carbon revenue is often small compared with power revenue it can still improve a project's ability to leverage financing and equity investment by letting the project carry higher debt [6,7]. However, since the aim of the CDM is to offset less capital intensive thermal power generation, the carbon revenue for hydropower needs to be considered in the context of the added transaction cost required to undertake additional E&S safeguarding mechanisms (either HSAP or WCD) and hence access the available financing.

The carbon revenue analysis (for details of methods and assumptions see the Appendix) provided the following insights:

- The average large CDM hydropower projects registered during the Kyoto Protocol's second commitment period (CP2) generates 617,961GWh/yr, translating to around US$49.4 million/yr in gross power revenue and 365,906CERs/yr.
- The average small CDM hydropower project registered in CP2 generates 40,180GWh/yr, or US$3.2million/yr in gross power revenue and 22,030CERs/yr.

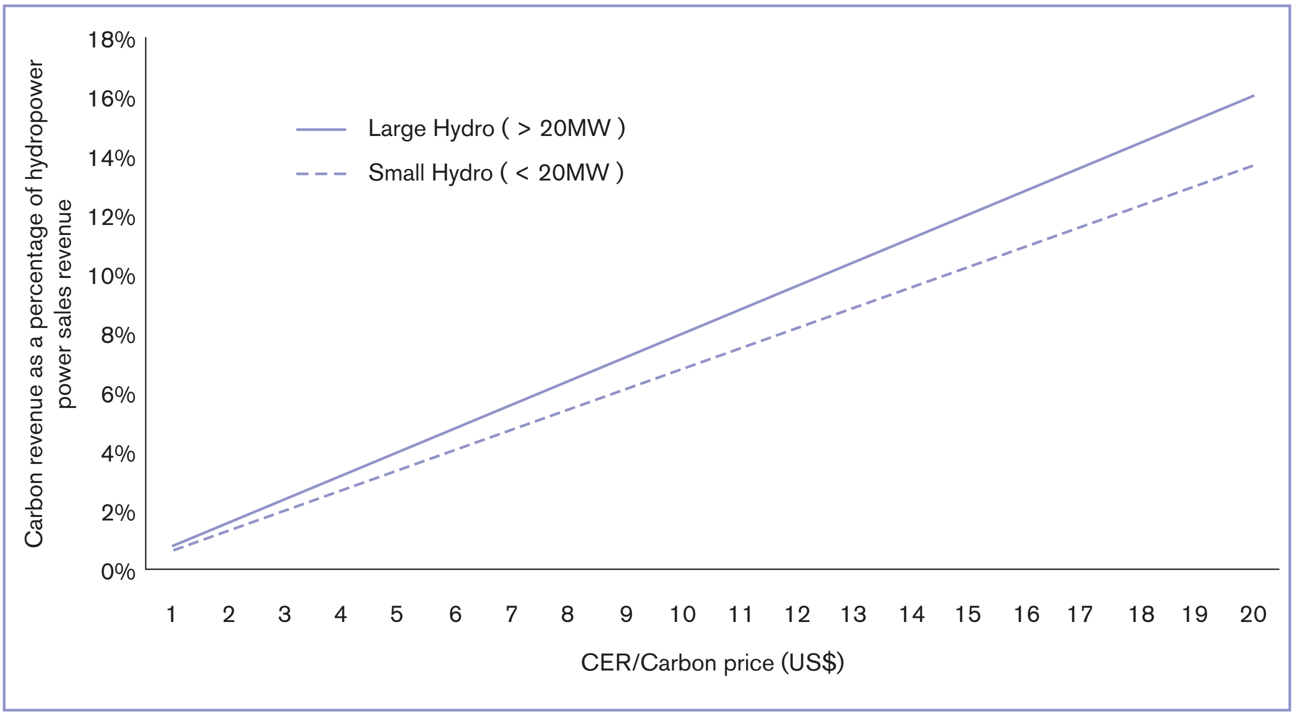
Consequently, at a CER price of US$1 the carbon revenue is less than 0.8 per cent of the power revenue for the average large and small CDM hydropower project. However, when the CER price rises to US$9 the carbon revenue then rises to 6.2 and 7.2 per cent of the power revenue respectively (Figure 15). Combined with past experiences in the CDM (see next section) carbon prices in 2015 offered little incentive for investment in hydropower, especially as they require additional transaction costs for market entry. But if the price rises above US$9 per CER (as has been seen in the past), carbon revenue would increase to 6–7 per cent of the power revenue, creating a real revenue incentive for renewable energy project investment. From a policy-makers perspective, prices of US$6–9 per CER would not stifle CDM entry and would allow short payback times for the additional costs incurred.

4.3 Case study: the Bujagali hydroelectric project

The 250MW Bujagali hydropower project in Uganda, which began commercial operations in 2011, provides a helpful example of how carbon revenue fits into the overall project financing picture for large hydropower within the CDM. The Bujagali project is 2.2 times the average size of large hydropower presently within the CDM Pipeline, and its power density is above 10W/m^2, meaning reservoir emissions are considered negligible.

A recent study by Frisari and Micale[6] examined the risk mitigation instruments for renewable power generation using the Bujagali hydropower project as part of its analysis. Bujagali has two sources of project revenue, a power purchase agreement (PPA) which includes the

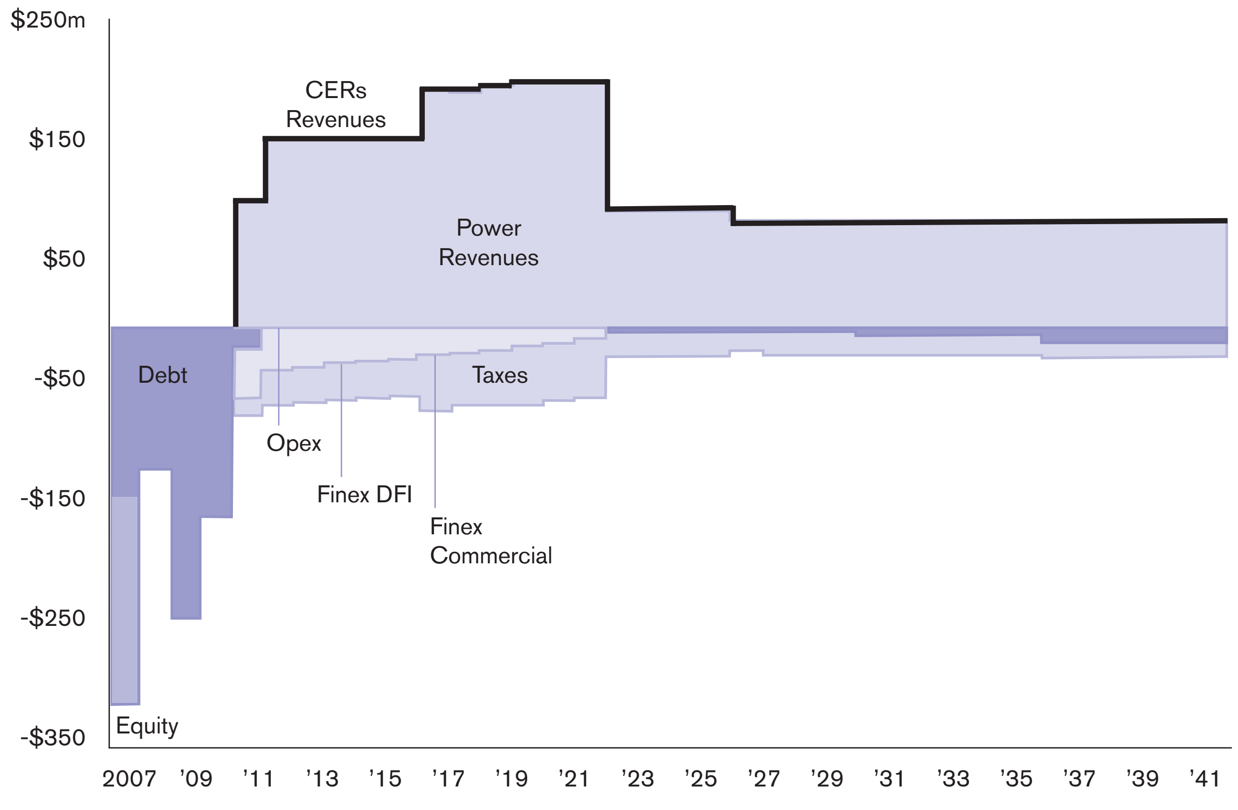
Figure 15. Carbon revenue from emissions reduction purchase agreements as a percentage of power sales revenue (from Power Purchase Agreements) versus carbon market price (US$/CER) for the average large and small CDM-CP2 hydropower project



project company Bujagali Energy Ltd. and an emissions reduction purchase agreement (ERPA), co-signed by the Government of the Netherlands (Annex I DNA), Uganda (host country DNA) and Bujagali Energy Ltd. The scheme was expected to generate 1,338GWh/yr and be credited with 858MtCO_2e/yr in emissions reductions. Total carbon revenue generation by the ERPA was estimated at US$4.3 million/yr for the first 12 years of operation, which suggests a CER value of around US$5. That makes the carbon revenue 2–2.8 per cent of the power sales in the first 12 years and 4.8–5.1 per cent thereafter (see the Appendix for details of the assumptions underlying this calculation). These fall within the range of the payback curves (see Figures 13 and 14), illustrating the significance of carbon finance to power revenue.

Figure 16 shows the expected cash flow for the Bujagali project after financial closure. Loans and equity injection were used between 2007–2011, followed by debt servicing, dividend payments, taxes and operational costs after commercial operations began in 2011. The revenue flow from conventional power revenue is shown to be significantly greater than the revenue from the expected CERs. However, this carbon finance was also a particularly important tool for stimulating additional debt raising potential[6] and the PPA revenue term reduces after the majority of commercial debt is retired.

Figure 16. Projected cash flows (US$ million) under the purchasing power agreement for the Bujagali Hydroelectric Power project, with the carbon revenue from the sale of issued CERs in black



Source: adapted from Frisari and Micale, 2015[6]

Looking forward

By May 2015, the CDM had registered 2064 hydropower projects, of which up to 573 should have been covered by additional E&S safeguarding mechanisms in the form of "respect" for the World Commission on Dams' (WCD) guidelines, as required under the EU Linking Directive.

The EU ETS and Switzerland constitute the largest flow of financing from OECD to BRICS and LDC countries for hydropower, and the only one including legally binding environmental and social safeguards. The main European countries supporting these projects are the United Kingdom, Switzerland, the Netherlands, Sweden, and to a lesser extent Germany, but compiling data on EU ETS support, and CER attribution and sale is challenging because information is often scattered between agencies as there is no clear central registry.

EU legislators intended to ensure that large dams >20MW financed by the EU ETS respected the WCD guidelines, and could be considered environmentally, socially and economically sustainable. However the way EU member states ensure compliance is very weak, partly because the WCD's provisions are hard to measure and report on for individual dam projects, and partly because the EU voluntary self-assessment process is badly designed. Any additional barriers to large hydropower investment through the CDM have developed more through confusion on how to implement the WCD guidelines than through setting the sustainability bar too high and rejecting unsustainable projects[19,5].

OECD member states are caught between wanting large hydropower built to reduce global carbon emissions, and recognising how badly-sited or planned hydropower can damage ecosystems and communities. There is a continuing need for systems that weed out bad projects while supporting sustainable ones. Otherwise, carbon finance mechanisms may increasingly marginalise large hydropower, as has already occurred in the Swiss and New Zealand cap and trade systems[23,4].

The International Hydropower Association has developed a Hydropower Sustainability Assessment Protocol (HSAP) that measures sustainability across a broad set of indicators, and incorporates standards from the World Commission on Dams, World Bank, Equator Principles and the International Finance Corporation, amongst others. All carbon financing streams would benefit from using this Protocol to measure the sustainability of individual projects.

A HSAP costs between US$80,000–150,000, depending on the project's complexity. Financial analysis shows that, with a carbon price above US$9/$tCO_2e$, the costs of HSAP assessments at all four project stages, and of the additional ESIA and reservoir monitoring, can be recouped from carbon revenue within three years. Furthermore, the HSAP's additional transaction costs might provide a case for 'additionality' (as required by the CDM) for many hydropower projects currently unable to receive carbon finance[24,12]. Private developers may be unable to justify funding a voluntary HSAP without additional carbon finance revenue, yet proven sustainable projects have fetched price premiums. Thus carbon market mechanisms can also play an important role in broadening improved E&S safeguarding mechanisms.

Carbon prices have been low for several years and requests for CDM financing for large hydropower have decreased since 2012. However, with the promotion of carbon market linkages and a new market mechanism within the 2015 Paris Agreement, there are hopes of a revitalised carbon market and cap and trade systems that can incentivise reduced emissions from the private sector in the future.

We recommend:

- The EU ETS should adopt the HSAP as the best tool to measure "respect" for World Commission on Dams guidelines, and reduce the use of the voluntary template (2009) for hydropower projects.
- It is essential to harmonise data presentation and improve the transparency of project records, notably concerning the distribution of offsets between investors; the date at which project approval from supporting countries is provided, and improved reporting transparency on why some projects fail to gain accreditation and/or approval. A successful carbon market hinges on the availability of information. Confusion on sustainability issues has already seen hydropower offsets being traded at discounted prices or even banned.
- Emerging trading systems should similarly consider adopting the HSAP before financing hydropower projects.

Appendix: Methodological issues

Portfolio analysis

The data in the CDM Pipeline Database[14] and those of the main European DNAs[15] are not systematically consistent. We encountered numerous issues that ultimately led to some compromises in data analysis. The main three areas of inconsistency were:

- Differences in total project numbers between the CDM Pipeline and European DNA databases. The four main national DNAs were contacted to determine the reasons behind these differences but were unable to provide a clear response. The German DNA suggested that the CDM Pipeline Database would be the more accurate source, but this did not provide all the information required for our analysis. This problem was compounded by many poor recording techniques within the DNA databases, which made it impossible to locate some projects even though they were known to have received a LoA.
- Within the DNA databases many projects are duplicated, i.e. LoAs were provided to each investor entity. Many of these duplicated projects also recorded different LoA dates. We based our selection on the closest match between the registration date in the CDM Pipeline database and the LoA date.
- The DNA databases do not record the updated status of projects within the CDM pipeline, therefore absolute project numbers are different to those extracted from the CDM Pipeline Database.

A sensitivity analysis showed that the difference in projects between the DNAs and the CDM Pipeline Database varied by up to 25 per cent in the case of the Netherlands, and down to just 5 per cent for Sweden. This further highlights the need for improved and harmonised recording techniques to enable carbon finance and E&S safeguarding procedures to be tracked.

Transaction costs

Transaction costs involved in accessing CDM carbon financing and the expected carbon revenue flows are primary elements of the simple payback calculation. Some transaction costs are one time, whereas others are recurrent. For hydropower projects they occur during the project preparation, construction and operation stages, including activities for CDM assessment, monitoring, reporting and administration functions. We used reported transaction costs for small and large scale CDM projects as a starting point[25] (columns 1–4 in the table below). We then used this with analysis of the average hydropower (large and small) project in the CDM Pipeline Database.

Table 3. Assumptions on CDM transaction costs for hydropower projects (>20MW).

CDM PROJECTS - UNEP DATA ON ALL TYPES				ASSUMPTIONS FOR CDM HYDROPOWER PROJECTS >20 MW	
ACTIVITY	COST (LARGE-SCALE PROJECTS, US$)	COST (SMALL-SCALE PROJECTS, US$)	TYPE OF COST	COST ASSUMED (US$)	BASIS FOR ASSUMPTION
Planning phase					
Initial feasibility study, i.e. Project Idea Note (PIN)	5,000–30,000	2,000–7,500	Consultancy fee or internal	17,500	Assumes middle of large scale-project cost range.
Project Design Document (PDD)	15,000–100,000	10,000–25,000	Consultancy fee or internal	57,500	as above
New methodology	8,000–30,000	6,500–10,000	DOE fee	19,000	as above
Validation	8,000–30,000	6,500–10,000	DOE fee	19,000	as above
Registration fee (advance on SOP-admin – see below)	10,500–350,000	0–24,500	CDM EB fee	180,250	as above
Total CDM-specific costs – planning phase	38,500–610,000	18,500–117,000		324,250	as above
Construction phase					
Construction, plant and equipment	Variable, depending on project type.		Contractors fees		Assume cost is not CDM specific.
Installation of monitoring equipment	Usually minimal relative to total plant and equipment cost.		Contractors fees		Assume cost is not CDM specific except for reservoir emission monitoring (below).
Reservoir baseline emission monitoring	Cost added to UNEP table which is specific to hydropower only. Requirement depends on power density (W/m^2) of reservoir surface area. If >10W/m^2 emission monitoring is not required.			300,000	Assumes hydro specific in-situ baseline monitoring (e.g. regular/daily sampling, laboratory testing of samples, logistics/labour, equipment O&M, reporting, etc.)
Other Incidental / reporting costs	Cost added to the UNEP table which is specific to hydropower only.			50,000	Assumed cost per year for hydropower specific reporting (best guestimate).
Total CDM-specific costs – construction phase	Usually minimal relative to total plant and equipment cost.			2,150,000	Assumes a 7-year construction period for large scale projects.

CDM PROJECTS - UNEP DATA ON ALL TYPES				ASSUMPTIONS FOR CDM HYDROPOWER PROJECTS >20 MW	
ACTIVITY	COST (LARGE-SCALE PROJECTS, US$)	COST (SMALL-SCALE PROJECTS, US$)	TYPE OF COST	COST ASSUMED (US$)	BASIS FOR ASSUMPTION
Operation phase					
UN Adaptation Fund fee	2 per cent of CERs	2 per cent of CERs	EB fee	71,263	Assumes 2 per cent of 395,906CER/yr calculated as the average for CDM CP2 registered projects >20 MW, and US$/CER of US$9.0.
Reservoir emission monitoring programme	Cost added to the UNEP table which is specific to hydropower only. Requirement depends on power density (W/m^2) of reservoir surface area. If >10W/m^2 emission monitoring is not required.			300,000	Assumed cost per year of ongoing reservoir monitoring programme, (e.g. requiring activities similar to the operation phase monitoring programme).
Initial verification (incl. system check)	5,000–30,000	5,000–15,000	DOE fee	15,000	Assumes middle of large scale-project cost range (Col2).
Ongoing verification (periodically)	5,000–25,000	5,000–10,000	DOE fee	15,000	As above
Share of proceeds to cover administration expenses (SOP-admin)	The fee paid at registration is effectively an advance that will be 'trued up' against actual CERs issued over the crediting period (if different to emission reductions projected at registration). SOP-admin is not capped.		EB fee	20,000	Assumed cost per year for fees (best guestimate).
Total CDM-specific costs – operation phase	Variable – minimum 2 per cent of CERs plus 5,000/year (if verification undertaken annually).			421,263	Includes the 2 per cent of CER calculated as noted above plus sum of other costs as indicated.

Note: Columns 1 to 4 are carbon transaction costs for all CDM-project types adapted from Fenhann and Hinostroza, 2011[25]. Columns 5 and 6 are the assumptions (see below) applied in this analysis.

Assumptions: Our starting point was the assumption of Fenhann and Hinostroza (2011)[25] for CDM-specific costs for large-scale projects, which are broadly applicable to large CDM hydropower projects (>20MW), and similarly data on all types of small-scale CDM projects, which are broadly applicable to small CDM hydropower projects (<20MW). The mid-range values from the UNEP data were then combined with costs that are specific to hydropower projects only, such as the estimated cost of reservoir emissions monitoring. The hydropower-specific costs generally reflect the higher end of the cost range for reservoir monitoring (as may be required on hydropower projects <10W/m^2 power density).

Payback and revenue calculation procedure: The procedure to calculate the simple payback was straight forward. The total transaction cost at a given carbon price is divided by the gross CER revenue per year at that same carbon price (for results see Table 2, section 4). The most significant transaction cost that depends on carbon prices is the UN Adaptation Fund fee of 2 per cent of CERs. The calculation of carbon revenue per year was based on the 'average' hydropower project generating 395,906CER/yr and 22,030CER/yr respectively for the projects above and below 20MW registered in CDM CP2 (i.e. from 2013 to the point of analysis).

Table 4 illustrates the procedure for calculating the carbon revenue for the average hydropower CDM project (for projects above and below 20MW) and shows carbon revenue as a percent of power sales revenue. A key simplifying assumption in the power revenue calculation is US$80/MWh for the bulk supply electricity tariff.

Table 4. Carbon revenue calculation compared with hydropower revenue.

	PROJECTS (>20MW)	PROJECTS (<20MW)	COMMENT/DESCRIPTION
Number of projects	42	53	Projects registered in second CDM-CP2
MWh/yr	25,954,371	2,129,527	Total for all registered hydropower projects in CDM-CP2
CERs/yr	16,628,068	1,167,591	
MWh/yr average	617,961	40,180	Average energy generation per project
CER/yr average	395,906	22,030	Average CER per project each year
Hydro PPA Tariff	US$80	US$80	Assumed US$/MWh (simplified)
Hydro Revenue/yr	US$49,436,897	US$3,214,380	Gross revenue (before costs)
CER Value	US$9.0	US$9.0	Value used in this for illustration
Carbon Revenue/yr	US$395,906	US$22,030	Gross revenue (before costs)
Carbon Revenue as a percentage of Power Production Revenue	7.2 per cent	6.2 per cent	For the "average" project in category
When CERs prices drop to $1.0/CER	0.8 per cent	0.7 per cent	

Acronyms

CDM	Clean Development Mechanism
CDM EB	Clean Development Mechanism Executive Board
CERs	Certified Emissions Reductions
CP	Commitment Period
DNA	Designated National Authority
E&S	Environmental and Social
EEA	European Economic Area
ERPA	Emissions Reductions Purchasing Agreement
ERUs	Emissions Reduction Units
ESIA	Environmental and Social Impacts Assessment
EU	European Union
EUA	European Union Allowances
EU ETS	European Union Emissions Trading Scheme
EUFTA	European Union Free Trade Agreement
HSAP	Hydropower Sustainability Assessment Protocol
JI	Joint Implementation
LDCs	Least Developed Countries
LoA	Letter of Approval
OECD	Organisation for Economic Cooperation and Development
PDD	Project Design Document
PPA	Power Purchasing Agreement
tCO_2e	tonne(s) of carbon dioxide equivalent
UNEP	United Nations Environment Programme
WCD	World Commission on Dams

Related reading

Skinner, J and Haas L (2014) Watered Down? A Review of social and environmental safeguards for large dam projects. http://pubs.iied.org/17517IIED.html

Haas, L and Skinner, J (2015) The business case for bilateral support to improve sustainability of private sector hydropower. http://pubs.iied.org/17573IIED.html

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The Clean Development Mechanism (CDM) has helped finance more than 2000 hydropower projects, representing the largest source of OECD bilateral funding for hydropower. Europe, through its European Union Emissions Trading Scheme, has been the major supporter. However, environment and sustainability regulations intending to ensure 'respect' for the World Commission on Dams' guidelines are falling short, prompting calls to use the industry-led Hydropower Sustainability Assessment Protocol (HSAP). This Issue paper explores CDM project data and finds that, under a healthy carbon price, the cost of the HSAP would not be a barrier to accessing carbon finance, and could even strengthen the carbon market.

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