Upgrading of China SHP Capacity Project
Final Report

Project No.: SAP 140196

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1. Project Background

1.1 Background, Objectives and Project Rationale

Small hydropower (SHP) is a promising option for supplying clean and renewable energy. On one hand, the very low greenhouse gas emission of hydropower on average (Bruckner *et al.*, 2014) offers an important tool for decarbonising energy portfolios under the challenging warming climate around the globe. On the other hand, the use of renewable but intermittent energy sources such as wind and solar, in many cases depend on suitable backup solutions for compensating the fluctuations or storing (Engeland *et al.*, 2017). For the former, hydropower is often a promising tool (Fan *et al.*, 2023). While large-scale development of hydropower is often considered controversial due to its social and environmental implications, small-scale hydropower projects are generally considered environmentally benign and cost effective (Paish, 2002; Gagnon, 2008). However, it is not difficult to conclude through global research and studies that such benefits are dependent on how their environmental impacts are managed.

China is touted as the global leader in SHP development. Among the world's installed SHP capacity (≤10 MW), China accounts for 53% of the total. By Chinese SHP definition (≤50 MW), the installed SHP capacity is even greater, reaching 81,300MW, representing 63.5% of the total potential (128,000MW) (UNIDO and ICSHP, 2022). Yet China's SHP development is not problem-free. Most of its SHP infrastructure was built during the 1970s or 1980s when environmental well-being was not a prevailing concern in general. While producing considerable economic benefits, various problems in planning, technology, and management negatively impact environmental integrity and cause degradation, including alteration of natural water cycle and river connectivity, water quality degradation, biodiversity loss, etc (Yang *et al.*, 2022). Operational safety is another problem of growing concern. The ageing SHP infrastructure pushes up safety risks, and since most SHP projects are located in remote and rural areas, monitoring and regulations are challenged. The remoteness in locations also causes the lack of professional and capable staff for safety management. Underdevelopment in these regions may also mean a priority of economic benefits over safety (Shi and Chao, 2019).

As China's top SHP regulator, the Chinese Ministry of Water Resources (MWR) has ambitious plans to improve and modernise this industry, which was demonstrated in their capacity expansion programmes embedded in the National Five-Year Plans (FYPs). This is relevant on one hand due to SHP's promising role in clean and renewable energy supply, and on the other, necessity to address environmental and safety concerns. During China's 12th FYP (2010-2015), a massive 8.8 billion CNY (c. 1.3 billion USD) central government budget was released by the Chinese Ministry of Finance (MOF) to subsidise capacity expansion and efficiency improvement projects across the country. The governmental subsidies leveraged an additional 15 billion CNY (c. 2.1 billion USD) fund from local governments and private sectors (Xin, 2016; Zhou, 2016). However, as regulated in the MWR and MOF (2011) policy, the subsidies were targeting "refurbishment of electronic systems, metallic structures, and transmission facilities, and prohibited nonproductive uses". Though environmental concerns were mentioned, they were not put in a central place in the 2011 policy. The capacity expansion programme continued in China's 13th FYP (2016-2020) with a total central government contribution of 4.6 billion CNY (0.7 billion USD) (MOF and MWR, 2016; Su, 2023). A major change in the continued programme was that the central government subsidies highlighted efforts to minimise environmental impacts from SHP development, in particular that for releasing and maintenance of minimum ecological flows (MOF and MWR, 2016). In spite of this ambitious goal, much of its materialisation remained as fields that needed to be worked on.

Another important policy targeting SHP safety in China is MWR's programme in operational safety of SHP. Inclusive of SHP, the regulator is responsible for overseeing operational safety of all water engineering projects across the country, and it believes that 'standardising measures should be considered in both the construction and operation of water engineering projects for their entire lifetimes' (MWR, 2011). To adapt to the SHP industry, a three-tiered safety accreditation scheme was introduced in 2013 (MWR, 2013). The scheme addresses risks that are common to SHP projects, including those in resource inputs, operation schemes, emergency plans, occupational health, and capacity training.

In attempts to support this awakening awareness and concern over the environmental implications of SHP development, UNIDO, in partnership with MOF and MWR of China, started in November 2017 the implementation of the Project funded by the Global Environmental Facility (GEF), China Small Hydropower Capacity Upgrading (GEF ID 6919, & UNIDO ID SAP140196). The launch of the Project was after a successful project preparation phase spanning from 2014 to 2016 with the Project approved by GEF Council in June 2016. With an overall objective of environmental and safe upgrading of rural[1] SHP projects in the country, the Project consists of three technical components and another for monitoring and evaluation, with specific goals including:

- Component 1: Policy and institutional framework. This component aims at strengthening the policy and regulatory framework to effectively promote and support green SHP upgrading through industrial (ministerial) standards on green SHP and related practices, incentive policies for the adoption of green upgrades and safety improvements.
- Component 2: Technical demonstration. This component showcases technical feasibility and commercial viability of green and safe upgrades of SHP projects at different capacities. It consists of the demonstration of a variety of measures to mitigate environmental impacts of SHP development and to improve operational safety. The demonstrated feasibility is meant to build the confidence among both the SHP industry and the finance sector, and create best-practice examples for replication, on the basis of gained experience, reduced (perceived) risk, and increase capacity and awareness at multiple levels, i.e. industry (both at operational and decision-making level) and finance.
- Component 3: Capacity building and knowledge sharing. This component strengthens the institutional capacity as well as addresses the insufficient technical capacity training, awareness and the development of knowledge products. Activities under this component are implemented in parallel with components 1 and 2 on policy framework and technology demonstration in order to prepare for the scale up / mainstreaming of green and safe SHP within and beyond the Project.
- Component 4: Monitoring and evaluation. A two-pronged monitoring and evaluation (M&E) approach is followed: 1) M&E against the GEF's strategic indicators and 2) M&E project specific technical indicators for outputs per component (components 1-3 as listed above). Ultimately M&E outputs provide an indication of the achievement of the goals that the Project has set out to be achieved.

The general rationale of the Project is that through the implementation of the Project, its outputs and outcomes could create success stories, enabling institutions, and improved industrial capacity that would benefit the replication and scaling up of green and safe upgrades of SHP projects in the country.

[1] While most of China's SHP projects are located in rural areas, it is understood in the context of this Project that 'rural SHP' and 'rural small hydro' are interchangeable with 'SHP'.

1.2 Changes and adaptation

Over the implementation of the Project since late 2017, there have been a few changes and adaptations to the evolving context of the Chinese SHP sector compared to that during the preparation phase. These include:

1.2.1 Policy and institution related to green SHP certification

When the Project was in its preparation phase, the policy and institution component was designed to consist of three outputs, including (1) formulation and enactment of an industrial/ministerial standard for green SHP certification, (2) incentive policies at central and local government levels for the adoption of green SHP upgrades and certification, and (3) roll-out of a ministerial scheme (MWR, 2013) for the adoption of standardised measures for improving operational safety of SHP projects.

Policy development after the preparation phase of the Project was evolving at a faster pace than anticipated. MWR, China's top SHP regulator was pro-actively pushing a 'green turn' of the Chinese SHP sector to keep up pace with the SHP capacity expansion programme under the national 13th FYP (2016-2020). Therefore, it revealed in 2016 a blueprint of green SHP development in the country (MWR, 2016), and was moving ahead with its green SHP certification scheme and standard announced in May 2017 and enacted in August 2017. However, despite the head start, there was still space that needed to be improved in the framework.

Given the changed context, it was decided at the 2019 Project Steering Committee (PSC) meeting to adapt the planned outputs of the policy and institution component, in particular the first output on green SHP standard. See Table 1 for a full set of Key Performance Indicators (KPIs) of outputs before (preparation phase) and after (completed in implementation) under the policy and institution component.

Table 1. Outputs, KPIs and Targets of the policy and institution component before (finalised in preparation phase) and after (completed after implementation)

Nº	Output Before	KPIs & Targets before	Output after	KPIs & Targets after
1	Green SHP assessment [certification] standard formulated and issued by MWR	Draft and final versions of Chinese Green SHP Ministerial standard	Green SHP Assessment Standard and aligned technical standards formulated and revised	Final version of Green small hydro standard
		Management rules for green SHP assessment [certification]		Management rules for green SHP Assessment [certification]
		Guidance on green SHP construction and technical guidelines on how to implement green SHP measures published		Guidance on green SHP construction and technical guidelines on how to implement green hydro measures published
		Guidance on green SHP development issued		Guidance on green SHP development issued
		/		Green SHP Development Strategy

Nº	Output Before	KPIs & Targets before	Output after	KPIs & Targets after
		/		Technical Guidelines on Dehydration Recovery in Downstream River of Small Hydro aligned to Green SHP Assessment Standard
		/		Establishment and improvement of the online Management Information System for Green Hydropower
2	Preferential green SHP policies recommended and developed	Green SHP labelling system established	Preferential green SHP policies developed and recommended	Green SHP labelling system established
		Incentive policies in 8 provinces recommended for adoption		Incentive policies in 8 provinces recommended for adaption
		Introduction of mandatory ecological flows		Introduction of mandatory ecological flows
		National and provincial incentive policies recommended for adoption including a section on gender consideration		National and provincial incentive policies recommended for adoption including a section on gender consideration
3	Safe Production standard criteria rolled out nationwide	SHP safe production rolled out nationwide	Safe Production standard criteria rolled out nationwide	Safe production standard rolled out nationwide
		Provincial safe production standards issued		Provincial safe production standards issued

1.2.2 Refurbishment of demonstration plants

After the preparation phase of the Project, 24 SHP projects (including 7 projects that involve multiple plants) were selected to be refurbished as technical demonstration. These projects are distributed across 8 provinces of China, and would undergo different measures to improve their environmental implications, management and safety.

During the implementation of the technical demonstration, 6 projects had to withdraw their involvement, and another project joined as a replacement (see Figure 1 for locations). Two projects, Quanqiaohe Cascade and Jiuqianyan in Yunnan Province withdrew their participation before reaching agreements under the Project in 2018. Jiugonghe SHP Plant (Hubei) withdrew from the Project out of an ownership dispute. As a replacement of Quanqiaohe Cascade, Jiangjunzhu SHP Plant (Hubei) joined the technical demonstration in November 2019.

Contracts for another three projects, Baiyunxia (Shaanxi), Xiakou (Shaanxi), Jintanfeng and Huangyan (Chongqing) had to be terminated in 2021 and 2022 because of policy evolvement in China. After enacting a new policy (see 2.1.1) that audits natural resources and ecological integrity, a National Audit Office report (NAO, 2018) dramatically raised public concerns and pressure on environmental impacts of SHP development. Therefore, China tightened its regulation over SHP projects at the end of 2018 (MWR *et al.*, 2018). The four plants had to be decommissioned and demolished because they are classified within the ecological conservation zones according to the newly regulated scope of ecological protected area.

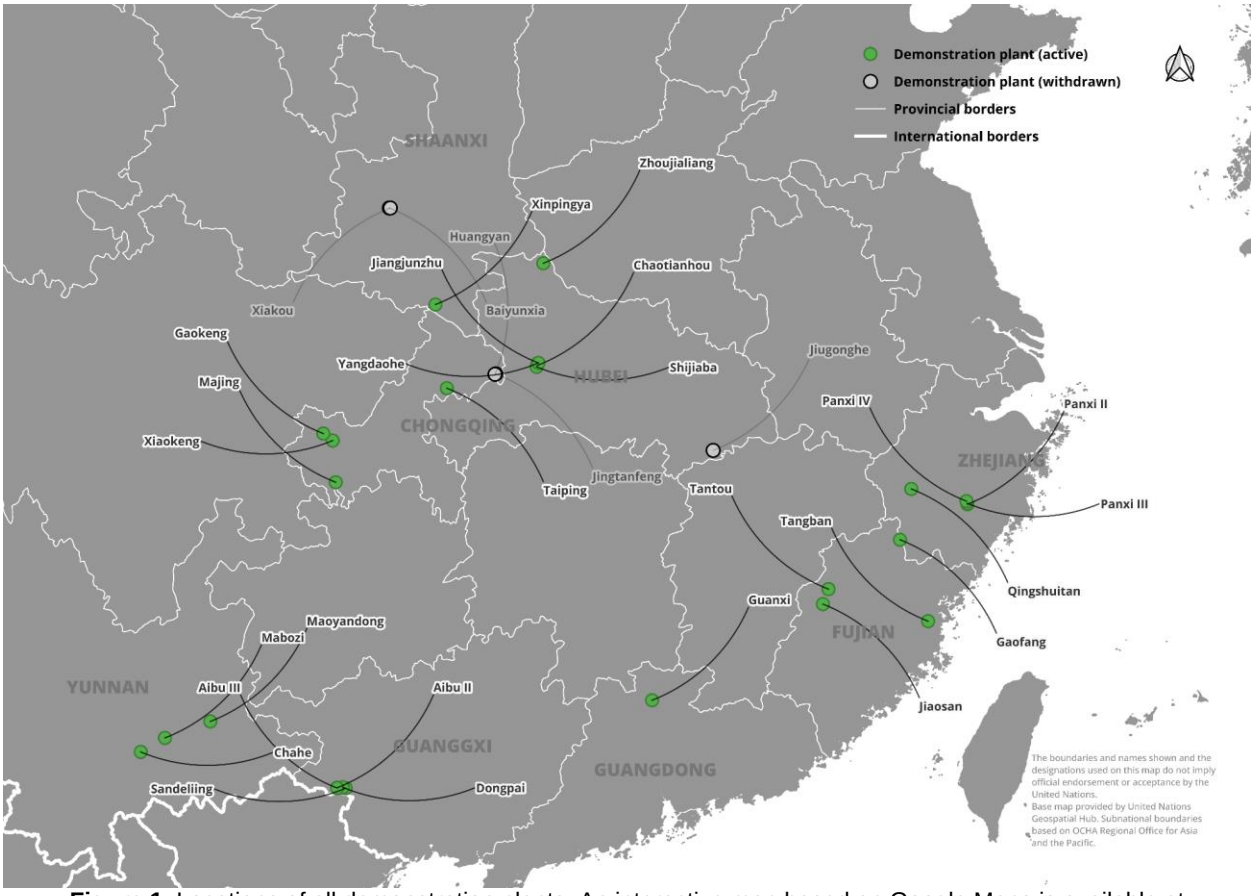

Figure 1. Locations of all demonstration plants. An interactive map based on Google Maps is available at https://t.co/Wjusya75JP

1.2.3 Capacity building programmes

The capacity building and knowledge sharing component of the Project was designed to include two outputs that centred on institutions and experts that would specialise in conducting assessments of SHP projects for green SHP certification and safety accreditation. However, as MWR's efforts to improve and advance its regulation over environmental impacts and operational safety of SHP projects moved ahead, there had been significant changes in its need for support for improving its capacities as the SHP regulator. Therefore, output 3.1.4 & 3.1.5 were adjusted in the TOR of the Project Contract Agreement that would be adapted to the new context (see Table 2).

Table 2. Outputs and KPIs of the policy and institution component before (finalised in preparation phase) and after (completed after implementation)

Nº	Output Before	Output after	KPIs & Targets after
1	Capacity building programme for SHP project owners,	Capacity building programme for SHP project owners, developers and technicians delivered to 1200 people	Training materials on green hydro and safe SHP with considerations on gender
			One train-the-trainer session delivered

Nº	Output Before	Output after	KPIs & Targets after
	developers and technicians delivered to 1200 people		50 (at least 25% female) trained trainers
			15 training workshops delivered to project owners, developers, managers, technicians, and design institutes
			1200 trainees trained
			1 study tour organised
			25 (at least 7 (25%) female) participants to the study tour
2	Capacity building programme for 200 officials on green SHP and safety and protection regulation	Capacity building programme for 200 officials on green SHP and Safety and Protection regulation	Training materials developed on green SHP policy and regulation, and on SHP safety with consideration on gender
			4 training sessions delivered to SHP officials
			200 (at least 50 female) officials trained
			1 study tour organised
			30 (at least 8 (25%) female) participants to the study tour
3	Awareness campaign delivered	Inception awareness raising workshop held	1 inception awareness raising workshop held
			150 (at least 38 (25%) female) participants to the workshop
			Awareness raising and marketing material available for the public
			3 national and provincial seminars on green SHP
			1 green SHP website established and updated regularly
			1 international green SHP event held in China with a side event relevant to gender
5	/	Establishment of pilot [model] green SHP plants	Training material developed for green SHP certification with consideration on gender
			24 plants refurbished and certified as green SHP
			350 (at least 88 (25%) female) trainees receiving training

Nº	Output Before	Output after	KPIs & Targets after
6	/	Establishment of safe production standardisation carried out	Training material developed for safe production establishment with consideration on gender
			24 plants improved and accredited in safety
			200 (at least 50 (25%) female) trainees receiving training

1.2.4 Impacts of the Covid Pandemic

The Covid Pandemic that broke out at the end of 2019 impacted the Project implementation significantly. Many of the activities, in particular that involved in-person communication and travelling, were highly impacted because of restrictions imposed by local governments.

The first major Project apparatus impacted was the Mid-Term Review (MTR). Just before the pandemic, in September 2019, an Interim Performance Evaluation (IPE) was organised by the Project Management Office (PMO) in compliance with MOF's evaluation requirements for projects funded through international financing institutions. Results from the IPE were completed in January 2020. Due to the strict restrictions of international travel imposed, UNIDO was not able to organise a separate MTR, which was also in repetition to the IPE. It was therefore agreed through the PSC in June 2020 and later with UNIDO that the findings and recommendations from IPE would be adopted for MTR.

Various activities planned under the Project, in particular those under the capacity building and knowledge sharing component, had to be down-sized, postponed or even cancelled. These included domestic or international travels of consultants (all components), in-person training workshops and seminars (Component 3), meetings (Component 1 & 4) etc.

Another major change due to the pandemic was the extension of Project completion date. As more activities requiring in-person communication and travelling were impacted, it was decided upon the PSC Meeting in April 2021 that an application had to be made for an extension of completion date. After obtaining endorsement in May 2021 from MOF (see Annex 3), the national GEF focal point in China, an extension of Project completion to 31 December 2023 was confirmed by UNIDO GEF focal point in October 2021 (see Annex 2).

2. Overall Results and Contribution to ISID

2.1 Overall progress towards results

By promoting the environmental upgrading of SHP development in China, the outcomes and results from the Project have directly contributed to these following areas of effects.

2.1.1 National development priorities

The Project is relevant to two priorities in national development of China. The first one addressed by the Project is sustaining growth in an ecologically civilised way, which is known as the concept of 'Ecological Civilisation' as proposed by China. The concept, first appeared in a report to the 17th CPC National Congress (Hu, 2007), and further stressed by the central government in 2015 in a top policy paper (CCP Central Committee and State Council, 2015), seeks to 'reconcile contradictions between economic development and the environment' (Zhang, 2015). Among the

principles set in 2015 policy, one is to 'sustain socio-economic development with minimum resource consumption' and 'give priority to environmental conservation'. Under the new policy, local governments are audited in their management of natural resources and ecological integrity, which has rich implications in reforming China's environmental management institutions.

A second national priority that the Project contributes to is decarbonising China's energy portfolio and cutting GHG emission. China pledged at the 2020 UN General Assembly to reach peak CO_2 emission before 2030 and carbon neutrality by 2060. A detailed action plan was released in 2021 (State Council, 2021). The action plan lays strict limits on coal-fired projects, and sets ambitious goals in replacing fossil fuel with renewable energy. Hydropower is seen in the plan as an important tool for the decarbonisation of the energy portfolio of the country, and the installed hydropower capacity is anticipated to increase by 80 GW between 2021 and 2030. But additionally highlighted is also the need to 'adapt [hydropower development] to local conditions' and 'green development of small hydropower'.

The outcomes and the results of the Project are benefiting the advancement in these national development priorities. On one hand, through mitigating the environmental impacts of SHP development by environmental upgrading, the outcomes of the Project effectively reduce the environmental costs for the development of small hydropower. On the other hand, through capacity expansion and efficiency improvements of SHP projects, the additionally generated clean electricity would be valuable for meeting demands that would have to be fulfilled by fossil energy, and therefore contributing to decarbonisation.

2.1.2 UN 2030 Agenda

Among the 17 UN Sustainable Development Goals (SDGs), four are directly addressed by the Project, which are affordable and clean energy (SDG7), industry, innovation and infrastructure (SDG9), climate action (SDG13) and gender equality (SDG5). Specifically, targets under these SDGs that the Project has contributed to include:

- SDG7**: ensure access to affordable, reliable, sustainable and modern energy for all**
  - Target 7.2: by 2030, **increase substantially the share of renewable energy** in the global energy mix
  - Target 7.b: by 2030, **expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries**, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support
- SDG9: **build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation**
  - Target 9.1: **develop quality, reliable, sustainable and resilient infrastructure**, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
  - Target 9.4: by 2030, **upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes**, with all countries taking action in accordance with their respective capabilities
- SDG13: **take urgent action to combat climate change and its impacts**
  - Target 13.2: integrate climate change measures into national policies, strategies and planning
- SDG5: **achieve gender equality and empower all women and girls**

- Target 5.5: **ensure women's full and effective participation and equal opportunities for leadership** at all levels of decision-making in political, economic and public life
- Target 5.b: **enhance the use of enabling technology**, in particular information and communications technology, to promote the empowerment of women

Part of the Project is to expand capacities and improve efficiency of SHP projects, from which the outcome is outputting additional clean electricity from hydropower, and therefore increasing the share of renewable energy (Target 7.2). Since the additional output of clean electricity is anticipated to meet demands that should have been fulfilled by fossil energy, it is subsequently reducing GHG emission from the consumption of fossil energy (Target 7.b and 13.2). The upgrading and refurbishment of SHP plants in China, while on one hand making them environment-friendly and, on the other, helping operating them safer and more efficiently, are meaningful for more reliable, sustainable and resilient Chinese SHP infrastructure (Target 9.1 and 9.4). All components under the Project have paid special attention in involving women in the industry, including providing tailor-made support and knowledge for their career development in the field (Target 5.5 and 5.b). The success stories created by technical demonstration of the Project are expected to be replicated extensively across the country so that these contributions could be further scaled up. Policy and capacity related components under the Project are improving institutional frameworks and knowledge that would further consolidate these impacts.

2.1.3 GEF Results Framework

As proposed during its preparation phase (see Annex 1), the Project is anticipated to contribute to the Results Framework set by the GEF-6 Programming Directions (GEF, 2014). Under the updated Results Framework set for the GEF-7 cycle (GEF, 2018), outcomes from the Project are still meaningful (see Table 3). Among the 11 core indicators that are monitored and analysed, the Project directly contributes to 3 of them through reducing GHG emission, improving riverine ecosystems, and supporting women in the SHP industry.

Table 3. Project contribution to GEF Results Frameworks

Project outcomes	GEF-6 RF Core Indicators & Target	GEF-7 RF Core Indicators & Target
Reducing GHG emission by outputting additional clean electricity from SHP	**750 million tons** of CO2e mitigated (including both direct and indirect)	Greenhouse gas emissions mitigated: **1,500 million metric tons** of CO2e
Improving riverine ecosystems by adopting environmental upgrades including maintaining minimum ecological flow, waste treatment, etc	Improved management of landscapes and seascapes covering **300 million hectares**	Area of landscapes under improved practices: **320 million hectares**, excluding protected areas
Providing tailored support for women in SHP industry for their career development	Projects that incorporated gender equality and women empowerment issues: **Monitored**	Number of direct beneficiaries disaggregated by gender as co-benefit of GEF investment: **monitored**

2.2 Financial implementation

TO be provided UNIDO.

According to the CEO Endorsement Document, the total GEF investment was USD 8,925,000 and the envisaged co-financing totaled USD 74,578,448. Of the amounts, USD 8,925,000 is provided by GEF, and the co-financing funds are provided by Chinese government and UNIDO.

During the implementation of the project, five demonstration projects withdrew from the GEF refurbishment, so the corresponding co-financing commitment funds deducted accordingly. Therefore, the co-financing commitment fund amount from Chinese government is USD65,175,720 (including USD9,709,000 in kind and USD55,391,720 in cash). Upon the completion of the project, the actual cofinancing funds in place from the Chinese Governments totaled USD62,909,667 (including USD9,787,200 in kind and USD53,047,467 in cash).

2.3 Contributions to ISID dimensions

The Project has contributed to inclusive and sustainable industrial development (ISID) by operationalizing the following four strategic priorities that UNIDO's work centers on through concrete and measurable actions and interventions undertaken.

2.3.1 Safeguarding the environment and mitigating climate change

With an overarching objective of environmental and safe upgrading of rural SHP projects of China, the Project's outcomes are making valuable additions to efforts in conserving and restoring the environment and ecological services that it provides. The technical demonstration component of the Project has refurbished and upgraded SHP plants with modern and environment-friendly technology and management practices to lower their impact on the riverine ecosystem. These demonstration activities have been very successful as planned according to continued monitoring and evaluation. As these examples created by technical demonstration being replicated elsewhere in the country, supported and incentivised by outcomes from the policy and capacity components under the Project, it is foreseeable that the benefits from similar practices are going to be scaled up further.

Additionally, the outcomes of the Project have rich implications in climate change mitigation. The feasibility studies undertaken prior to the approval of the project made recommendations on the interventions by aligning the retrofitting of the demonstration SHPs with the Green SHP Standard. The recommendations were reviewed at the start of the project and followed through during the retrofitting process. SHPs were also required to develop environmental and social management plans (ESMP) and their environmental performance was monitored and/or analyzed by teams contracted by the project. Another outstanding outcome of the project is the improvement of river longitudinal connectivity through the implementation of minimum e-flows. The project was a forerunner in promoting minimum e-flows, which later became mandatory for all SHPs across China. On biodiversity, the revised Green SHP Standard puts increased emphasis on the protection of aquatic and terrestrial species, which encourage considerations on biodiversity conservation in hydraulic engineering. It was observed that wetlands were restored at some demonstration sites and new fish species was reported in a restored river.

The additional output of clean electricity from SHP after capacity expansion and efficiency improvements is quantifiably offsetting carbon emission that could have been made if the energy demand was met by burning fossil fuels. Such contribution is highly valuable for countries like China, whose energy supply predominantly relies on fossil energy. Moreover, the benefits from the Project in conserving and restoring ecosystems and services they provide are highly relatable to mitigating climate change, in particular when the practices proliferate as the demonstrated success under the Project being replicated extensively across the country. Living natural ecosystems play a significant role in the carbon cycle across the earth system. Ecosystems could

'not only reduce carbon emissions but alsoactively remove carbon dioxide from the atmosphere', and are 'the only feasible option for removing carbon from the atmosphere at large' (Trumper *et al.*, 2009).

2.3.2 Creating shared prosperity

The outcomes from the Project are sharing benefits from SHP development among a wide range of stakeholding parties, including SHP owners, local communities, regulators and so on. Historically, SHP played a significant role in the process of reducing poverty in rural regions of China (Xiao, 2008). Though now SHP is playing a less important role in a direct sense as China's centralised state grids mature over time, it is still a valuable option for supplying electricity, creating jobs, and therefore supporting local economies. Apart from this, outcomes of the Project help advance the goal of shared prosperity through contributing to local infrastructure. Besides upgrading the demonstration plants themselves, a significant amount of resources from the Project is to help improve local infrastructure that serve purposes including transport, leisure, tourism, safety and so on. This is further supported by the improved ecosystem services for mitigating environmental impacts from SHP development.

While retrofitting the SHPs, the property owners helped improve roads, bridges, and facilities related to irrigation, lighting, and water supply for villagers living nearby. SHPs are generally located at mountainous areas, and many of them are potentially very scenic. With the implementation of year-round e-flows, rivers under the Green SHPs now flow during the dry season, which then attracts urban tourists to spend weekends and holidays in the local areas around the sections of rivers affected by the SHPs. Some villagers operate farm stays to tourists to earn non-agricultural income. The new business opportunities gave a boost to rural development by attracting some farmers, who previously migrated to cities to earn a living, to come back and stay in their home rural areas. In addition, some SHPs, which are jointly owned by local communities, distributed increased profits to their local communities from the enhanced generation capacity after retrofitting.

For example, Tangban SHP prioritized collaboration and friendly negotiations with local construction teams in cases where lower-cost projects did not require a bidding process, and hired local villagers to participate in various tasks such as cleaning, logistics, greening management, and reservoir area sanitation. Notably, three male and five female villagers have been employed, contributing to the development and maintenance of the plant's facilities. Another Plant Mabozi SHP increased its investment in improving public lighting, roads, and irrigation facilities. Efforts were made to strengthen the downstream irrigation channel to ensure its water-carrying capacity. The plant annually distributes 30,000kg of rice to 42 households in the surrounding village Caozi Village, and extended a dedicated electricity line from the plant to provide free electricity for villagers' production and daily life, contributing to their welfare and convenience.

The implementation of the Project has also paid considerable attention to reducing inequalities between genders so that its outcomes could benefit women in the SHP industry inclusively. By guaranteeing the female participation in capacity training programs (totally 1945 people trained including 593 females, accounting for 30.5%) and proportion of female employees in demonstration projects (about 28%) to provide women in this industry with gender-sensitive support in their knowledge and capacity, it advances women's participation in, and influence on, SHP interventions, in particular at the company or enterprise level, so that both women and men equally benefit from this Project and future SHP development.

2.3.3 Advancing economic competitiveness

The Project creates opportunities for owners, and the SHP industry in general, by helping them gain direct competitive advantage in efficiency and safety. The implementation of GEF refurbishment measures has improved the energy efficiency and automation level of the pilot power stations, increased the power generation income, reduced the operating cost, and improved the economic income. In addition, the restoration of the ecological flow of the river and the improvement of the surrounding ecological environment have driven the development of local tourism, providing more employment opportunities for community residents and increasing their income level.

Apart from environmental upgrading, the Project has leveraged resource inputs from the capacity expansion programmes of China under its 13th FYP. By adopting up-to-date technology in energy development and practices in operation, efficiency improvements bring additional benefits that include both income from extra electricity output and cost-savings in operation. Operational safety is another concern that is addressed in the refurbishment and upgrading of SHP plants under this Project. With most Chinese SHP plants built over three or four decades ago, their outdated and ageing facilities, and managerial practices as well, raise operational safety risks considerably. The practices and technology demonstrated and promoted under this Project are helping owners and operators to lower their risks and therefore gain additional economic competitiveness through lowered safety risks and opportunity costs in case of failures. These are in particular relevant to the SHP industry because most SHP projects are owned or operated by medium or small, or in some cases, micro sized enterprises that are highly sensitive to these benefits.

The policy and capacity components of the Project are indirectly fostering economic competitiveness of the SHP industry at the same time. The incentive policies for green SHP in China that the Project works on are in essential to funnel, through both government and market institutions, economic resources that the industry needs to proliferate similar green upgrading, so that it could align its development closely along national priorities in reconciling economic development and ecological wellbeing, and decarbonising its economy. Equally important is the professional capacities needed for the SHP industry, to which the capacity component of the Project has contributed. This component holds particular significance because it equips the industry with a group of skilled experts specialised in green and safe SHP that will enact further advantage of the SHP industry over fossil energy.

2.3.4 Strengthening knowledge and institutions

The Project has infused positive elements into the knowledge and institutions of China's SHP field. In November 2017, the project inception workshop was held in Hangzhou, at which project management training was implemented for the demonstration project owner. In 2019, two study tours for SHP practitioners and officials were organised to the United States and Europe separately to communicate and understand the experience in green small hydropower. In 2023, another study tour was organized to attend International Vienna Energy & Climate Forum for Chinese SHP technicians.

By September 2022, the project has carried out 16 capacity building training courses on green small hydropower and safe production, and trained 1,991 small hydropower owners, technicians and government officials, with a completion rate of 102.1%. In order to carry out service training, the project has prepared 4 sets of training materials and implemented teaching training for 50 teachers.

The capacity component of the Project, besides various efforts to bolster professional capacities of SHP developers, technicians, and regulators, is creating a new pool of knowledge and tools for dissemination based on experiences under the Project on green SHP development in China. The knowledge pool and tools are adapted to fit the Chinese context so that they could address

country-specific issues, and have been made public to be reached by interested groups without any barrier.

Moreover, outcomes of this component include raised awareness of green SHP development among the general public, which is going to win over more public support for the agenda. Equally important is the policy component of the Project that has reinforced and enhanced the Chinese institutions related to SHP. This has included green SHP certification programmes, standardisation of operational safety measures, and targeted policies to incentivise uptake of these schemes. The strengthened knowledge and institutions are benefiting not only the Chinese SHP industry itself, but also wider domains like environmental conservation and climate adaptation.

3. Achievements and Measurable Results

The achievements and measurable results attained at the conclusion of the Project represent significant milestones in the advancement of environmental and safe upgrading of SHP development in China. Besides contributions to higher-level priorities of the country, the outcomes generated from the project's three technical components (see Table 4, Table 5, and Table 6) provide compelling and empirical evidence for this agenda. These include refurbished and upgraded SHP plants with tangible and quantified proofs of technical and economic feasibility, improved policies to sustain the ‘green turn’ institutionalised into a self-reinforcing way of SHP regulation and governance, and enhanced professional capacities among multiple key roles within the industry that will further consolidate and replicate the achievements. The outcomes serve to bolster confidence among stakeholders and raise public support, which will divert more resources, apart from economic investments, to sustain the green development of SHP in China.

Table 4. Achievements and measurable results under Component 1 (policy and institutions)

Results and indicators	***Baseline***	***Final target***	***Total achieved value***	
OVIs: Objectively Verifiable Indicators	*At the start of the project*	*Planned at the end of the project*	*At the end of the implementation period*	
Output Nº 1-1: Green SHP Assessment Standard and aligned technical standards formulated and revised				***Indicators' attainment***
A. Final version of Green small hydro standard	• Preliminary version of Chinese Green SHP standard	• Draft and Final versions of Chinese Green SHP Ministerial standard	• The Chinese green SHP standard was ratified and enacted by MWR as industrial standard SL/T 752-2020 in February 2021.	**Yes**
B. Management rules for green SHP Assessment	• No management rules for green SHP	• Management rules for green SHP Assessment	• The management rules were completed by vendor and submitted to UNIDO in June 2022, and integrated into MWR's routines.	**Yes**
C. Guidance on green SHP construction and technical guidelines on how to implement green hydro measures published	• No technical guidelines on green SHP in China	• Guidance published	• Official policy document was finalised and published by MWR in December 2016 • Technical guidelines were developed and finalised in November 2020.	**Yes**
D. Technical Guidelines on Dehydration Recovery in Downstream River of Small Hydro aligned to Green SHP Assessment Standard	• No aligned technical guidelines	• Technical Guidelines developed in alignment to Green SHP Assessment Standard	• The technical guidelines were ratified and enacted by MWR as industrial standard SL/T 796-2020 in September 2020.	**Yes**
E. Green SHP Development Strategy	• No strategy adopted	• Green SHP Development Strategy developed	• A proposal on the development of green SHP in China was developed in December 2020 based on research and studies of SHP development in China, its major environmental impacts and technical countermeasures, and policy options.	**Yes**
F. Establishment and improvement of the online Management Information System for Green Hydropower	• No online system	• Online Management Information System for Green Hydropower	• The MIS was put into use in 2018.	**Yes**

Results and indicators	*Baseline*	*Final target*	*Total achieved value*	
Overall results on output 1-1: All the six KPIs under this output have been fulfilled as planned. The overall results from this output have contributed to the improvement of China's green SHP development institutions including its long-term development goals, technical guidelines and standards for mitigating SHP development and green SHP certification, and routine management on the regulator side (see Annex 4).				
Main activities corresponding to Output 1-1:				*Status*
1. Revise and finalise the industrial standard on green SHP certification				**Completed**
2. Review China's 'Green SHP Assessment Stand' with reference to international standards and practices				**Completed**
3. Develop management rules for green SHP certification				**Completed**
4. Develop policy goals and agenda, and technical guidelines for green SHP development in China				**Completed**
5. Develop technical guidelines as an industrial standard for recovering depleted river sections downstream SHP projects				**Completed**
6. Review international experience of mitigating negative impacts of SHP				**Completed**
7. Review international experiences of green SHP development strategy				**Completed**
8. Make proposals for green SHP development strategy based on policy studies and trend analysis				**Completed**
9. Improving the online management system of MWR for green SHP certification				**Completed**
Output Nº 1-2: Preferential green SHP policies developed and recommended				*Indicators' attainment*
A. Establishment and improvement of the online Management Information System for Green Hydropower	• No system in existence	• Green SHP labelling system established	• Recommendations were made to MWR with a proposal developed based on studies on labelling schemes in Europe and North America in December 2019. • MWR is using a single-tier labelling scheme that gives out plaques for certified plants.	**Yes**
B. Incentive policies in 8 provinces recommended for adaption	• Few (1-2) specific green incentive policies in place	• At least one incentive policy recommended for adoption in each of 8 provinces	• A package of policy recommendations were developed and submitted to local governments in December 2020.	**Yes**
C. Introduction of mandatory ecological flows	• Guidelines in place in 5 provinces	• Mandatory ecological flows introduced in 2 provinces	• Ecological flow is now made a mandatory requirement for all SHP projects across China.	**Yes**
D. National and provincial incentive policies recommended for adoption including a section on gender consideration	• No green SHP incentive policies in place	• At least one incentive policy recommended for national adoption	• Policy recommendations have been submitted to MWR in June 2023.	**Yes**

Results and indicators	*Baseline*	*Final target*	*Total achieved value*	
Overall results on output 1-2: All the four KPIs under this output have been fulfilled as planned. This output has produced further results that incentivises the wider adoption of green upgrades of SHP projects across the country (see Annex 5, Annex 6, and Annex 7).				
Main activities corresponding to Output 1-2:				*Status*
1. Analyse international and domestic experience to make proposal on labelling scheme				**Completed**
2. Review local incentive policies and make policy proposals for adoption of local (provincial) governments on green SHP development, including the introduction of mandatory e-flow				**Completed**
3. Review international and domestic experiences in national policies on green SHP development and make policy recommendations on incentive policies to be adopted by central government				**Completed**
Output Nº 1-3: Preferential green SHP policies developed and recommended				*Indicators' attainment*
A. Safe production standard rolled out nationwide	• Draft 'document' on safe production	• Safe production standard rolled out nationwide	• A best-practice manual based on case studies has been developed for use in December 2020. • A report was prepared for the promotion of standardised measures for improving operational safety.	**Yes**
B. Provincial safe production standards issued	• No provincial standards issued	• Issuance of provincial standards on safe production in 8 provinces	• Related standards and measures widely adopted by provinces.	**Yes**
Overall results on output 1-3: All the two KPIs under this output have been fulfilled as planned. The outcomes from this part are improvements and wider adoption of standardised measures for operational safety of SHP projects in China. This output has initiated a continued process of updates and improvements in the tools and practices for SHP safety (see Annex 4).				
Main activities corresponding to Output 1-3:				*Status*
1. Review international experiences of standardised measures to improve operational safety of SHP projects				**Completed**
2. Conduct case studies to develop best-practice manual				**Completed**
3. Promoting the adoption of standardised measures for improving operational safety of SHP projects				**Completed**

Table 5. Achievements and measurable results under Component 2 (technical demonstration)

Results and indicators	*Baseline*	*Final target*	*Total achieved value*	
OVIs: Objectively Verifiable Indicators	*At the start of the project*	*Planned at the end of the project*	*At the end of the implementation period*	
Output Nº 2-1: Business plans and feasibility studies finalised for upgrading SHP demonstration plants				***Indicators' attainment***
A. Number of detailed feasibility studies and business plans including gender considerations	• No studies or plans	• 19 studies and plans prepared (formerly 24)	• 19 studies and plans were prepared in the PPG phase.	**Yes**
Overall results on outcome 2-1: The one KPI under this output has been fulfilled as planned. These plans have provided a solid basis and robust framework for the refurbishment of the demonstration SHP plants (see Annex 8).				
Main activities corresponding to Output 2-1:				***Status***
1. Developing business plans based on feasibility studies				**Completed**
2. Review plans based on studies of international and domestic experiences, and finalise plans with improvements				**Completed**
Output Nº 2-2: Upgraded green SHP plants rehabilitated at 19 sites with additional capacity and annual power generation				***Indicators' attainment***
A. No. of demonstration projects	• 0	• 19 (formerly 24)	• 19 projects (by contract) have completed technical demonstrations. • 6 projects (by contract) withdrawn from demonstration under force majeure. • One project joined later as a replacement.	**Yes**
B. Additional Installed Capacity (MW)	• 0	• 20.2 (formerly 23.47)	• Target level was lowered to 20.2 due to withdrawals of demonstration plants. • 20.2 MW was additionally installed.	**Yes**

Results and indicators	Baseline	Final target	Total achieved value	
C. Annual additional MWh generated	• 0	• 133,585 (formerly 157,000)	• The increased annual output is 44,560 MWh from 2020 to 2022, which is lower largely due to extreme and continuous drought according to feedbacks from owners and provincial PMOs. • All plants were put into operation in 2020 except Xiaokeng SHP which was put into operation in 2021.	**Partially**
D. Annual GHG emissions reduced additionally	• 0	• 93,595 (formerly 110,000) tCO_2	• With all plants aggregated, the 2020-2022 average GHG emission cut for increased power output was 28583.9 tCO_2 per year due to lower than long-term average outputs under extreme and continuous drought. • Excluding plants with annual output below their long-term averages before, the 2020-2022 average GHG emission cut for increased power output was 75,265.1 tCO_2 per year.	**Partially**
E. No. of pilot sites where ecological flow maintained year round	• 0	• 19 (formerly 24)	• All demonstration plants are now maintaining e-flow year-round.	**Yes**
F. #/% of female-led (management team) pilot SHP plants (beneficiaries)	• 16 (61.5%)	• 15	• 17 (65.4%) plants now have female-led management teams.	**Yes**
G. #% of female employees at pilot SHP plants	• 115 (29.2%)	• 25%	• The demonstration plants now have 104 female employees, accounting for 28.3% of the total.	**Yes**
H. Number of rivers with improved ecology	• 0	• 19 (formerly 24)	• All the rivers where the demonstration plants sit have improved ecology after restoring minimum ecological flows.	**Yes**

Results and indicators	*Baseline*	*Final target*	*Total achieved value*	
Overall results on output 2-2: Six of the eight KPIs under this output have been fulfilled as planned and the other two partially fulfilled. These results have been 19 successfully refurbished and upgraded SHP plants with additional installed capacity and power output. These plants create vivid success examples of green SHP development that could be replicated (see Annex 9 and Annex 10). The under-performance in power output and subsequent GHG emission cuts are largely due to lower than average precipitation at many demonstration plants.				
Main activities corresponding to Output 2-1:				*Status*
1. Refurbishment and upgrades of demonstration plants, including capacity expansion and efficiency improvements, measures for mitigating environmental impacts, improvements in operational safety, contribution to local infrastructure, etc.				**Completed**
2. Monitoring of refurbishment and upgrades				**Completed**
3. Analysis of hydrological regime under future climate and impacts on power output				**Completed**
Output Nº 2-3: Socio-economic and environmental impact of green SHP rehabilitation recorded				*Indicators' attainment*
A. No. of Environmental and Social Management Plans prepared	• 0	• 19 (formerly 24)	• 19 ESMPs were prepared for the demonstration projects before the start of the demonstration. • Implementation of the ESMPs were monitored.	**Yes**
B. No. of baseline and socio-economic and environmental studies of local area and population prior to rehabilitation, including a chapter on gender	• 0	• 10	• Baselines studies were completed in November 2021 for 10 plants.	**Yes**
C. No. of socio-economic and environmental impact studies post SHP rehabilitation, including a chapter on gender	• 0	• 10	• Ex-post studies were completed in March 2022 for the 10 plants selected.	**Yes**
D. % of female/male beneficiaries at project areas	• 43%	• 50%	• The F/M ratio[2] of plant employees reached 44% after completion of demonstration, without consideration of indirect beneficiaries. • Data for all beneficiaries at entire project areas are not available and difficult to collect. •	**Partially**

Results and indicators	*Baseline*	*Final target*	*Total achieved value*	
E. No. of case studies prepared (% that includes gender section/dimension)	• 0	• 19 (100%, formerly 24)	• Case studies were completed for 19 demonstration plants, with all reports including gender dimensions.	**Yes**

Overall results on output 2-3:
Four of the five KPIs under this output have been fulfilled as planned and the other one partially fulfilled. The results have recorded quantitatively the socio-economic and environmental impacts of green upgrades of SHP, and provide convincing evidence for the replication of similar practices elsewhere (see Annex 11, Annex 12, Annex 13, and Annex 16). The quantitatively recorded impacts are also useful tools for bolstering confidence among the SHP industry and financiers. Due to data availability, the female/male ratio of entire project areas is not clear, and empirical estimation should be higher than target level as the activities are benefiting local communities within the areas.

Main activities corresponding to Output 2-3:	*Status*
1. Preparation of the ESMPs	**Completed**
2. Monitoring of ESMP implementation	**Completed**
3. Survey of baseline conditions	**Completed**
4. Investigation of ex-post conditions and analysis of change	**Completed**
5. Preparation of case studies	**Completed**
6. Cost and benefit analysis of refurbishment activities	**Completed**

Table 6. Achievements and measurable results under Component 3 (capacity and knowledge)

Results and indicators	*Baseline*	*Final target*	*Total achieved value*	
OVIs: Objectively Verifiable Indicators	*At the start of the project*	*Planned at the end of the project*	*At the end of the implementation period*	
Output Nº 3-1: Capacity building programme for SHP project owners, developers and technicians delivered				*Indicators' attainment*
A. Training materials on green hydro and safe SHP with considerations on gender	• None	• Material developed with a chapter on gender	• Development of documents was completed in April 2020.	**Yes**
B. No. of train-the-trainer sessions	• None	• 1	• One train-the-trainer session was organised in August 2020.	**Yes**
C. No. of trained trainers	• 0	• 50	• 50 trainers (13 female, 26%) were trained in August 2020.	**Yes**
D. No. of training workshops delivered to project owners, developers, managers, technicians and design institutes	• 0	• 15	• As a result of the impact of Covid-19, the number of the training workshops was reduced to 8, but the total number of the trainees is overachieved.	**Yes**

Results and indicators	*Baseline*	*Final target*	*Total achieved value*	
E. Total No. of trainees	• 0	• 1200 (min. 300 female, 25%)	• A total of 1226 trainees (399 female, 32.5%) were trained by the end of 2022.	**Yes**
F. No. of study tours	• 0	• 1	• One study tour was organised to the US in June 2019.	**Yes**
G. No. of study tour participants	• 0	• 25 (min. 7 female, 25%)	• 27 people (including 7 females，25.9%) signed up. • 11 quit due to visa restrictions or personal reasons.	**Yes**

Overall results on outcome 3-1:
Five of the seven KPIs under this output have been fulfilled and the other two partially fulfilled. As outcomes from this part, the professional capacities of a large group of SHP owners, developers and technicians have been raised. Another outcome here is a group of experts specialised offering training in the green SHP field (see Annex 4, Annex 17, and Annex 18). Due to restrictions of Covid policies in China, the number of training workshops organised had to be reduced and some of the workshops moved online, but the online workshops also allowed accommodation of more participants. More than 25 participants signed up for the study tour, but some had to cancel due to visa issues or conflicting schedules.

Main activities corresponding to Output 3-1:	*Status*
1. Develop training materials	**Completed**
2. Organise train-the-trainer session	**Completed**
3. Organise training workshops for owners, developers and technicians	**Completed**
4. Organise study tour to USA	**Completed**

Output Nº 3-2: Capacity building programme delivered for officials on green SHP and Safety and Protection regulation				*Indicators' attainment*
A. Training material developed on policy and regulation on Green Hydro and on Safe Production with considerations on gender	• None	• Material developed on policy and regulation of green SHP and standardised safety measures, with chapters on gender	• Development of documents was completed in April 2020.	**Yes**
B. No. of training sessions for MWR officials in provinces	• 0	• 4	• The training objective (200 officials) was achieved by organizing 2 workshops in 2022 due to Covid restrictions.	**Yes**
C. No. of officials trained	• 0	• 200 (min. 50 female, 25%)	• A total of 211 officials (55 female, 26.1%) were trained.	**Yes**
D. No. of study tours	• 0	• 1	• A study tour was organised in November 2019 to Europe.	**Yes**

Results and indicators	*Baseline*	*Final target*	*Total achieved value*	
E. No. of study tour participants	• 0	• 30 (min. 8 female, 25%)	• 34 people (including 9 females，26.5%) signed up. • 11 quit due to visa restrictions or personal reasons.	**Yes**
Overall results on output 3-2: Three of the five KPIs under this output have been fulfilled as planned and the other two partially fulfilled. The overall results here is a considerable group of Chinese officials with raised capacities in the field of SHP regulation (see Annex 4, Annex 17, and Annex 19). Due to restrictions of Covid policies in China, the number of training workshops had to be cut down and some moved online, but the online workshops allowed more participants as a result. More than 30 participants had plans to take part in the study tour to Europe (Austria and Switzerland), but some of them had to cancel due to visa issues or conflicting schedules.				
Main activities corresponding to Output 3-2:				*Status*
1. Develop training materials				**Completed**
2. Organise training workshops for SHP officials				**Completed**
3. Organise study tour to Europe				**Completed**
Output Nº 3-3: Inception awareness raising workshop held				*Indicators' attainment*
A. Inception awareness raising workshop	• 0	• 1	• An inception awareness-raising workshop was organised in November 2017.	**Yes**
B. No. of attendees at workshop	• 0	• 150 (min. 38 female, 25%)	• A total of 156 participants (40 female, 25.6%) took part in the event.	**Yes**
C. Awareness raising and marketing material available for the public	• Shortage of effective and quality material	• Public awareness raising, marketing and training material developed and adapted for Chinese conditions and made available in printed and electronic format. Posters available at project sites	• A brochure in Chinese and English was developed and made public, featuring knowledge and experiences from the project. • Posters have been prepared for use at demonstration sites.	**Yes**
D. Awareness raising and marketing material available for project developers and officials including consideration on gender	• No material in Chinese	• Public awareness raising, marketing and training material developed (with a chapter on gender) and adapted for Chinese conditions and made available in printed and electronic format.	• A project film has been prepared in English and Chinese and made public. • Project newsletters were developed in English and Chinese, featuring progress and knowledge sharing.	**Yes**

Results and indicators	*Baseline*	*Final target*	*Total achieved value*	
E. National and provincial seminars on green hydro	• 0	• 3	• Three national seminars were organised in 2022 and 2023 in Xi'an, Nanchang and Kunming.	**Yes**
F. Chinese Green SHP website established	• 0	• Website established and regularly updated	• A website has been completed in Chinese featuring knowledge and experience accumulated through the project. • Posts to share knowledge and experience have been organised and will be published continuously till the end of the project.	**Yes**
G. International green hydro event held in China with a side event relevant to gender	• 0	• 1	• An international webinar was organised in November 2022.	**Yes**

Overall results on output 3-3:
All the seven KPIs under this output have been fulfilled as planned. The outputs are a number of tools that have been used for awareness-raising and knowledge dissemination. The tools have also been made publically available at various Project-related sites in hard or digital copies (see Annex 20, Annex 21, and Annex 22).

Main activities corresponding to Output 3-3:	*Status*
1. Organising inception awareness-raising workshop	**Completed**
2. Develop Project brochures and posters	**Completed**
3. Develop Project film	**Completed**
4. Organise national green SHP seminars	**Completed**
5. Organise international webinar on green SHP	**Completed**
6. Develop Project website	**Completed**
7. Develop newsletters and social media campaigns	**Completed**

Output Nº 3-4: Establishment [certification] of 24 pilot [model] green SHP plants				*Indicators' attainment*
A. Training material developed for green SHP establishment with consideration on gender	• Ad-hoc training material	• Material developed with a chapter on gender, promoted by MWR and ICSHP.	• Development of documents was completed in April 2020.	**Yes**
B. Establish 24 refurbished SHP plants as pilot green SHP plants	• 0	• 24	• 24 plants, with technical support provided by the project, completed green SHP certification by 2022.	**Yes**

Results and indicators	*Baseline*	*Final target*	*Total achieved value*	
C. No. of trainees receiving training	• 0	• 350 (min. 88 female, 25%)	• A total of 352 trainees (99 female, 28.1%) were trained.	**Yes**

Overall results on output 3-4:
All the three KPIs under this output have been fulfilled as planned. The results are 24 plants that have been certified by MWR as green SHP plants, and raised professional capacities of employees at these plants (see Annex 17).

Main activities corresponding to Output 3-4:	*Status*
1. Organise training workshops	**Completed**
2. Provide technical support for SHP plants	**Completed**
3. Pass green SHP certification of MWR	**Completed**

Output Nº 3-5: Establishment [accreditation] of safe production standardisation carried out at 24 SHP plants				*Indicators' attainment*
A. Training material developed for green SHP establishment with consideration on gender	• Draft training material	• Material developed and promoted by MWR	• Development of documents was completed in April 2020.	**Yes**
B. Promoting safe production standardisation at 24 refurbished SHP plants	• 0	• 24	• 24 plants, with technical support provided by the Project, improved their operational safety and passed safety accreditation.	**Yes**
C. No. of trainees receiving training	• 0	• 200 (min. 50 female, 25%)	• A total of 202 trainees (49 female, 24.3%) were trained.	**Yes**

Overall results on output 3-5:
All the three KPIs under this output have been fulfilled as planned. The results are 24 plants that have adopted standardised measures for operational safety, and obtained Tier 1/2/3 accreditation for those measures. The professional capacities of employees at these plants have also been raised as a result (see Annex 17).

Main activities corresponding to Output 3-5:	*Status*
1. Organise training workshops	**Completed**
2. Provide technical support for SHP plants	**Completed**
3. Pass safety accreditations	**Completed**

Among all the 51 key performance indicators (KPIs) of the Project, 48 (94.1%) have been fulfilled as planned, and the other three partially fulfilled. Over-achievements observed in relation to eight out of the 48 accomplished KPIs. Upon examination and analysis of the activities related to the seven under-achieved KPIs, the underlying factors contributing to the results could thoroughly delineated as follows:

- **Additional power output and GHG emission cuts** (KPI 2-2-C & 2-2-D, see Table 5): The additional power output from a demonstration plant (ΔP) in a particular year after refurbishment is defined in the Project proposal as the increased amount in the electricity generated in that year (P) compared to a long-term average annual output (P_0, $\Delta P = P - P_0$). Subsequently, the additional GHG emission cuts (ΔE) in that year is equivalent to the emission that could have been made if that amount of electricity (ΔP) was generated through means with average emission intensity (f) of power generation in that part of China ($\Delta E = f \times \Delta P$). Since January 2020, 18 demonstration projects have resumed operation, while in January 2021, the Xiaokeng project also resumed operation, the under performance of the demonstration plants in cutting GHG emissions is therefore directly related to that in electricity output which is often under influence of precipitation and river flow. Therefore, an analysis of data on electricity output, precipitation in the river basins, and the long-term average annual outputs adopted in Project preparation shows that:(1) precipitation at most of the river basins where the demonstration plants are located is at lower than average level from 2020 to 2022, (2) the targets were set based on design output after refurbishment of the plants which in reality often differ from actual output, and (3) a number of the adopted long-term average annual outputs were overestimated and needs correction. After correcting the long-term averages (see Figure 2), the additional average power output and GHG emission cuts of the demonstration plants would increase to 49030.8 MWh and 22,930.4 tCO_2e respectively (see Annex 14 for detailed analysis). For longer terms, analysis of hydrological regimes under future climate scenarios shows that output will be growing further (see Annex 15).
- **Female/male ratio of beneficiaries at project areas** (KPI 2-3-D, see Table 5): The concept of ‘project areas’ was not very strictly defined in the Project proposal, but could be inferred by textual context to mean the areas where refurbishment of demonstration plants would benefit. However, the measures undertaken as technical demonstration included not only upgrades inside the plants themselves, but also contribution to local ecosystems and infrastructure. These interventions would generate significant spillover benefits apart from people directly related to the plants (owners, employees, investors, etc.), but it would be very difficult to exhaustively identify the beneficiaries and quantify the benefits. To allow easier quantification, the numbers of employees of the plants were used for reporting here. According to the ex-post and ex-ante survey (see Annex 12), the demonstration plants had a total of 252 employees among whom 76 were female. After refurbishment and upgrades of the demonstration plants, the figures changed to 239 and 73. Therefore, the female/male ratio increased from 43% to 44%. Though different data sources from different reporting periods or studies, for example, case studies and owners’ reports, have slightly different figures, but the ratios are more or less similar around 40%. Since these figures are only accounting for the employees of the plants, but the actual beneficiaries are including a wider population, the ratio could be higher as it should be around the female/male ratio of the local communities.

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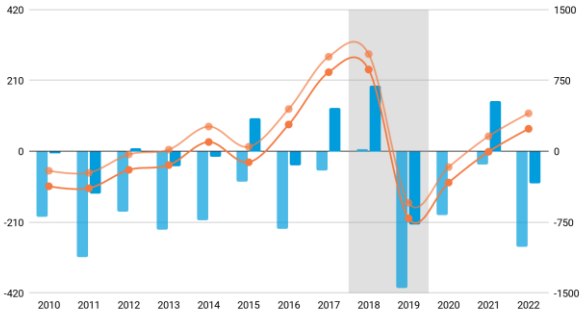
Chahe



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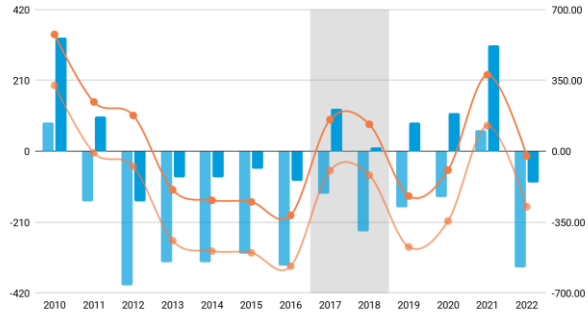
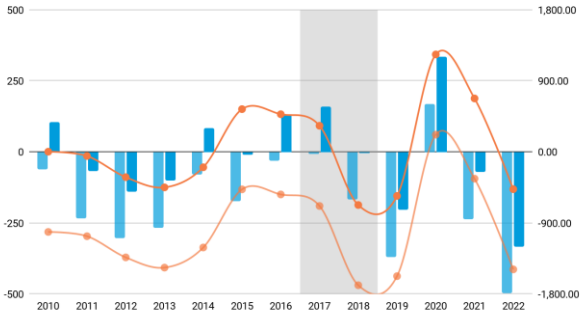


Yangdaohe



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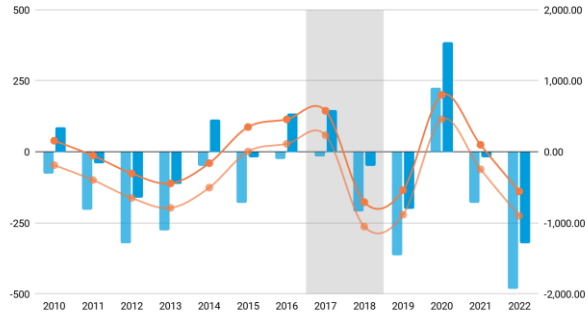

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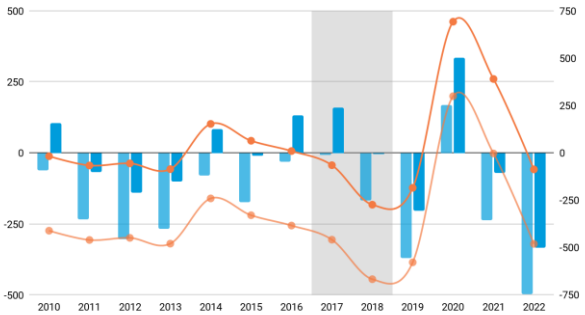

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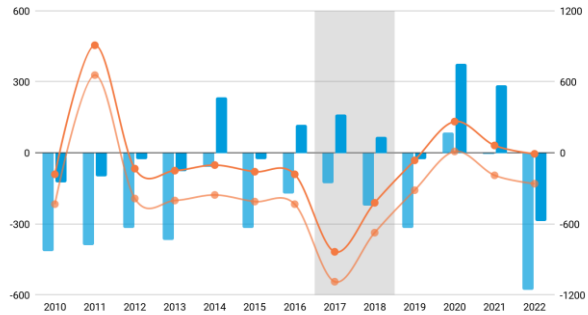

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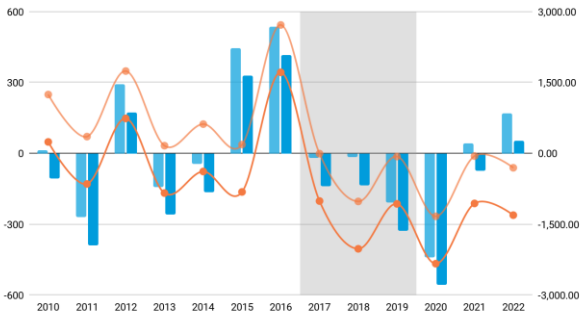

Xinpingya

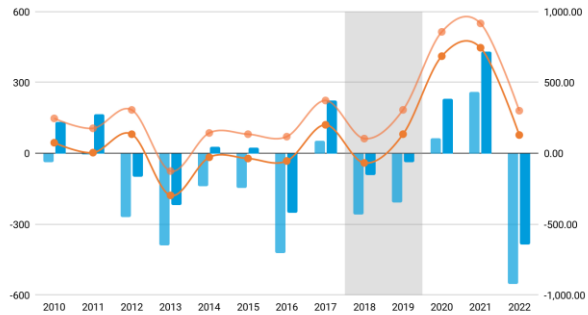

Figure 2. Anomalies in annual precipitation and power output of demonstration plants before and after correction. Precipitation and power output of demonstration plants are plotted as: **light orange lines** (right axis) for anomalies in power output against averaged annual outputs adopted in Project preparation; **light blue bars** (left axis) for anomalies in precipitation against 1950-1979 average; **orange lines** (right axis) for anomalies in power output against corrected AAOs; **blue bars** (left axis) for anomalies in precipitation against averaged annuals corresponding to corrected AAOs. Shaded area on the horizontal axis denotes time when the generators were fully or partially stopped for refurbishments.

4. Other relevant results

Besides the measurable results and achievements made under individual components of the Project, there are a few more aspects that it has made substantial strides in.

4.1 Stakeholder engagement

Primary target beneficiaries of the project are energy and environmental policy-making and implementing institutions at national and local levels, primarily under the umbrellas of MWR and MEE (Ministry of Ecology and Environment), SHP owners (end beneficiaries), designers, installers, training institutions, energy professionals, service providers and the financial sector. The outcomes of the planned project activities and potential recommendations for bridging the gaps have been discussed with all identified potential stakeholders during the preparation stage of the Project.

Stakeholders in the field of green SHP have consistently played active roles in the decision-making processes and interventions executed throughout the Project. UNIDO, as the GEF project management agency, works closely with MWR and ICSHP to steer the implementation of the project, and is effectively involved in project identification, formulation and approval. MWR, as the national executing agency, provided high-level support to the project through policy discussion, the Steering Committee and by convening the necessary inputs by local water departments. ICSHP, which hosts the project management office, coordinates with the wide range of affected project partners to ensure the timely delivery of activities and supports UNIDO in contracting and monitoring. The provincial level PMUs works alongside local SHP owners and collaborated with other government agencies. Universities and research institutions provides technical support to the project in research, training, monitoring, and organising events.

Six sessions of the PSC Meetings (held in 2023, 2022, 2021, 2020, 2019 and 2017), which were open to interested parties, including owners of the demonstration plants, for them to remain updated on implementation progress, engage in discussions addressing challenges, and collectively devise work plans. Further updates and progress have been shared regularly through continued communication with instant messaging groups, e-newsletters and written reports. To effectively mitigate potential impacts arising from demonstration activities, and accommodate their specific needs in local infrastructure and sharing of benefits, stakeholders like the local residents took active parts in the preparation and implementation of the refurbishment plans and ESMPs (environmental and social management plans) of the plants. Policy and capacity components of the Project were implemented with extensive consultations with a broad range of stakeholders across different domains to keep comprehensive engagement.

4.2 Gender mainstreaming

The Project takes a consistent approach in gender mainstreaming throughout the project cycle. The project document includes a results framework with clear gender dimensions and prescribed

measures for gender mainstreaming during implementation, and the strong gender considerations were visible in the planning, contracting, delivery, and monitoring of project activities. Gender-related data, such as SHP female employees and beneficiaries, have been collected and analysed in various monitoring reports under Component 2. Similar gender supporting practices have also been followed in the training and seminar activities, which includes gender as a standalone chapter in curricula and lectures.

During the project implementation, gender mainstreaming has been considered as a pivotal priority for all Project partners in fulfilment of their responsibilities. From the perspective of project management, requirements in the attained female interests and proportion in results (25% for minimum) are mandatory in the organisation of each activity. Female engineers and scientists are especially welcomed to take part in the Project as national and international consultants. With all vendor and consultant teams aggregated, female members account for 39.5% of the total.

Among Project components, it has been particularly highlighted in capacity building and knowledge sharing to have equal participation of women. The focus is to enable female professionals to upgrade their skills to equally compete for higher positions in their careers and increase their participation in the development and management of green SHP. Training documents have been designed to include additional support for women. Female participation rate exceeds 25% in each capacity building training programme.

On top of that, gender mainstreaming is also demonstrated in the programmes to upgrade the management of the demonstration plants. The female employees of the pilot power station account for about 28% of the total, the average income growth rate is 37.5%, and more than 50% of the pilot power station leadership team has female members. The Project's support of SHP automation reduced the reliance on manual labor in the monitoring and operation of SHP facilities, which was considered to benefit female staff in particular. For the adoption of more automated and standardised measures in plant operation, the total number of plant employees reduced slightly (-5.2%), the proportion of female employees stayed around 30% with minor increase. The number of female team leaders, however, increased to 9.6% (+1.3%) (see Annex 12).

4.3 Cooperation environment

Implementation of the Project has generated synergies with or could contribute to a few other projects or programmes promoted by UNIDO in the field of SHP. These include:

- **World Small Hydropower Development Reports** (WSHDR, SAP ID 200192): The WSHDRs play a vital role in providing essential data, case studies, and a strategic perspective for nations aiming to develop their SHP potential. Serving as a valuable repository of knowledge, these reports serve as a guiding reference for policymakers and investors involved in the global advancement of SHP. The refurbishment and upgrades of SHP plants under this Project has created highly convincing success stories of green SHP development which could be used as case studies valuable for the WSHDR.
- **Small Hydropower Technical Guidelines** (SHPTGs, SAP ID 170216): Drawing upon international collaborations with experts and leveraging successful experiences, UNIDO has formulated the SHPTGs, which are serving as valuable resources facilitating the dissemination of knowledge, sharing of best practices, and offering crucial insights from a global perspective. Policymakers, industry professionals, and academic institutions can rely on the SHPTGs as an authoritative source of information, empowering them to make informed decisions and effectively navigate the multifaceted landscape of small hydropower development. Experiences and knowledge accumulated under this Project could be a valuable addition for further improvements to the SHPTGs.
- **The SHP Technical Development Service Package** (SAP ID 150095): The Service Package aims to facilitate the development of SHP projects worldwide, especially in

regions where renewable energy is crucial for sustainable growth. It targets enhancing green energy access, promoting job creation, and supporting the development of remote areas through sustainable energy solutions. The services are tailored for a diverse group, including governments, SHP investors, owners, operators, social and environmental organizations, as well as regulators. Focused on aiding developing countries, UNIDO is committed to addressing the challenges they face in developing small hydropower projects.

- **Other GEF projects on SHP** (e.g. Madagascar 120094, Nigeria 120119, Burundi 140332): A few other projects focusing on developing SHP in African countries are undergoing. For those projects, local organisations have more technical limitations and less developed capacity to support project implementation, but the fundamental needs to minimise the environmental impacts of SHP and fulfil investment requirements are highly relatable. The knowledge and experience accumulated under this Project, together with various tools developed for training and awareness raising, are a meaningful basis to start with for adaptation and assimilation.
- **Further opportunities on pumped storage potential**: The implementation of this Project coincides with a time where both China and the global community are making concerted efforts to replace fossil fuels with renewable energy alternatives, such as solar and wind power. However, due to the inherent intermittency of these renewable sources, the imperative for extensive energy storage systems to mitigate supply fluctuations has become paramount. Notably, through the implementation of this Project, it has been found that a significant number of SHP projects in China have the potential to be repurposed into pumped storage facilities, in particular cascade SHP projects, so that the existing SP infrastructure could be optimised in their value. Access to suitable resources and support from donors such as GEF would facilitate the realisation of these prospects..

5. Risk Analysis and Mitigation Actions

During the preparation phase of the Project, a comprehensive assessment was conducted on potential risks during the Project implementation. The categories identified include political, implementation, technical, sustainability, financial, social and environmental, and climate risks. The outbreak of the Covid pandemic and subsequent restrictions due to public health policies also brought in additional implementation risks that were not anticipated at the preparation phase. To effectively address these identified risks, specific mitigation measures were implemented (see Table 7).

Table 7. Risks and mitigation measures

Nº	Description	Mitigation/management actions		
Description of risk(s) per category		*Actions carried out*	*Deliverables*	*When/Frequency*
1	Political risk: ● Lack of government commitment to support the project	● The Project objectives and activities crafted in line with national policies and objectives. ● MWR closely involved in all stages of Project preparation and implementation to ensure their full. ● Provincial governments actively engaged in the Project and have their interest	● Project proposal ● Various implementation plans	In Project preparation and throughout implementation

Nº	Description	Mitigation/management actions		
Description of risk(s) per category		*Actions carried out*	*Deliverables*	*When/Frequency*
		in greening projects aligned.		
2	Implementation risk: ● Lack of interest or trust in green SHP technology ● Unsuccessful demonstration at selected sites due to lack of capacity to operate and maintain projects ● Lack of management and coordination capacity ● Restrictions due to Covid policies	● Project design paid special attention to strengthening industrial actors across the value chain of China's SHP	● Project proposal	In Project preparation
		● Selection of demonstration sites with active contribution from MWR and provincial governments ● Regular contact and communication maintained throughout Project implementation	● Feasibility studies and business plans ● Refurbished and upgraded SHP plants ● Regular reporting on progress	Throughout technical demonstration
		● Capacity building trainings delivered to plant staff ● Progress closely monitored through key indicators	● Training workshops for SHP owners, technical staff, etc. ● Regular reporting on progress	Throughout technical demonstration and capacity building
		● Project management office set up at national and provincial levels ● Project management monitored under M&E plan ● Clear indicators prepared for tracking outcomes and outputs with a focus on implementation milestones and project results	● M&E plans and implementation ● Regular reporting on progress	Throughout project implementation
		● Project extension applied for ● Project activities adapted	● Project completion extended to 2023 ● Adapted indicators for monitoring	Implementation since 2020
3	Technical risk: ● Green and safe technologies and measures not performing as described mainly due to lack of skills to operate the technologies	● Detailed assessment of suitable sites for demonstration conducted, with active inputs from Chinese government ● Training for operating personnel provided	● Feasibility studies and business plans ● Refurbished and upgraded SHP plants ● Staff with improved skills and knowledge	In Project preparation, and technical demonstration
4	Project sustainability: ● lack of collaboration by key agencies ● failure to achieve project outcomes and objectives after	● PSC established across agencies to oversee implementation and ensure collaboration ● Awareness raised among market players	● Communication and coordination between agencies for decision making and adaptive management of the Project	Throughout Project implementation

Nº	Description	Mitigation/management actions		
Description of risk(s) per category		*Actions carried out*	*Deliverables*	*When/Frequency*
	successful delivery of outputs. ● lack of technical capacity ● failure to scale-up the project activities	of the benefits of green SHP ● Capacity developed for stakeholding parties of green SHP to realise its benefits ● Incentive mechanism recommended to create a positive context for project impact and sustainability	● Various tools for awareness raising, including brochures, films, posters, etc., targeting potential SHP owners, financiers, local governments ● Various training workshops and capacity building programmes ● Policy recommendations for incentive-based institutions	
		● Social and environmental impacts recorded as part of the M&E ● Operational capacity improved at owners/operators' side for green and safe SHP	● Quantified records of Project impacts ● Success stories in green and safe SHP	Throughout Project implementation
5	Financial risk: ● SHP owners' lack of resources to repay loans ● lack of business case for green SHP ● lack of co-finance ● lack of interest among banks for large scale uptake	● Business plans developed with secured co-financing ● Measures included in plant upgrades for generating additional revenue and cutting costs ● Financial incentives included in policy recommendations ● Cost-benefit analysis of plant refurbishment conducted	● Business plans implemented ● SHP plants upgraded with expanded capacity and raised efficiency ● Policy recommendations with integration of financial incentives ● Quantified costs and benefits of plant refurbishment and upgrades	Throughout technical demonstration and policy studies
		● Banking sector included in knowledge and experience sharing	● Seminars organised with engagement of the banking sector ● Awareness raising tools integrating financial aspects	Throughout knowledge sharing
6	Environmental and social risk: ● failure to mitigate environmental risks ● Failure to ensure social safeguards ● resistance against, or lack of interest in, the project activities from stakeholders, especially with regard to the active promotion of gender equality	● Measures taken to mitigate environmental impacts in SHP operation, including maintaining minimum ecological flow, waste treatment, etc ● ESMPs prepared for each of the demonstration plants before interventions ● ESMPs implemented under monitoring	● Improved measures for managing environmental impacts in plant operation ● Refurbishment of plants conducted in accordance ESMPs ● Monitored results in ESMP implementation	Throughout technical demonstration

Nº	Description	Mitigation/management actions		
Description of risk(s) per category		*Actions carried out*	*Deliverables*	*When/Frequency*
	• low participation rates of suitable female candidates due to lack of interest, inadequate project activity or missing qualified female population in the sector	• Communication maintained in inclusive and gender responsive ways to engage stakeholders at all levels • Local communities actively consulted and engaged in plant refurbishment and upgrades • Training workshops made women-friendly in content and timing	• Demonstration plants refurbished and upgraded with improved women empowerment and benefit sharing with local communities • Training workshops delivered with sufficient women's participation	Throughout technical demonstration and capacity building
		• Commitment to Project confirmed by owners	• Confirmation letters from owners	Before start of technical demonstration
7	Climate risk: • Water flow variability could affect hydropower generation	• Power output continuously monitored • Analysis of hydrological regimes under future climate scenarios and potential impacts	• Records and analysis of output data • Forecast of future hydrological change and impacts	During technical demonstration

6. Project Sustainability and Scale-up of Results

The implementation of the Project has generated tangible results and substantial benefits, with a strong emphasis placed on ensuring sustainability and scalability of these accomplishments. The first aspect that would support project sustainability is the inclusive collaboration between stakeholders. The partnership and positive work relation between partners under the Project have enabled sustained implementation of the Project. The project steering committee is composed of the relevant responsible personnel from MWR， MOF, ICSHP, UNIDO, and provincial water conservancy administrative departments where the demonstration projects are located, which is mainly responsible for the decision-making of major issues such as project policy design, target tasks, fund allocation, as well as the project implementation progress, quality and fund arrangement. Under the leadership of the project steering committee, PMO closely cooperates and smoothly communicates with provincial PMOs to ensure the smooth implementation of the project. Technical demonstrations have been successfully completed with outcomes and impacts monitored and recorded, which has been valuable experiences to showcase the technical feasibility of the demonstrated measures. These experiences are valuable in bolstering confidence among the SHP industry to sustain the adoption of the demonstrated measures. Contributions from the Project in improving Chinese SHP policies and institutions are expected to contribute further to the sustainability of the green upgrades of SHP development across the country. It has established an institutional framework system consisting of industry standards, macro policies, technical guidelines, and development plans. This has facilitated the revision of industry standards related to green small hydropower and ecological flow release, guided the formulation of macro policies, promoted the standardization of small hydropower safety production, and provided strong support for the sustainable development of green small

hydropower in China. Moreover, the implementation process has prioritised inclusivity by actively involving women and local communities.

Equally important is the economic viability of the interventions. In the overall value chain of environmental and safe upgrades of SHP projects, the interventions generate a variety of benefits that include both social-economic (additional power output, irrigation, job creation, water supply, management efficiency, occupational health, women's empowerment, local scenery, local infrastructure improvement, ESG compliance, etc), and environmental one (GHG emission cuts, biodiversity restoration, soil erosion prevention, water quality improvement, carbon sequestration, etc). All the demonstration plants were certificated as green SHP plants and safe production standardized plants after the GEF refurbishment carried out, all of which discharged ecological flow according to the requirements, and improved the river ecological environment, and promoted the management optimization of the plants. Among the 19 demonstration plats, the water energy utilization rate of 9 has been significantly improved, the reduction and dehydration of the downstream river of 7 has been controlled, and 4 have provided support for the irrigation of surrounding farmland. On the opposite side, expenditures are necessary for capital investments and operational costs, and these would inevitably incur opportunity costs. To maintain the economic viability of the upgrades, demonstrating full cost recovery with the benefits generated outweigh the costs incurred is of utmost importance first, which has been supported by results from cost-benefit analysis (CBA, see Annex 16). However, as found through the CBA, from the perspective of SHP projects (plants), while all the costs are internalised to the owners (inclusive of Project contribution and governmental co-financing), a significant proportion of the benefits are still externalised from the owners, and therefore they need a significantly longer time to recover costs through revenue generated by continued operation of the plants if no other measures are taken to support them. Therefore, policies that offer additional incentives to the owners, through both governmental and market institutions, would be essential for uptake of similar measures and proliferation of SHP upgrades, and recommendations have been made to central and local governments on that.

Results in capacity building and awareness raising are a third aspect that would consolidate the Project sustainability with its impacts sustained. These include the training of SHP owners, technicians, officials, etc., who, with improved capacity, are going to sustain their direct contribution to the green development of SHP across the country.According to the feedbacks from the participants in training program of GEF Project, the training guided them to scientifically plan and formulate the SHP capacity upgrading plan, and created their interests on green SHP that made significant contributions to the dissemination, expansion and sustainable development of small hydropower technology and management. Moreover, training programmes and knowledge management are completed with heavy involvement of universities specialised in water management, who are going to, even after Project completion, continue benefiting parties that seek knowledge and education with them. Additionally, awareness-raising materials and campaigns, including brochures, posters, films, webpages, and SNS posts, have been developed and organised and will soon be released publicly to sustain the impact from the Project.

Institutional frameworks are another layer to strengthen the Project sustainability. The policy packages that have been recommended to local and central governments include those for ecological flow releasing and monitoring, payment for ecosystem services, feed-in tariffs, investment schemes, stakeholder engagement, and awareness raising to support green SHP development in China. These are contributing to self-reinforcing frameworks that combine multiple forms of institutions for sustained uptake and scaling-up of the promoted measures and upgrades for SHP. The Project significantly improves China's institutional and political framework for green SHP development. In 2020, the revised Green SHP Certification Standard and Technical Guidelines on Dehydration Recovery in Downstream River of Small Hydro were released by MWR (MWR, No.22, 2020) (MWR, No.9, 2020). From February 1, 2024, Chongqing has implemented an incentive price policy for small hydropower stations assessed as green small hydropower

demonstration stations, that is, the on-grid price will be increased by 0.01 yuan/KWH on the basis of its current on-grid price (Notice of Chongqing Development and Reform Commission on on-grid Electricity Price of Green Small hydropower and related matters). Additionally, the policies that have been materialised under the Project, including technical guidelines and management rules, address operational aspects of green and safe SHP, and are removing functional barriers for both the industry and the regulators for proliferation of the promoted interventions by the Project.

7. Lessons Learnt

Implementation and conclusion of the Project provides a valuable opportunity to reflect on the project lifecycle and distil key insights and knowledge for informing future projects. By examining the strengths and weaknesses, identifying best practices, and highlighting areas for improvement, these lessons are valuable for continuous learning and enhancement.

First, engagement of national governments is crucial for project execution. One of the key lessons learnt here is the critical importance of support from national governments for successful Project execution. The involvement and endorsement of national authorities bring a significant amount of co-financing into the refurbishment of SHP plants, enabling smoother implementation and overcoming potential barriers. Other support received in policy studies, regulatory facilitation, and coordination with relevant stakeholders not only provides a solid foundation for project activities but also enhances the chances of long-term sustainability and scalability. The lesson learned here emphasizes the need for early and continuous engagement, as early as in the preparation phase of the Project, with national governments to secure their commitment and alignment with project objectives.

Second, effective and transparent communication is key to the inclusivity of stakeholders. Through this project, it became evident that open and clear communication channels, both formal and informal, are essential for engaging stakeholders, addressing their concerns, and fostering collaboration. This Project has involved a substantial number of stakeholders in the SHP industry, including owners, developers, technicians, financiers, regulators, researchers and local communities. Regular communication and consultation, tailored to the needs and preferences of various stakeholders, helps build trust, manage expectations, and mitigate potential conflicts. Additionally, transparency in decision-making processes and access to information empower stakeholders to actively participate, contribute their expertise, and align their interests with Project goals. This lesson highlights the need for robust communication strategies and stakeholder engagement plans as integral components of Project management.

Third, the implementation of project responsibility system can effectively improve the project management efficiency and speed up the project implementation schedule. The project established management organizations including National Project Coordination Committee (NPCC), the Project Management Office (PMO) and Provincial Project Management Office (PPMO) whose management functions were defined. The NPCC is responsible for coordination of Project execution activities, provides necessary guidance and oversight on the Project's execution. Under the leadership of the NPCC, PMO is responsible for the day-to-day execution and monitoring of project activities, and PPMOs are responsible for supervising the SHP demonstration projects in the refurbishment work. Management organizations at all levels perform their duties seriously, which promoted the solution of project difficulties and the formulation of major decisions, thus the progress of project implementation promoted.

Fourth, ecological flow discharge can not only improve the ecological environment of the river, but also ensure the demand for farmland irrigation and stimulate the economic growth of

communities around the power station. Most of China's SHP plants are built in rural areas near farmland and irrigation canals which were in disrepair and relatively dilapidated, that has affected the amount of water diverted from channels and the yield of farmland.The discharge of ecological flow not only ensures the stability of downstream river flow, prevents the river cut-off, but also satisfies the downstream farmland irrigation water demand to a certain extent. In combination with the renovation of irrigation facilities such as flood control embankments and irrigation canals, farmland yields have been further increased which brought an increase in farmers' income, thereby improving the economy of surrounding villages.

Fifth, practical training at the operational level is essential for overcoming cultural differences. Practical barriers at the operational level, for example, norms and habits in procurement, accounting, and reporting, emerged as a prominent difficulty out of cultural differences between international and national partners under this Project. The lesson learned here emphasizes that mere awareness of cultural diversity is insufficient, and there needs to be practical training to equip project teams with the necessary skills and knowledge to navigate cultural differences effectively. During the implementation of the Project, informal practical training helped build stronger relationships between partner teams, overcome potential misunderstandings, and adapt project activities to align with cultural contexts. This lesson underscores the significance of cultural competence as a means to promote collaboration, respect, and successful project outcomes.

Appendices

Annex 1. Project Proposal endorsed by GEF CEO, in English, dated 5 May 2016

Annex 2. Letter from UNIDO GEF Focal Point, Ciyong Zou, confirming the extension, in English, dated 28 October 2021

Annex 3. Letter from GEF Operational Focal Point in China, Peng Xiang, endorsing and requesting the extension, in English, dated 7 May 2021

Annex 4. Final report on revising and improving the policy packages related to green SHP development and certification, including related technical guidelines and management practices, and training materials for capacity building, in English, dated June 28 2022

Annex 5. Final report on policy recommendations on green SHP labelling schemes, in English, dated December 2019

Annex 6. Final report on policy recommendations for local governments in green SHP development, in English, dated December 2020

Annex 7. Final report on policy recommendations for national government in green SHP development, in English, dated 18 May 2023

Annex 8. Feasibility studies of demonstration plants, including reports in Chinese for Maoyandong 2, Mabozi, Chahe, Zhoujialiang, Yangdaohe Cascade, Jiangjunzhu, Majing, Xiaokeng, Gaokeng, Taiping, Tangban, Jiaosan, Tantou, Gaofang 2, Xinpingya, Guanxi, Sandieling & Dongpai, Aibu 2&3, Qingshuitan, and, Panxi 2, 3 &4, dated around end of 2015

Annex 9. Final reports by demonstration plant owners, …

Annex 10. Final report for monitoring of the refurbishment of demonstration plants, in English, dated 10 December 2021

Annex 11. Final report for monitoring of ESMP implementation, in English, dated June 2023

Annex 12. *Ex-post* and *ex-ante* comparison report, in English, dated 16 November 2021

Annex 13. Case study reports, in English, for Maoyandong 2, Mabozi, Chahe, Zhoujialiang, Yangdaohe Cascade, Jiangjunzhu, Majing, Xiaokeng, Gaokeng, Taiping, Tangban, Jiaosan and Tantou, Gaofang 2, Xinpingya, Guanxi, Sandieling & Dongpai, Aibu 2&3, Qingshuitan, and Panxi 2, 3 &4

Annex 14. Analysis of output and precipitation data at demonstration SHP plants, in English, dated 28 July 2023

Annex 15. Analysis of hydrological regimes under future climate scenarios and their possible impact on power output of demonstration plants, in English, dated 10 November 2023

Annex 16. Cost-benefit analysis of plant refurbishment, in English, dated November 2023

Annex 17. Final report for organisation of capacity building training, in English only, dated 26 May 2023

Annex 18. Final report for the study tour to US, in English only, dated July 2019

Annex 19. Final report for the study tour to Europe, in English, dated 4 December 2019

Annex 20. Project brochure, in English, not dated

Annex 21. Project film, in English and Chinese, not dated

Annex 22. Posters, in Chinese, not dated, for Maoyandong 2, Mabozi, Chahe, Zhoujialiang, Yangdaohe Cascade, Jiangjunzhu, Majing, Xiaokeng, Gaokeng, Taiping, Tangban, Jiaosan, Tantou, Gaofang 2, Xinpingya, Guanxi, Sandieling & Dongpai, Aibu 2&3, Qingshuitan, Panxi 2, 3 &4

List of Abbreviations

CBA	Cost-benefit analysis
CNY	Chinese Renminbi Yuan
ESG	Environmental, Social, and Governance
FYP	National Five-Year Plan of China
GEF	Global Environmental Facility
GHG	Greenhouse gas
ISID	Inclusive and sustainable industrial development
KPI	Key Performance Indicator
MEE	Ministry of Ecology and Environment, China
MOF	Ministry of Finance, China
MTR	Mid-Term Review
MWR	Ministry of Water Resources, China
PIPE	Interim Performance Evaluation
PMO	Project Management Office
PSC	Project Steering Committee
SDG	Sustainable Development Goal
SHP	Small hydropower

SHPTG	Small Hydropower Technical Guideline
SNS	Social network services
UNIDO	United Nations Industrial Development Organisation
USD	United States Dollar
WSHDR	World Small Hydropower Development Report

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