

## Small hydropower

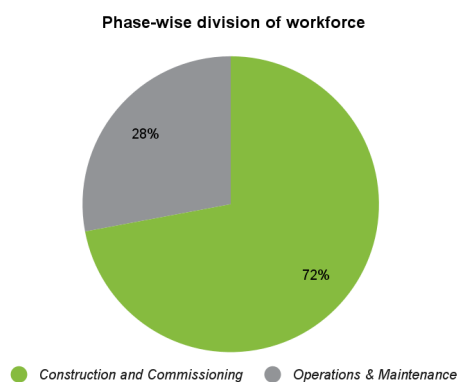
In India, hydro plants with a capacity of ~1 - 25 MW or below are categorised as small hydro (MNRE). Small hydropower has a total assessed potential of 21,133 MW across 7,133 sites (MNRE) with Odisha having a potential of 286 MW. Odisha can look to capitalise on its reservoirs and water bodies to generate power using small hydro which poses a lesser extent of environmental and rehabilitation-related concerns as compared to large hydro (Doso et al. 2020, Khan 2015, Mishra et al. 2015).

## Opportunities for 2030

### Jobs overview

- As per MNRE's assessed potential for Small Hydropower (SHP) in Odisha, it will deploy 286 MW of SHP by 2030, which in turn can generate **500 FTE jobs**.

Figure 1: Phase-wise division of workforce



Source: Authors' analysis adapted from IASS and TERI, 2019

### Market opportunity

- As per the total MNRE assessed potential, 286 MW small hydro in Odisha has a market opportunity in terms of revenue from electricity generated of **INR 700 crore (USD 80 mn) in 2030**.
- Kandhamal, and Angul** are the high-impact districts with 132 MW of proposed capacity as per GEDCOL (SHEProject). Garjan Khol in Angul and Mandira SHEP in Sundargarh are two further prospective sites being looked at with ~25 MW SHP capacity.

### Investment opportunity

- The investment opportunity of **INR 1400 crore (USD 170 mn)** can be realised with 286 MW of small hydro deployment in Odisha.

## Why should Odisha invest in small hydro deployment?

1. The current installed capacity of large hydro is 46.9 GW (MOP 2024) as of December 2023 whereas CEA optimal generation mix forecast assumes 61.6 GW (CEA 2023) of large hydro by 2029-2030 (including hydro imports of 5.8 GW). This low additional large hydro power installation target is due to various factors like long gestation period, adverse environmental and social impacts, etc. This increases the need for small hydro since the high ramping rate and high CUF is crucial to meet India's power demand and aid grid balancing. With the reduction of large hydro, small hydro will have to support the grid.
2. Small hydro has a relatively lower environmental footprint than large hydro given it is free from issues related to relocation of locals and deforestation, which are usually associated with large hydro. Further, since no water is stored and most small hydro plants are canal-based or run-of-river type using running water, it is considered to be cleaner and more environmentally sustainable as compared to large hydro (Doso et al. 2020, Khan 2015, Mishra et al. 2015). Other benefits include water supply management, which significantly contributes to the well-being and economic health of local communities, small hydro being less prone to fish migration and sedimentation as compared to large hydro, etc (Khan 2015, Sachdev 2015, Diduck et al. 2016).
3. It enables local development by improving infrastructure in terms of development of roads, bridges, transmission lines, etc. In cases wherein micro hydro is used for village electrification, it provides opportunities for the development of small enterprises like agro processing units, cottage industries etc. and helps improve the local economy. Further, given local employment generation opportunities, it helps arrest migration from rural to urban areas. (Khan, 2015, Kumar et al., 2016, Doso et al., 2020).

## Inspiration from a success story



The San Michele dei Mucchietti Hydropower Plant is a 1.8 MW SHP plant in the Secchia River, Italy. It is known for extracting the benefit of small hydropower using existing water distribution network and retrofitting it with smart technical solutions<sup>1</sup> leading to cost savings of EUR ~5,00,000 (UNIDO, ICSHP, 2022). The weir was built in 1980 to provide water for the region's irrigation through two

channels, however, due to the lowering of the riverbed, it was no longer serviceable. Via various innovative technical and construction-related innovations such as embankment of the lateral reservoir, double connection pipes between the lateral basin and the river, etc., it utilised this existing infrastructure to develop the SHP plant and enable carbon emission reduction of ~3,600 CO<sub>2</sub> tons/year. Further, the developer ensured that the construction did not impact the river regime by returning the water source into the Secchia riverbed about 100 m from the intake. The energy

<sup>1</sup> 1. Double connection pipes between the lateral basin and the river which helped in stopping the hydropower intake when reaching the minimum water level in the river/ This helped ensure the level necessary for irrigation and protecting the intake from silting.

2. Embankment of the lateral reservoir to ensure protection of the plant from floods which helped avoid the cost of EUR 200,000 needed to construct protection screens, stone boulders and walls higher than the two hundred-year period flood level.

generated satisfies the annual energy need of 3,500–4,000 families (7–10 GWh/year) in the Sassuolo community (UNIDO, ICSHP, 2022).

### Who could support in scaling small hydro deployment?

#### 1. Role of departments:

- a. Green Energy Development Corporation Odisha Limited (GEDCOL) and Odisha Hydro Power Corporation (OHPC) - GEDCOL, a subsidiary of OHPC, to actively look into potential sites for more SHP deployment, undertake feasibility studies and work with the Department of Water Resources to identify suitable sites after understanding geological, topological and hydrological conditions. In order to minimise local opposition and land acquisition-related issues as well as time and cost overruns, proper siting to be done through understanding site characteristics, natural reserves, land and transmission infrastructure, etc. and by creating strategic mitigation plans around them. Further, GEDCOL with OHPC to ensure availability of adequate connectivity via roads before project construction begins in these remote areas to minimise project delays. GEDCOL to ensure inter-departmental coordination for issuing all statutory permits and clearances methodically right from project inception. Likewise, all agreements like Implementation Agreements, PPA, Loan Agreements etc., to be monitored to ensure execution as per project timelines.
- b. Odisha Skill Development Authority (OSDA): Odisha Skill Development Authority (OSDA) to look to formally skill local individuals. These include skills relating to construction, contract management, testing, quality assurance, operation & maintenance, etc. Current training centres to be utilised to upskill local individuals in basic technical skills that can be utilised for further employment across RE sectors and O&M.
- c. Odisha Power Transmission Corporation Limited (OPTCL) - OPTCL under the Odisha Distribution System Strengthening Project (ODSSP) (OERC 2015) to look into building transmission and distribution networks in prospective areas of small hydro development and ensure last mile connectivity suiting project timelines.

#### 2. Role of local administration and civil society organisations (CSOs)

Local bodies and civil society organisations (CSOs) look into knowledge dissemination in the form of project specifics, completion date, etc. to ensure that the local community is informed of the project works as well as spread awareness regarding the merits and demerits. Since messaging and perception is extremely important in case of small hydro to set it apart from large hydro (Khan 2015), it is important for local governance bodies like gram panchayat to be the agent of such information dissemination.

### 3. Role of the private sector

Enabling Private sector developers to work with CSOs and gram panchayats to conduct stakeholder consultations and undertake measures to minimise adverse project impacts to local communities and formulate community development plans, as necessary. Further, private sector players are important to ensure accelerated investments in the deployment of small hydropower.

### Overcoming challenges to scale small hydro deployment

- 1. Lack of availability of transmission infrastructure-** It is a major reason for delays in construction and implementation of SHP projects (Khan 2015). It is recommended that potential SHP areas be looked into for development of transmission lines and power evacuation infrastructure to attract private sector interest and improve ease and timeline of deployment, as well as improve cost effectiveness. Further, delays in access road availability or poor conditions of roads lead to project delays. It is recommended that these are made available before plant construction begins.
- 2. Lack of availability of local skilled manpower-** Another major challenge for project developers is the lack of availability of local skilled manpower in the rural areas surrounding SHP projects since outstation employees do not want to be located in remote areas for long durations. The development of SHP is highly dependent on indigenous technological skills and expertise since SHP is highly site-specific (Khan 2015, Kishore et al. 2021) and otherwise would put more financial burden on the project. It is thus recommended that OSDA set up skill development institutes to train locals in the prospective and viable sites pre, during and post implementation of SHP projects to attract more investment. Further, local manufacturing can also be scaled up to ensure that employment is generated and skilled individuals have more avenues of employment.
- 3. Lack of adequate hydrological data-** Lack of adequate hydrological data to assess site viability leads to improper assessment of power potential (Khan 2014, Kishore et al. 2021). It is important that the river flow changes with season are measured and flow rate measurement should be carried out throughout the year to obtain proper discharge data in potential viable sites to ease project planning and ensure maximum utilisation of potential.
- 4. Social opposition and delays in land acquisition** - Social opposition and delays in land acquisition and compensation setting is another major challenge towards deployment of SHP projects. This can be mitigated by ensuring that individuals understand the relatively lower impact of small hydro and through better focus on perception and messaging (Khan 2015) since it is usually seen interchangeably with large hydro.
- 5. Delays in statutory permits-** Delays in statutory permits, clearances, Implementation Agreement, PPA, Loan Agreement, etc., pose various challenges and risks to investment, financiers, timely project completion, etc. It is thus important to ensure that adequate capacity is built internally to fast-track these processes and that knowledgeable staff are assigned to follow up according to project timelines.

### Risk-proofing the scale-up of small hydro deployment

1. **Risks to investment:** Risk to investment arises due to various factors like flooding during monsoons and accumulation of silt, which damage turbines (Sharma et al. 2017) and specifically for Odisha, coastal areas pose a cyclone risk.

Mitigation: It is important for developers to adequately assess risk and ensure that they are sufficiently insured against them.

2. **Social and environmental risks:** Although small hydro is more environmentally friendly as compared to large hydro, there are certain risks associated with it, which need to be mitigated in a timely manner to ensure that it remains a clean and sustainable resource.

Mitigation: High wastes and muck generation needs to be disposed of sustainably to minimise impact on the environment (Kishore et al. 2021). Further, it is also important to implement rules and guidelines to strike a balance and divert the required water while maintaining environmental flow in the river to minimise impact on aquatic ecosystems and maintain proper balance between the local ecosystem and the amount of energy unit generated for utilisation (Sharma et al. 2017, Khan 2015, Kumar 2019). Thus, although small hydro is exempted from conducting ESIA studies, it is important to adequately assess its impact on local ecosystems to be able to ensure effective mitigation strategy formulation (Sharma et al. 2017, Diduck et al. 2016, Kumar 2016). Further, it will aid raising finance since most developmental banks offering concessional or soft loans require such assessments to be carried out to assess the financial attractiveness of the project.

## Annexure

### Scoping of the small hydro value chain

This section focuses on estimating jobs and markets only for ‘deployment’ of small hydro and does not include manufacturing of components or end-of-life management.

Small hydro deployment is further divided into the stages of 1) construction and commissioning and 2) operations and maintenance. All these sub-phases have been considered for job estimation.

### Jobs and market estimation

*Jobs estimation:*

Total number of jobs that can be created through small hydro deployment in Odisha by 2030 is calculated using phase-wise full-time equivalent (FTE) per MW coefficients and potential market size.

$$\text{Total FTE jobs} = \text{FTE jobs per MW} \times \text{potential market size (MW)}$$

**Table 1: The phase-wise FTE considered are as follows:**

| Sl. No. | Phase                          | FTE/MW       |
|---------|--------------------------------|--------------|
| 1.      | Construction and Commissioning | 13           |
| 2.      | Operations and Maintenance     | 0.84         |
| 3.      | <b>Total</b>                   | <b>13.84</b> |

*Source: IASS and TERI, 2019*

The first phase of project deployment (i.e. construction and pre-commissioning) creates one-time jobs whereas in the last phase of the project (i.e. operations and maintenance), the employment generated lasts for the lifetime of the project.

A linear trajectory of wind deployment is assumed and jobs are calculated in a manner that the workforce employed in one year will be reabsorbed in the deployment of small hydro in the next year for the first three phases of project deployment. This would help avoid double counting of jobs and align with the aim of creation of a renewable energy workforce that can offer sustained employment by accelerated deployments.

*Market sizing (in units):*

MNRE assessed the potential of small hydro in Odisha at 286 MW. Of this, 109 MW has already been deployed in the state (DoE, 2023), and projects of ~70 MW are in pre-feasibility, Detailed Project Report (DPR) and construction stages, to be developed by Green Energy Development Corporation of Odisha Ltd. (GEDCOL). Thus, we expect 286 MW to be deployed by 2030 as the ambitious market potential.

## Market opportunity (in USD) estimation

The market value of small hydro deployment through the ambitious scenario set for Odisha has been estimated by forecasting the revenue generated from the sales of power in 2030. In order to convert MW ambitious scenario to MWh in terms of electricity generation, the following formula was used:

$$\text{Capacity Utilisation Factor (CUF)} = \frac{\text{Injected energy (MWh)}}{\text{Project capacity (MW)} \times 8766} \times 100$$

$$\text{Revenue potential} = \text{Tariff rate (USD/kWh)} \times \text{Injected energy (kWh)}^2$$

Table 2: Input values and rationale for each parameter:

| Sl. No. | Parameter             | Value       | Rationale/Source                             |
|---------|-----------------------|-------------|----------------------------------------------|
| 1.      | CUF                   | 45 per cent | CEA, 2022                                    |
| 2.      | Project capacity (MW) | 286 MW      | Built as per the scenario mentioned          |
| 3.      | Tariff rate (INR/kWh) | 5.8         | Tariff rate for Odisha, Source - Joshi, 2023 |

Source: Authors' analysis

## Investment opportunity estimation

To arrive at the investment opportunity when deploying the ambitious target for wind in Odisha by 2030, we multiplied the capital cost of small hydro per MW<sup>3</sup> to the total additional capacity to be installed:

$$\text{Investment opportunity (USD)} = \text{Capital cost of small hydro per MW} \times \text{Total additional capacity to be installed (MW)}$$

<sup>2</sup> 1 USD = INR 83

<sup>3</sup> As per the Indian Technology Catalogue (CEA, 2022), the capital cost of photovoltaics of small hydro is INR 8.04 Cr per MW as on 2020

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