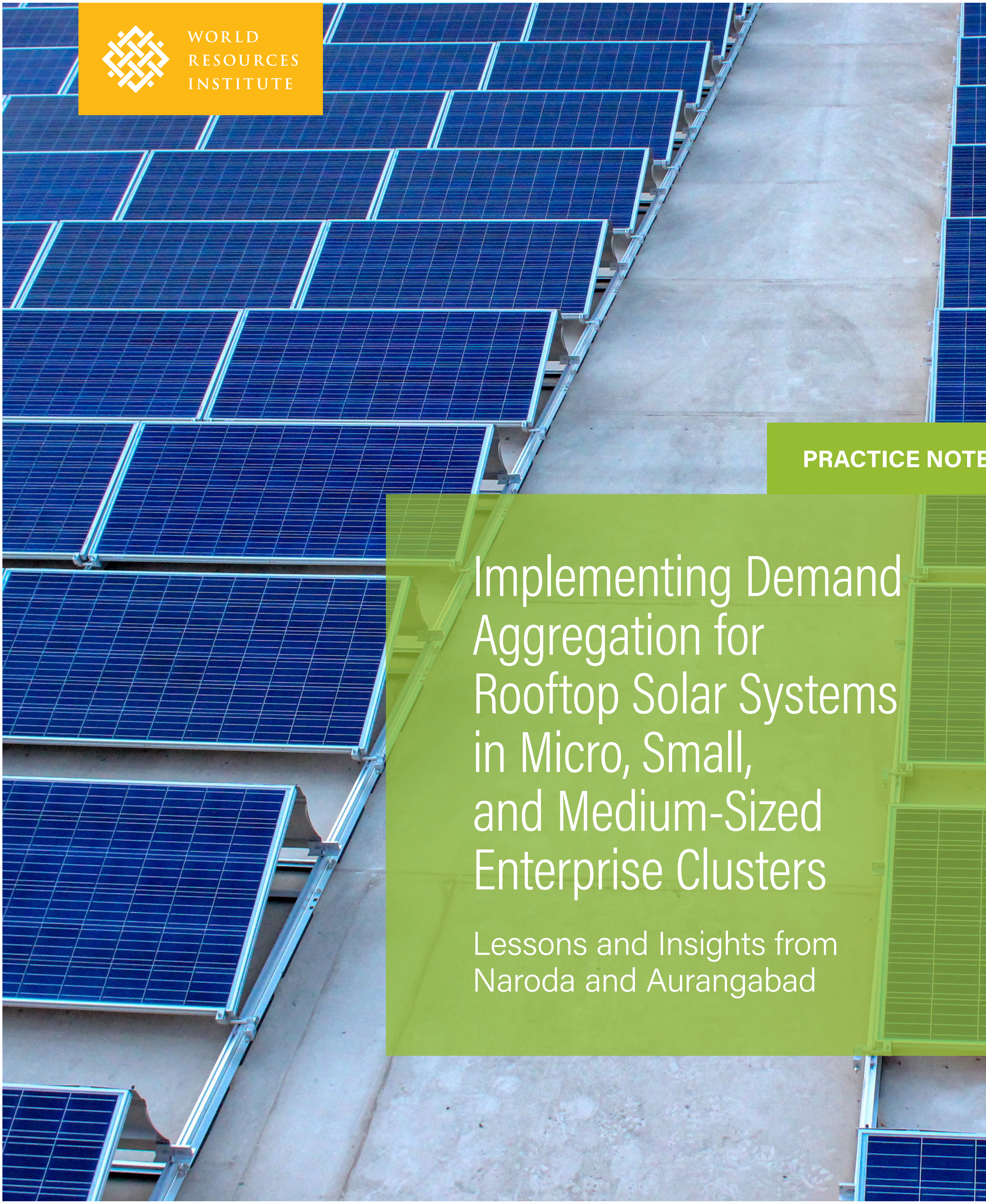

WORLD RESOURCES INSTITUTE

PRACTICE NOTE

Implementing Demand Aggregation for Rooftop Solar Systems in Micro, Small, and Medium-Sized Enterprise Clusters

Lessons and Insights from Naroda and Aurangabad

Practice notes provide rapid analysis of experiences related to a particular project. The analysis and recommendations are limited to the specific context presented in the note and should not be construed to apply more broadly.

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CONTENTS

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EXECUTIVE SUMMARY

HIGHLIGHTS

- India has 63.3 million Micro, Small, and Medium-Sized Enterprises (MSMEs). Thirty-one percent of these are manufacturing units (Government of India 2018a), which account for 25 percent of the industrial sector's energy consumption. Advancing the implementation of clean energy measures in the MSME sector can play a key role in India's clean energy transition.
- We present a pilot implementation of demand aggregation of solar rooftop photovoltaic systems (SRT PV) in two MSME clusters in Naroda and Aurangabad. We estimated a total of 4 megawatt peak (MWp) of distributed SRT PV potential in Aurangabad and 1 MWp in Naroda. We demonstrated successful implementation through installation of 160 kilowatt peak (kWp) (3 percent of estimated potential). Another 441 kWp (9 percent of estimated potential) is being installed.
- There were four factors critical to successful implementation: provision of technical assistance, coordination with industrial associations, transparent vendor selection process, and regular follow-ups.

Setting the context for this study. An estimated 63.3 million Micro, Small, and Medium-Sized Enterprises (MSMEs) in India produce 45 percent of the national manufacturing output and contribute 28.9 percent to India's gross domestic product (GDP) (Government of India 2018a). The MSME sector accounts for 90 percent of the total industrial sector in India. Thirty-one percent of the MSME sector comprises manufacturing industries (Government of India 2018a). The report of the Working Group on Power for Twelfth Plan (2012–2017) provides an estimate of the energy consumed by the MSME sector. According to this report, this MSME manufacturing sub-sector alone consumed about a quarter of the total energy consumed by the industrial sector (Government of India 2012). The industrial sector, in turn, accounted for 41.48 percent of the total electricity consumption in the country for the fiscal year 2018 (Government of India 2019). It is evident that the MSME sector will be called upon to play a key role in India's clean energy transition. This remains a challenge as most MSMEs are individually owned and operated, and have limited capital and manpower resources. Given the inherent contradiction outlined by this scenario, demand aggregation presents a viable alternative.

Demand aggregation as a potential mechanism to scale up the deployment of renewable energy in the MSME sector. In 2014, the World Resources Institute India (WRII) and the Confederation of Indian Industry (CII) attempted to demonstrate a demand aggregation model by combining renewable energy procurement for six companies in Bangalore under one bid (Thanikonda et al. 2016). This initiative made a compelling argument for demand aggregation. Currently, most industries in India procure on-site solar rooftop photovoltaic system (SRT PV) installations via individual contracts and do not harness the economies of scale. This, in effect, causes them to lose out on the substantial benefits that they would derive from collaborative procurement. While large companies are in a better position to drive clean energy and energy efficiency

measures, MSMEs are in a relatively disadvantaged position. MSMEs lack the leverage to influence renewable energy (RE) developers, energy efficiency (EE) technology providers, and financing institutions. As a consequence, MSMEs are generally unable to procure products that are customized to their needs. Demand aggregation can help them get better terms and to participate in India's clean energy transition. Figure ES-1 below summarizes the different stakeholders and the key activities of demand aggregation for the procurement and deployment of SRT PV systems for MSME industrial clusters in Aurangabad and Ahmedabad.

This publication aims to demonstrate a pilot implementation model for demand aggregation of SRT PV projects in two MSME industrial clusters in Western India. In this publication, we set out the methodology and approach we adopted to aggregate the demand for SRT PV systems in both the MSME clusters. We also present the processes that we evolved to overcome the challenges and barriers we were confronted with during the implementation of the project. There is currently limited empirical data available to inform policy and guide practice on energy usage and demands (including renewables), within MSME clusters. Through this practice note, we aim to consolidate learning from the previous WRII 2014 project as well as to develop a model for demand aggregation implementation through on-ground insights. The key metrics we shall use to measure the success of this project are: the number and size of installations that came about as a result of our facilitation, emissions reductions achieved, and replicability of the process. We believe that this publication will be of use to other MSME industrial associations and clusters, SRT PV vendors, and practitioners, consultants, and policymakers working on clean energy transitions in the MSME sector.

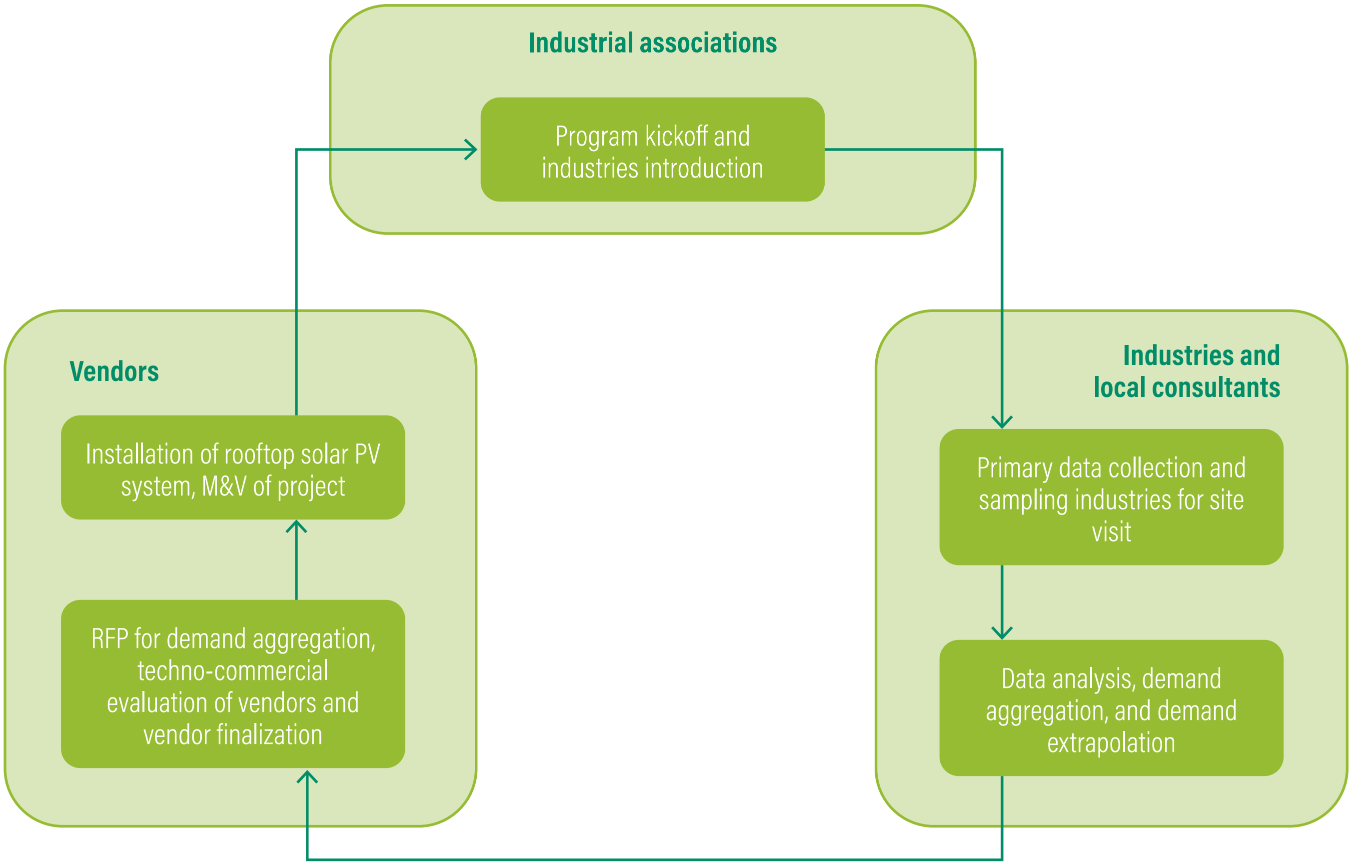
APPLIED LEARNING FROM PREVIOUS WRII STUDIES AND PROJECTS.

The 2014 WRII study documented the following three major learnings from its unsuccessful attempt to demonstrate the implementation of demand aggregation:

- Demand aggregation implementation—is most effective in geographical or common-purpose clusters.
- Strength in numbers—the higher the number of individual participants in a demand aggregation project, the more favorable the terms they are able to obtain. A greater number of participants also has a direct correlation to a higher rate of success as the project is less prone to being adversely affected by participants backing out during the process.
- Anchor partners—these are the institutional partners who function as aggregators during the demand aggregation implementation process. They play a crucial role in connecting a third-party enabler (in this instance, WRII) with their member industries. Effective anchor partners have a strong motivation and commitment to work for the betterment of their member industries and are key for the successful implementation of a demand aggregation project.

Drawing upon these key learnings from the 2014 WRII study, our first step was to secure the involvement of the respective industrial associations—Naroda Industries Association (NIA) in Ahmedabad and Marathwada Association of Small Scale Industries and Agriculture (MASSIA) in Aurangabad—as anchor partners. We conducted multiple capacity-building workshops working with the two anchor partners and our local partners at both locations. These workshops were an important part of the process. At the initial stage, the workshops generated

FIGURE ES-1 Key Stakeholders and Activities for Demand Aggregation of SRT PV Deployment



Source: WRI.

awareness and aided discussion. As the implementation process progressed, they helped build trust among the member units by demonstrating the transparent methodology adopted for the selection of solar vendors. Overall, the workshops helped us gain acceptance for demand aggregation from the member industries/units.

PROJECT PARTICIPANTS

We defined the following criteria to select the MSME cluster participants for this project: size, willingness to participate in demand aggregation, demand aggregation potential, and the presence of a supportive industrial association as the anchor partner. We then narrowed our focus to 70 units from each cluster, selected on the basis of their willingness to share data and participate in the demand aggregation project.

For the purpose of this study, we define the anchor partner as an aggregator for the demand aggregation and implementation process. We define the local partner as an entity that is familiar with the stakeholders in the respective clusters who would help WRII with data collection and coordination efforts on the ground. Our local partners and anchor partners for both locations are shown in Table ES-1 below.

PRE-IMPLEMENTATION ASSESSMENT

We conducted an initial assessment through data collection, along with the use of Google Maps and sample on-site visits. The results of this exercise provided us the basis to estimate the total SRT PV installation potential for the 140 participating MSME industries. We identified a total potential of approximately 5 MWp for both the locations (4 MWp for the Aurangabad MASSIA cluster and 1 MWp for the Ahmedabad NIA cluster), which is equivalent to approximately 2,700 tonnes of avoided coal consumption per year. We used an assumption of 70 percent of utilization area to derive this calculation in accordance with the Central Electricity Regulatory Commission (CERC) thumb rule that 1 kilowatt (kW) of rooftop solar installation would need an area of 10 square meters (sq m) (Government of India 2014).

POST-IMPLEMENTATION EVALUATION

We evaluated the success of this demand aggregation implementation project through the following key metrics:

- The number and size of installations implemented
- Emissions reduction
- Replicability of the process

Our aim was to demonstrate that demand aggregation implementation proved to be effective in accelerating the adoption of SRT PV systems in both of the MSME clusters. We were able to identify a total potential of 5 MWp, of which 160 kWp of the SRT PV system is already installed and 441 kWp of SRT PV system is in the process of being installed. If the entire capacity is installed it could potentially result in emissions reduction of around 5,483 total carbon dioxide (tCO_2) annually. In addition, implementation across two different clusters in two different states illustrates the replicability of the idea and the process.

As a part of the post-implementation process, we surveyed participants comprising 19 MSME industry members. In addition, we interviewed members of the two industrial associations, two local consultants, and the two selected solar vendors drawn from both locations. Seven of the surveyed MSME industries said that the potential for cost reduction was a critical incentive for them to join the project, 11 gave significant weight to having access to expert technical support from a third-party partner (in this instance, WRII and its local partners), and 6 gave significant weight to better contractual terms, as compared to individual procurement.

CHALLENGES TO THE SUCCESSFUL IMPLEMENTATION OF DEMAND AGGREGATION AND COUNTERMEASURES

Perhaps the most significant challenge we faced was the lack of data on energy consumption in the MSME units. Even in instances where data was available, it often proved to be unreliable or of poor quality. We found that most of the

TABLE ES-1 Anchor Partners and Local Partners at Both Locations

Naroda, Ahmedabad	**Local Partner:** Gujarat Cleaner Production Centre (GCPC), an environmental information system center working on cleaner production and technology since 2003 under the Ministry of Environment, Forest and Climate Change, Government of India. **Anchor Partner:** Naroda Industries Association (NIA), established in 1967 in the Gujarat Industrial Development Corporation (GIDC). NIA has around 900 MSME industrial members.
Aurangabad	**Local Partner:** Eco Energy Management System (EEMS), incorporated in 2011 with the objective of delivering savings to its clients through training, audits, and implementation of energy efficiency projects. **Anchor Partner:** Marathwada Association of Small Scale Industries and Agriculture (MASSIA), formed in 1977 under the name IAYE, today known as MASSIA. It has 1,500 small and medium-scale industries as members.

MSME units do not monitor their energy consumption or maintain a record as they lack both awareness and resources. We devised a workaround for this challenge by conducting field visits to sample MSMEs to assess their consumption pattern, determine the type of load installed, and evaluate the potential for on-site renewable energy interventions.

The other critical challenge that we identified was the difficult task of convincing and converting the MSME units to install a clean energy source. Demand aggregation is predicated upon the willingness of each participant in the process to engage in the process. With limited resources available to them, MSME units most often do not place a high priority on clean energy interventions. The capacity-building workshops we conducted for the MSME members went a long way toward overcoming this challenge and securing their acceptance of demand aggregation.

PROJECT RESULTS AND LEARNINGS

Our findings based on data compiled post-installation are the following:

- As of July 31, 2019, 160 kWp (3 percent of the estimated potential) SRT PV systems have been installed. This will enable an approximate 0.25 million units (MUs) of clean energy generation within a year.
- A further 441 kWp of SRT PV systems (9 percent of the estimated potential) are in the process of being installed. This will enable an approximate 0.69 MUs of clean energy generation within a year.

Our learning from this project emphasizes two key elements that influence and impact the demand aggregation implementation at every stage—from inception to actualization.

- The presence of a willing and supportive anchor partner (in this instance, the respective industrial associations) proved to be crucial to the process. The anchor partner cements the credibility of the process, provides a clear point of contact to liaise with third-party experts/enablers and helps both vendors and participants to negotiate and resolve any issues. At a secondary level, it provides a platform for capacity building and awareness, establishes a trust equation, and encourages adoption through peer recommendation.
- The involvement of a technical and sector expert as facilitator (in this instance, WRII) emerged as an important factor, particularly since the clean energy transition process within the MSME sector is still at a nascent stage. The participants in both clusters expressed the opinion that the skills, information, expertise, and transparency that the facilitator provided positively influenced their willingness to adopt demand aggregation. We have listed the following activities we undertook during the demand aggregation implementation process in order to define the role of a facilitator in a more objective manner:

Pre-implementation activity checklist

- Creating awareness, leading to the adoption of demand aggregation
- Evaluating the solar potential
- Facilitating the bidding process for the acquisition and installation of SRT PV systems
- Evaluating and identifying the best vendor options

Implementation-support activity checklist

- Finalize the generic agreement and contractual terms
- Facilitate regular follow-ups from both the vendor and the association to keep the industries motivated and accelerate the installation

In conclusion, we feel that we were able to road test the findings of the 2014 WRII study/project and to establish them as valid, key elements in the successful implementation of demand aggregation. We were also able to add new learning to our previous understanding of the demand aggregation process through a successful demonstration of implementation.

1. INTRODUCTION

1.1 ENERGY CONSUMPTION IN INDUSTRIES

The commercial and industrial sectors in India combined account for 50 percent of the national electricity consumption. The increasing penetration of solar energy in these sectors represents an opportunity to reach the goal of 100 gigawatts (GW) of solar by 2022 (India's INDC to UNFCCC 2015). Installation of SRT PV systems showed a remarkable growth of more than 70 percent over 2017 despite utility-scale installations seeing a decline of approximately 20 percent. As of June 2019, India had 29.5 GW of installed solar capacity (Government of India 2019). Solar rooftop installations in the commercial and industrial sectors grew by 72 percent during FY2018 (Sai and Rustagi 2019). This is especially encouraging given the fact that India's solar target of 40 GW to be met by SRT PV by 2022 currently stands at 2.2 GW (NITI Aayog 2015).

Currently, most industries in India procure rooftop solar systems individually, regardless of whether or not the industry is within an industrial cluster. However, recent literature highlights the benefits of aggregating demand for energy (Bird and Holt n.d.). WRII and CII also made the case for demand aggregation in 2014 (Thanikonda et al. 2016).

1.2 ENERGY CONSUMPTION IN THE CONTEXT OF MSMES

An estimated 63.3 million MSMEs in India produce 45 percent of the national manufacturing output and contribute 28.9 percent to India's GDP (Government of India 2018a). The MSME sector accounts for 90 percent of the total industrial sector in India. Thirty-one percent of the MSME sector comprises manufacturing industries (Government of India 2018a), which are responsible for 25 percent of the total energy consumed by India's industrial sector (Biswas et al. 2018; Government of India 2012). The report of the Working Group on Power for Twelfth Plan (2012–2017) has provided an estimate of the energy consumption of the entire MSME sector. According to this report, this MSME manufacturing sub-sector alone consumed about a quarter of the total energy consumed by the industrial sector (Government of India 2012).

Overall, the industrial sector in India accounted for 41.48 percent of the total electricity consumption in the country for FY2018 (Government of India 2019). The energy consumption of the MSME units was expected to reach 68.2 metric tons of oil equivalent (mtoe) by 2017 with a projected annual growth of 6 percent (Government of India 2015). According to the latest MSME census (2014–2015), approximately 32 percent of the MSMEs use electricity to meet their energy requirements.

Financial institutions, bilateral and multilateral organisations such as Small Industrial Development Bank of India (SIDBI), the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, and the United Nations Industrial Development Organization (UNIDO), among others, are working on cluster-level programs and pilot studies to enhance adoption and implementation of clean energy solutions across MSME clusters in India. We drew upon our experience of working with MSMEs and a review of the relevant literature (Government of India et al. 2011; Biswas et al. 2018) on clean energy uptake in MSME clusters to understand the multiple elements that influence the uptake of clean energy in MSMEs. We found the following:

- Capacity building emerges as an essential tool to raise awareness and encourage the transition to renewable energy within the MSME sector. Most of the industries are understaffed and their focus tends to be centred on the process of production and marketing. They require additional support in terms of access to technical know-how, recent innovations, and best practices for the implementation of clean energy solutions.

- MSMEs are ill-informed and, at times, wholly unaware of various financial schemes/subsidies/models available with specialized financial institutions, banks, and government bodies.

- There is a high level of uncertainty on data availability and the accuracy of data on energy consumption and energy saving potential in MSMEs in India since there is no comprehensive, reliable source of energy consumption data for the 6,000 estimated MSME clusters in the country (Biswas et al. 2018).

1.3 THE SIGNIFICANCE OF DEMAND AGGREGATION IN MSMES

It is an established fact that companies with a large electricity requirement get better contractual terms, such as better price and before-and-after service guarantee, on renewable energy purchase agreements (> 1 MWp) as compared to smaller players (Mahindra World City 2017). Aggregation of demand allows demand from multiple smaller enterprises to be clubbed together and plays an essential role in scaling up the deployment of renewable energy among smaller companies (Deloitte Center for Energy Solutions 2017). In this publication we present our experience with the implementation of demand aggregation for SRT PV systems in two MSME clusters located in Aurangabad and Ahmedabad. These clusters were selected based on the following carefully defined criteria:

- size of the cluster

- willingness of the respective industries to participate in demand aggregation

- demand aggregation potential

- the presence of an anchor partner such as an industrial association

Our first location, Aurangabad, is in the state of Maharashtra, India. There are four industrial clusters in this district—Chikalthana Maharashtra Industrial Development Corporation (MIDC) area, Shendra MIDC area, Railway Station MIDC, and Waluj MIDC area. Of the four clusters, we worked with the MASSIA cluster, comprising 1,500 units and spread over two locations: Chikalthana MIDC and Waluj MIDC. Electricity and light diesel oil are the primary fuels used in the MASSIA cluster. The industries within this cluster are largely automobile components manufacturing and light engineering units. There were no reliable sources to enable us to ascertain the total energy consumption data for this cluster.

Our second location, Ahmedabad, is the state of Gujarat, India. There are twelve industrial clusters in this district—Apparel Park, Vatva Industrial Estate, Kathwada Industrial Estate, Odhav Industrial Estate, Kerala Industrial Estate, Dholka Industrial Estate, Viramgam Industrial Estate, Dhandhuka Industrial Estate, Zone D Ahmedabad Industrial Estate, Vani-Viramgam Industrial Estate, Sanand Mini-industrial Estate, and Naroda Industrial Estate. We selected the Naroda Industrial Estate (NIE) for this project. NIE has approximately 700 chemical manufacturing MSMEs. These units are spread over three industrial areas—Vatva, Odhav, and Naroda. The Naroda cluster comprises 200 chemical manufacturing MSME units. The primary fuels used in this cluster are natural gas, light diesel oil, furnace oil, white coke, briquettes, coal, wood, and electricity. According to data collected under the BEE_SME Program, the total energy consumption in this cluster during 2010–2011 was 262,481 tons of oil equivalent (toe) (Government of India et al. 2011).

1.4 OBJECTIVES OF THE DEMAND AGGREGATION PROJECT

Our objectives for this project were: to pilot and develop a model for demonstration of demand aggregation and implementation for the installation of SRT PV systems in both MSME clusters, to define an objective process template and workflow, and to document the project as a case study to disseminate the learning from this exercise.

2. APPROACH AND METHODOLOGY

2.1 KEY ACTIVITIES IN THE DEMAND AGGREGATION IMPLEMENTATION PROCESS

In this section, we sequence the following:

- The demand aggregation implementation process through the workflow for each of the three actors: technical expert/facilitator, anchor partner/aggregator, and local partner/consultant.
- Activities for the technical expert/facilitator who enables and directs the overall process (in this instance, WRII) through
  - engaging with the respective industrial associations to get them on board as anchor partners;
  - organizing capacity-building workshops and stakeholder consultations;
  - collecting and analyzing data;
  - identifying and engaging with vendors;
  - conducting a competitive procurement process and assisting in the finalization of the solar vendor.
- Activities for the aggregator/anchor partner (in this instance, NIA and MASSIA, respectively) who drives and coordinates the implementation process by
  - sending association staff with a local partner representative to liaise with industry members;
  - encouraging industry members to accept and adopt demand aggregation through capacity-building workshops;
  - being actively involved in the finalization of a solar vendor.

FIGURE 1 Two MSME Industrial Clusters in India Selected for Demand Aggregation of SRT PV Projects

- Activities for the local partner/consultant—an entity familiar with the stakeholders in the respective clusters who would help WRII with data collection and coordination efforts on ground (in this instance, GCPC and EEMS, respectively).

The sequence of key activities for the demand aggregation implementation process is illustrated in Figure 2.

The methodology we followed was divided into the following two parts:

- Our pre-implementation process focused on the collection of primary data to develop a baseline and interviews with industries to assess their knowledge of clean energy interventions. Very few solar installations were observed during the baseline study period, and these systems were primarily implemented through individual transactions. We gathered that the general understanding among the MSME units, with regard to solar technology, solar policy, and availability of financial support from different institutions, was limited as well.

- Our post-implementation process focused on gathering information on the challenges faced during implementation and the barriers confronting the industrial associations, industries, and solar vendors.

2.2 PROJECT KICKOFF

We launched the project in Ahmedabad in December 2017 with a workshop at the NIA office. We held a similar kickoff workshop at the MASSIA office in Aurangabad in October 2018 (Figure 3). The launch workshops focused on meeting industries and explaining the project with a view to winning their trust that data confidentiality would be maintained. We committed to assisting in the reduction of greenhouse gas (GHG) emissions in each cluster and facilitating clean energy interventions. We also organized capacity-building workshops on clean energy for the member industry owners to create an awareness about SRT PV systems, energy efficiency, and ways to reduce GHG emissions.

2.2.1 Data Collection and Analysis

We conducted the primary data collection exercise with the support of local partners in both clusters. The local partner at each location was familiar with the industrial association and its member units. We selected the local partners based on their prior experience with industrial clusters, team strength, and inclination for sustainability work (Table 2).

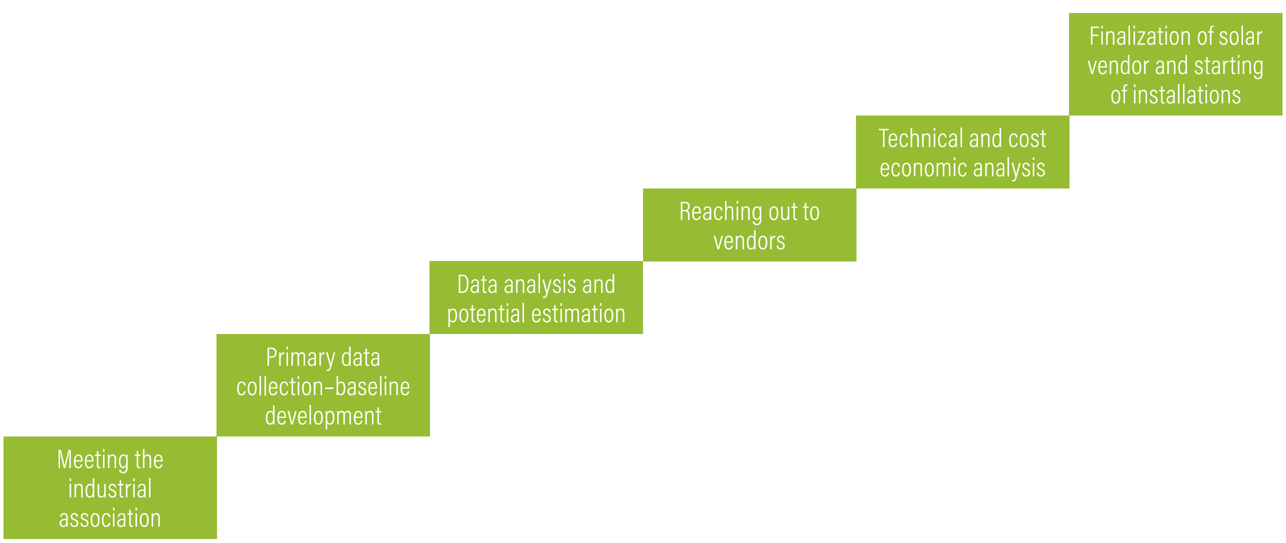
TABLE 2 Local Partners in the Demand Aggregation Implementation Process

Naroda, Ahmedabad	Gujarat Cleaner Production Centre (GCPC), an environmental information system center working on cleaner production and technology since 2003 under the Ministry of Environment, Forest and Climate Change, Government of India.
Aurangabad	Eco Energy Management System (EEMS), incorporated in 2011 with the objective of delivering savings to its clients through training, audits, and implementation of energy efficiency projects.

Source: WRI study.

We worked with the local partners to establish connections with individual industries, create awareness about the program, compile contact details, and collect data. The format (Appendix I) we used for primary data collection was designed to automatically calculate the GHG emissions once the required data was entered. We collected specific data on electricity consumption, fossil fuel consumption,

FIGURE 2 Key Steps for Implementation of Demand Aggregation for SRT PV



Source: WRI study.

connected load, solar rooftop potential, operational hours, and equipment to help us develop a baseline. At this stage, we collected data through interviews and meetings with individual industry owners. Based on an analysis of the data we obtained, we were able to estimate the GHG emission reduction percentage and the SRT PV potential for sample individual industries in each cluster, which we then extrapolated onto the entire cluster.

We observed, during the data collection process, that in the Aurangabad MASSIA cluster, electricity was the major source of energy for industries. Liquefied petroleum gas (LPG) and furnace oil were the secondary sources of fuel used by a few of the industries in the manufacturing process. In the Ahmedabad NIA cluster, natural gas was the major source of energy for industries, followed by light diesel oil, furnace oil, white coke, briquettes, coal, and wood. Electricity was the secondary energy source for this cluster.

In both clusters, most of the industries were connected at the low tension (LT) supply point of the distribution company—i.e., at 415 volts (V). The industries with high tension (HT) supply were mainly the medium-scale industries and a few small-scale industries that were engaged in die casting and used furnaces in the process. A graphic illustrating the distribution of industries in both the industrial clusters is shown below (Figure 4).

Sixty percent of the industries we evaluated in both locations were under 100 kilo-volt-ampere (kVA) contract demand. Heavy engineering industries, which are also medium-scale industries, had more than 100 kVA as contract demand. On an average, the tariff paid by industries in Naroda was Rs.6.8/kWh (including fixed and variable charges) and the corresponding figure in Aurangabad was Rs.7/kWh.

2.2.2 RFP and Vendor Selection

We set up a small working group, comprising two to three industries and senior industrial association committee members, at each of the locations. The objective of this working group was to maintain transparency and confidence in the process of selecting vendors for SRT PV systems.

We developed the technical specifications for SRT PV

FIGURE 3 Workshops and Stakeholder Consultancies in Naroda (left) and Aurangabad (right)

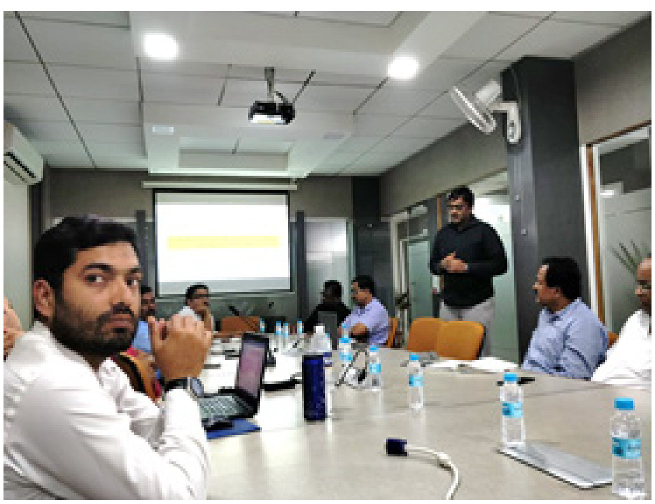


Photo credits: Ashok Thanikonda (left). Kajol (right).

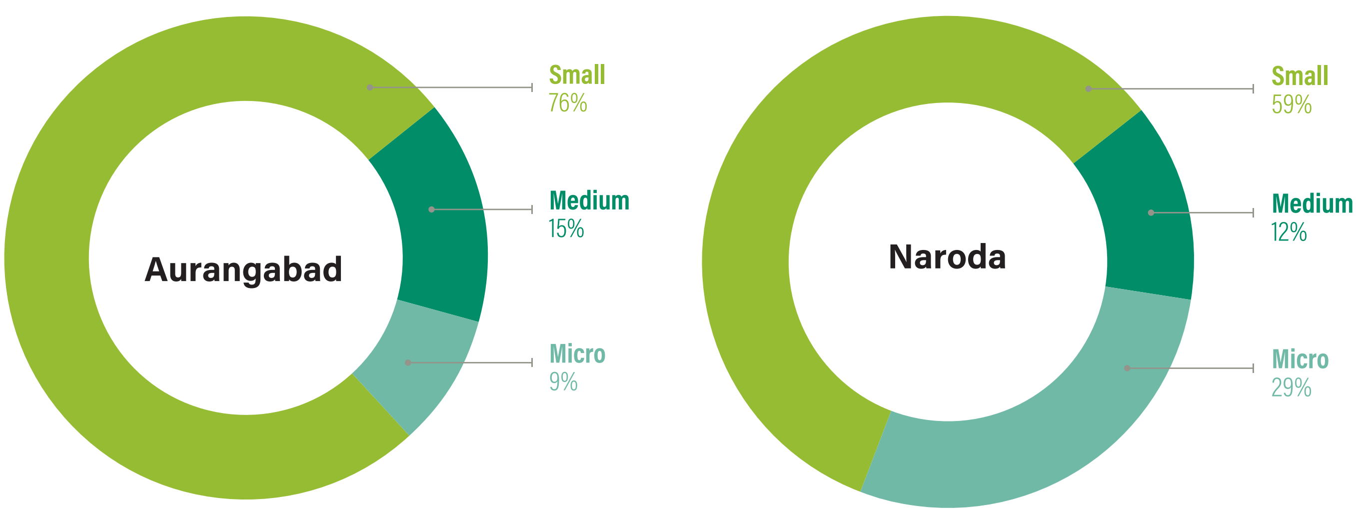
systems, following the MNRE guidelines (Government of India 2013), for inclusion in the request for proposal (RFP) from solar vendors. The vendors were presented with a consolidated demand from 70 units in each cluster, for SRT PV systems of 4 MWp in Aurangabad and 1 MWp in Ahmedabad. The potential for SRT PV systems was relatively less in Naroda as most of the industries have old roofs or the industry process under the roof is corrosive in nature. Technical and financial offers were invited from different solar PV vendors through a limited tendering process. The purpose of the limited tendering was to improve the quality of the bids received, to engage with local suppliers for better support post-installation, and to ensure that contractors with the necessary experience and competence are given an opportunity to submit bids. The primary filtering criteria for the evaluation of vendors were technology offerings; panel and inverter efficiencies; installation and response-time warranties; additional offerings, if any; and, importantly, annual recurring cost in terms of maintenance. The secondary filtering criteria were based on economic offering, rate of return, and financial cash flow analysis for the lifetime of the project (25 years), which we conducted along with the local partner. We calculated ROI (return on investment) and IRR (internal rate of return) based on the assumption that the SRT PV system is connected to the grid with a net metering system. We then assisted in finalizing a solar vendor through three stakeholder consultations over a period of three months.

3. RESULTS AND FINDINGS

3.1 ECONOMIC ANALYSIS

We were able to demonstrate a successful implementation of demand aggregation most directly through a reduced cost for SRT PV systems in both locations. The price finalized through our demand aggregation project was Rs.33,000/kW ($460/kW) for the MASSIA cluster and Rs.39,000 ($543/kWh) for the NIA cluster. This price was inclusive of panel cost, balance of material cost, and installation cost.

FIGURE 4 Categorization of Industries Based on Their Size



Source: WRI study.

We assessed that cost was brought down by 10 percent for the NIA MSME cluster and by 15 percent for the MASSIA MSME cluster, when compared with the CERC benchmark rate for large SRT PV projects (CERC 2017). We worked out the simple payback period to an average of approximately 48 months at the prevailing tariff rates and the depreciation benefits[1] on SRT PV systems to individual industries.

Figure 5 shows the cash flow comparison between a demand aggregation scenario and a scenario where demand aggregation is absent. Cash flow is seen to be positive from the fourth year with demand aggregation; while without demand aggregation, cash flow would have been positive only from the fifth year onward.

3.2 GHG EMISSIONS ANALYSIS

We estimate that the annual electricity generation from these installations implemented through this project could amount to 6.86 GWh, which, in turn, could avoid current scope 2 emissions (GHG emissions from electricity use) to the tune of around 5,483 tCO_2 annually. The GHG emissions are estimated based on the India GHG protocol tool, considering the reduction in electrical grid consumption (WRI et al. 2018). Extrapolating these figures to all MSME manufacturing units in the two clusters, we were able to arrive at a theoretical combined estimate of around 75 MW for both clusters.

3.3 IMPLEMENTATION AND INSTALLATION POTENTIAL

After the vendors were finalized in both locations, we conducted feasibility assessments to estimate the actual capacity of the installations and adapt the generic agreement to the specific requirements of each industry. We were only able to conduct a feasibility study for those industries that expressed clear interest and wanted to move forward with the project. The total potential for installations in both sites for the early adopters was 2.49 MW, across 41 units at both locations. A few early movers were interested the availing of tax benefits for installing rooftop solar panels. We decided to move ahead with the early movers with the expectation that the installation capacity will potentially increase as more industries join the demand aggregation implementation project. Of the total potential, 160 kWp has been installed and 441 kWp is in the process of being installed across both locations (Figure 7). An additional 874 kWp is in the combined pipeline for installation in both locations. Figure 6 depicts the distribution of the projects according to the updated status as of July 2019.

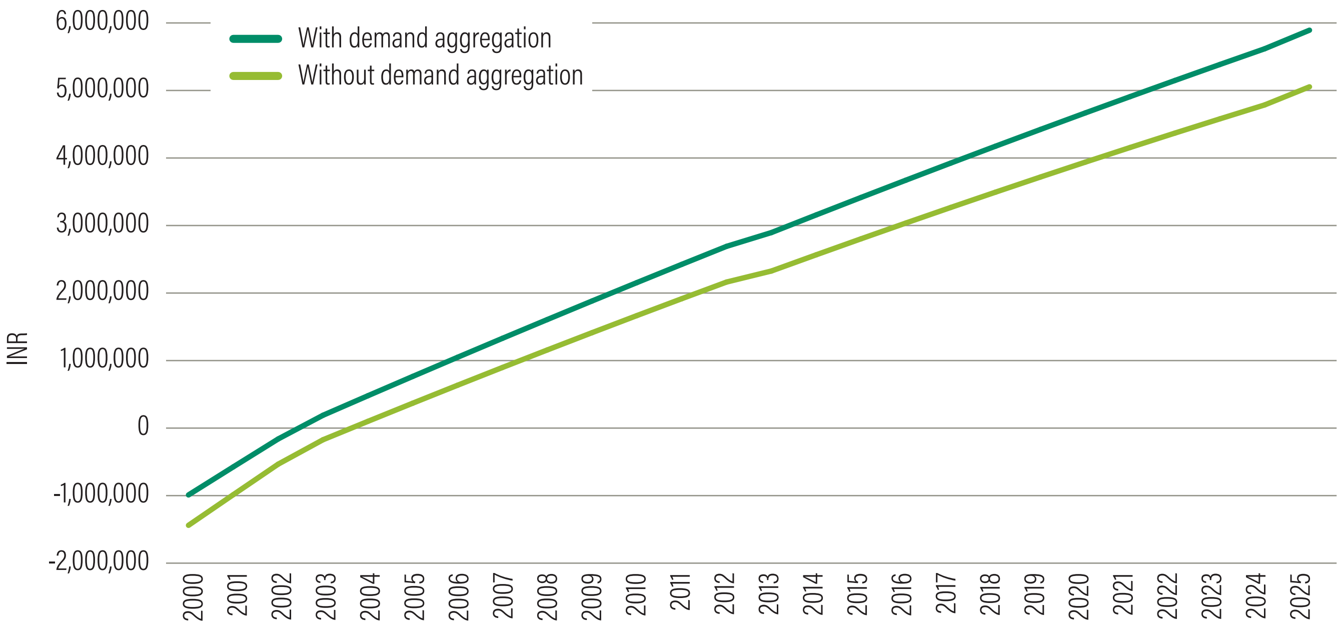
4. REFLECTIONS AND LEARNING

4.1 STAKEHOLDERS' FEEDBACK

We proceeded to conduct surveys and interviews after the finalization of a solar vendor in each cluster and the commencement of the installation of SRT PV systems. The respondents to this survey comprised 19 MSME industries; the interviews were conducted with both the anchor partners (industrial associations), the two selected vendors, and the two local partners.

Our objective was to receive feedback from the project stakeholders and understand the factors that enabled or hindered finalization of the procurement process and the implementation of the installations. For the industrial associations, local partners, and vendors, all the interviews we conducted were on a one-on-one basis. For the

FIGURE 5 Cash Flow Analysis Study of 30 kW System with and without Demand Aggregation



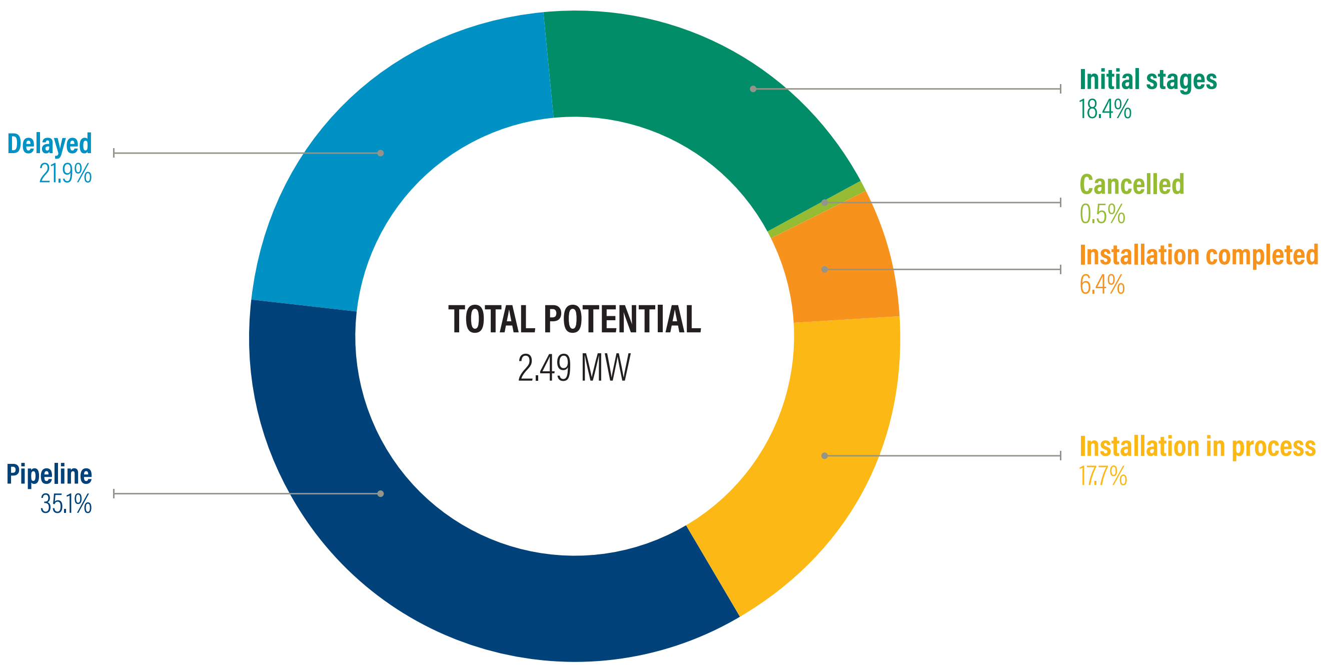
Source: WRI study.

individual industries, we conducted a few one-on-one interviews, distributed a survey questionnaire during group meetings, and circulated an online form to capture the industries' experiences. We interviewed 19 industries, selected randomly, post-implementation. Fourteen of these 19 industries had participated in the demand aggregation project and of these 7 had finalized a deal with the respective vendors (2 in Naroda and 5 in Aurangabad).

4.1.1 Industrial Associations

The feedback we received from the NIA and MASSIA clusters offered several key, common inputs. Both industry representatives and members of the associations agreed that having support from a technical expert/facilitator (WRII, in this project) and from a local consultant was crucial for helping them evaluate the proposals and move the project forward. The representatives of both associations particularly emphasized this point as they had previously attempted to incentivize the adoption of SRT PV systems but failed to move to an implementation process despite holding seminars and/or workshops. They all felt quite strongly that WRII's facilitation during this demand aggregation implementation project was instrumental in accelerating the adoption of demand aggregation and that this involvement added to the credibility of the respective associations and vendors. Another common input we received was that

FIGURE 6 Combined Status of the Projects as of July 2019



Source: WRI study.

FIGURE 7 Site Photo of Industry in Aurangabad with 50 kW Rooftop Solar PV System

Photo credit: Kajol.

the commencement of SRT PV systems' installation at a few of the MSMEs served to establish trust among other industries. The respondents explained that this was useful to demonstrate that there were no conflicts of interest and that the negotiated terms were beneficial for all the association members. Industry representatives from both clusters also felt that scaling the installation of SRT PV systems would require a demonstration, such as that provided by our project, to bring about an understanding that engaging in renewable energy procurement is possible for MSMEs and not reserved for larger companies.

Divergent inputs consisted of location-specific elements for each cluster. For instance, in the cluster at Naroda, some of the industries emit highly corrosive fumes as part of their processes. This had to be taken into consideration to avoid damage to or malfunction of the solar panels.

In the instance of the Aurangabad cluster, the minimum size of the inverter was considered as 25 kW, while in Naroda, the minimum size was 10 kW.

4.1.2 Vendors

The vendor responses highlighted the benefits of having the industrial associations involved in demand aggregation and the implementation process since it allowed both the vendors and the buyers to have a clear point of contact. Vendors also felt that their marketing efforts were reduced as the association plays a vital role in convincing its members and disseminating information. The respondents' feedback on the demand aggregation project was essentially that it helped them to reduce costs and save time and resources as compared to individual customer acquisition efforts. Demand aggregation also continues to offer a perceived advantage to the vendors by increasing the demand for and the sale of SRT PV systems in the long run.

4.1.3 Local Partners (GCPC and EEMS)

Local partners in both clusters felt that gaining access to accurate information on industrial energy consumption, process, and electricity rates was a critical constraint given the hesitation among industries to share their energy data with a relative newcomer (WRII). Our local partners in both clusters observed that their continuous interaction with the various member units, coupled with the support of the anchor partners, helped overcome the barriers in collecting information and data.

4.1.4 Industries/Units

Participant industries in both clusters told us that the involvement of the respective industrial association was a key factor, given the credibility and ability of the association to negotiate with the vendor on behalf of its member units. They felt that all the members were encouraged by the demonstration that the process for vendor selection was transparent and there were no conflicts of interest. Thus, the members were more inclined to join the effort without the need to reassess the financial proposals or renegotiate. Getting a lower price—between 10 percent less for NIA members and 15 percent for MASSIA member industries (as compared to the CERC price that the vendor offered)—as a direct consequence of aggregation, was a key factor for many industries to get on board with the project. They felt that the technical assistance provided by WRII saved them time and boosted their confidence in the identified vendors.

On the flip side, the industry feedback revealed renewable energy procurement is not viewed as a priority by MSMEs. Some industries had the financial capacity to pay the system up front, but they preferred to invest those resources in equipment directly related to their core business. In other cases, they simply did not have the time or ability to assess

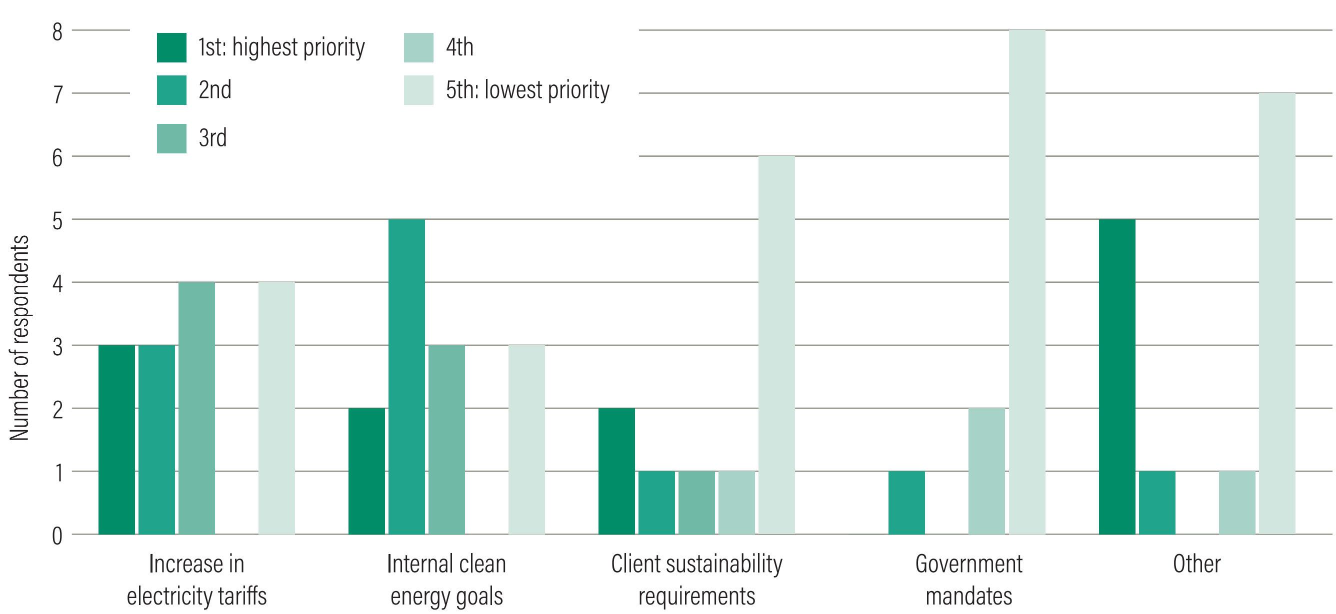
the final detailed proposal they received from a vendor. In Aurangabad, some industries faced financial constraints as they were preparing for expansion. They had cash flow limitations or were unable to take on additional debt. Several interviewees mentioned the lack of support from financial institutions. They expressed the opinion that the absence of attractive schemes specifically tailored to solar installations posed a considerable barrier to accelerating the adoption of renewable energy in the sector. Some initiatives that could help MSMEs are: creation of low-cost debt facilities, innovative financing mechanisms that help in risk mitigation, and construction of a new and useful paradigm when it comes to collateral requirements.

As depicted in Figure 8, cost is a primary factor when considering solar—either a tariff increase or cost reduction, as mentioned by those who ranked "other" as their highest priority. This category/option includes the depreciation tax benefit, peer-to-peer learning effect, and availability of finances for a capex model. In terms of their objectives to join the demand aggregation project, some participants chose multiple objectives. As depicted in Figure 9, most of them decided to join the demand aggregation project because WRII was providing technical support; the second top reason was cost reductions.

4.2 INSIGHTS AND CONCLUSIONS

At both the cluster locations, most of the MSMEs were ready for a capex model. This is typically a model in which the industry/consumer makes the entire investment for the installation of SRT PV systems. The MSMEs we engaged with were actually self-sufficient in terms of investing in SRT PV systems provided: the payback period is less than four to five years; the risk associated with new technology or installation is negligible; and terms and conditions are transparent and clear. Not all MSMEs fall into this bracket. A case in point was the instance of a few MSME units that were interested in solar installation but short on funds and found it difficult to meet bank requirements for collateral. These units tend to expect government subsidies, prefer to learn from peer experience, and, therefore, take longer to

FIGURE 8 Responses from Survey on Individual Motivations to Procure Solar Regardless of Demand Aggregation



Source: WRI study.

finalize the project. Overall, as the resources and finances are inherently limited in the MSME sector and business is highly dependent on market dynamics, it takes more time to convince MSMEs to adopt new technology. However, this is counterbalanced by the fact that these industries are typically run by one or two associates/owners who are the only decision-makers as compared to the more complex and lengthier decision-making process in large industries.

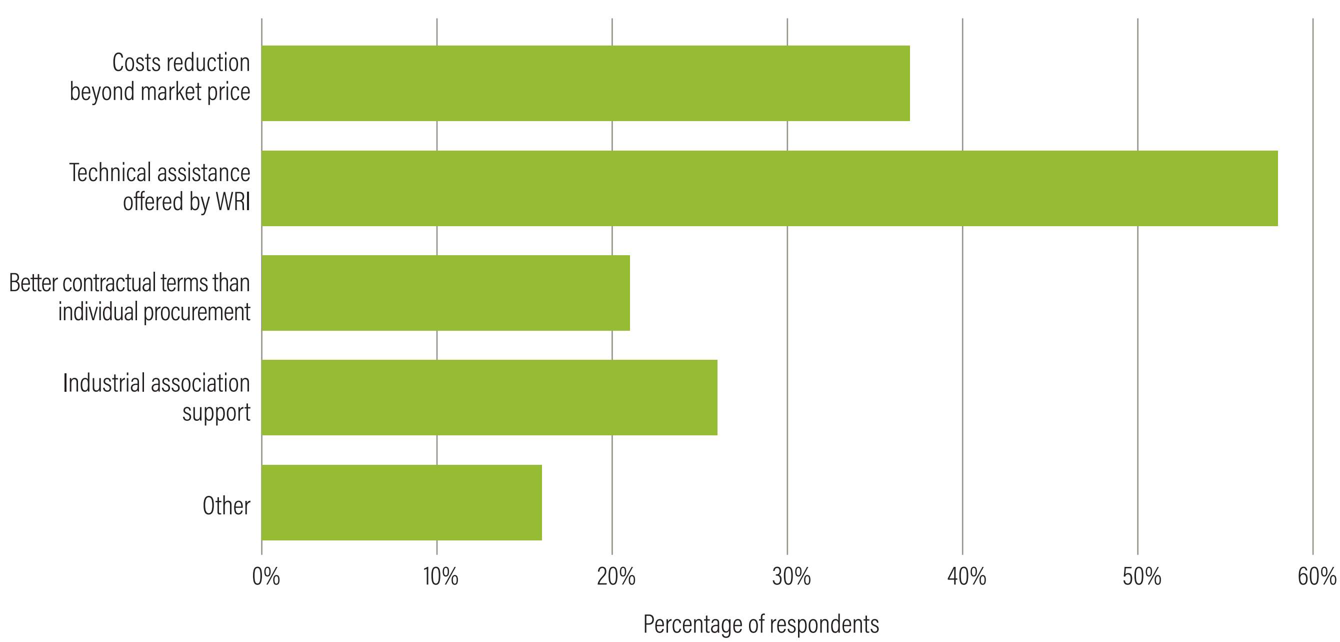
In the Aurangabad cluster, the pace of the project was relatively faster as there were a few MSMEs that were actively interested in the availing of tax benefits through SRT PV installation. The demand aggregation process and workshops significantly improved the capacity of industrial associations on technology know-how related to SRT PV systems, understanding of financial models, and clarity about solar policy.

MSMEs in both the cluster locations face problems in finding and employing skilled labor. Vendors have undertaken to clean the solar panels and monitor the SRT PV systems as part of the proposal, for a limited period and at no additional cost. Based on our experience and observations during this project, we feel it would be worthwhile for both industrial clusters to consider aggregating their entire operation and maintenance requirements for SRT PV installations. Apart from ensuring better plant performance, this approach will also most certainly provide economies of scale in operations and maintenance to the SRT PV system owners.

The following factors are critical to the successful implementation of the demand aggregation for solar PV systems project:

- Providing technical assistance
- Securing the support of and working closely with the industry association
- Transparent vendor selection process
- Presence of a local partner

FIGURE 9 Responses from Survey on Motivations to Join the Demand Aggregation Project



Source: WRI study.

There were a few operational challenges to project implementation. Structural issues in the Ahmedabad NIA cluster presented us with a challenge that we were unable to overcome.

Roof-related constraints were a common challenge present in many industries in the Ahmedabad NIA cluster. Cement and asbestos sheet roofs are not suitable for solar installations. Most of the industries in the NIA cluster have these roofs due to the types of chemicals they use and the corrosive fumes produced as part of the dyeing processes. Other infrastructure-related limitations were roof-space availability, orientation, and shade. Any of these limitations—either singly or in combination with others—affect the potential size and attractiveness of the projects. Hence the lower potential and actual installed capacity in the Ahmedabad NIA cluster.

Although such structural issues were also present in some industries in Aurangabad's MASSIA cluster, financial constraints were the main challenges in this cluster. In addition, subsidies for electricity costs distort market signals. This, in effect, means industries need to install larger systems to take advantage of net metering policies. Regulations around net metering and subsidies also present a challenging conflict for some MSMEs in the MASSIA cluster as engaging in net metering implies forgoing their current electricity subsidy. Considering a longer-term scenario, adopting net metering in Aurangabad's MASSIA cluster is viable only if the installed capacity is equivalent to at least 50 percent of the load of the consumer. Hence, some industries tend to use the system solely for internal consumption and lose potential gains from selling excess generation.

Weighing the principal challenges faced by the NIA and MASSIA clusters, we concluded that addressing the structural problems is the harder challenge. Alternative solutions like replacing the rooftop are cost-intensive and would not be a priority for these MSMEs. Hence, a framework that also prioritizes on-site ground installations compared to a narrow focus on rooftop solar could help such industries overcome structural problems. In conclusion, structural planning that provides for future installation could promote the adoption and implementation of SRT PV systems via subsequent demand aggregation initiatives following the model of this pilot project.

We believe that we have been able to successfully demonstrate a demand aggregation implementation model and have stayed true to our stated goal for this project. Through this practice note, we have also been able to capture and document our processes and learning on aggregating demand for MSME clusters. Efforts focused on the end-user demand side, especially in the case of energy-intensive consumers, can support and multiply the benefits of the supply-side efforts of the Indian government. To conclude, we believe that sustained efforts such as these can contribute to the ambitious drive to scale clean energy adoption and accelerate the transformation to a low-carbon economy.

APPENDIX

Appendix I: Template for Capturing Data for Baseline Determination

Template: General Questionnaire

Name of Organization	
Baseline year	
Total production (please mention units)	
Total revenue (please mention units)	

(Note: indicate all quantities relevant to the base year)

Fuel combustion in plant	Name of fuel	Quantity	Units (KL or MT)
Fuel 1			
Fuel 2			
Fuel 3			
Add more, if any			
Company-owned vehicles	**Name (Indicate type of fuel; e.g., car-diesel)**	**Quantity of fuel used/ distance travelled**	**Units (kg or km)**
Type 1			
Type 2			
Type 3			
Add more, if any			
Other	**Name/remark**	**Quantity**	**Units**
Refrigerant topped up			
Fire extinguisher topped up			
Electricity/utilities			
Electricity purchased from grid			
Renewable energy produced (returned to grid or used in plant)			
REC or other offset emissions			
Any other utility purchased from supplier (e.g., metered diesel generator [DG] set power supply [or] metered LPG supply)			

Template: Scope 1 Emissions

FUEL COMBUSTION								
S. No.	**Fuel Type**	**Description**	**Activity Data**	**Units**	**Emission Factor**	**Units**	**CO_2 eq. Emissions**	**Units**
	Input	Input	Input	Input	Built-in	Built-in	Estimated	Built-in
1								
2								
…..								
n								
	Sub-total							

COMPANY-OWNED VEHICLES								
S. No.	**Type of Vehicle**	**Mode of Data Entry**	**Activity Data**	**Units**	**Emission Factor**	**Units**	**CO_2 eq. Emissions**	**Units**
	Input	Built-in choice	Input	Input	Built-in	Built-in	Estimated	Built-in
1								
2								
…								
n								
	Sub-total							

AIR CONDITIONING							
S. No.	**Identity of Air Conditioner/ Refrigerator Machine**	**Refrigerant used**	**Capacity (Tons)**	**Quantity of Makeup (kg)**	**Global Warming Potential (GWP)**	**CO_2 eq. Emissions**	**Units**
	Input	Built-in choice	Input	Input	Built-in	Estimated	Built-in
1							
2							
…							
10							
	Sub-total						

FIRE EXTINGUISHER					
S. No.	**Identity of Fire Extinguisher**	**Quantity of CO_2 Makeup**	**Units**	**CO_2 eq. Emissions**	**Units**
	Input	Input	Built-in	Estimated	Built-in
1			Tons		
2			Tons		
...					
n			Tons		
	Sub-total			**0.0**	**Tons**

Template: Scope 2 Emissions

ELECTRICITY/UTILITY CONSUMPTION								
S. No.	**Source**	**Grid**	**Quantity**	**Units**	**Emission Factor**	**Units**	**Total Emission**	**Units**
	Built-in Choice	Built-in Choice	Input	Built-in	Built-in	Built-in	Estimate	Built-in
1	Select	Select Grid						
2	Select	Select Grid						
...	Select	Select Grid						
n	Select	Select Grid						
	Sub-total							

Appendix II: Summary of Data Collected from Aggregators

Aurangabad:

TOTAL NUMBER OF INDUSTRIES	70
Micro	6
Small	57
Medium	7
Number of industries with Diesel Generator set	10
Total installed capacity of DG set	608
Annual diesel consumption for DG set	12,795
Plants with number of shifts	
3	19
2	13
1	6

TOTAL NUMBER OF INDUSTRIES	70
Voltage level	
33 kV	0
11 kV	15
0.415 kV	33
Contract demand	
Less than 50 kVA	15
51-100 kVA	18
101-150 kVA	6
151-200 kVA	3
>200 kVA	6
Total annual electricity consumption (kWh)	15,271,703
Annual consumption less than 20,000	10
Annual consumption 20,001-50,000	4
Annual consumption 50,001-100,000	7
Annual consumption 100,001-200,000	8
Annual consumption 200,001-300,000	7
Annual consumption 300,001-500,000	8
Annual consumption more than 500,001	9
Plants with LPG consumption	5
Total LPG consumption (kg per year)	182,428
Plants with furnace oil consumption	1
Annual furnace oil consumption	720,000

Naroda:

TYPE OF UNITS	NATURAL GAS	COAL	DIESEL	ELECTRICAL	SCOPE 1	SCOPE 2
	SPECIFIC CUBIC METER (SCM)	TONNES	LITER	KWH	TOTAL THERMAL ENERGY (TONS CO_2)	TOTAL ELECTRICAL ENERGY (TONS CO_2)
Dye and Dye Intermediates	11,775,985.7	560	8,000	6,187,775	43,606.4	5,074
Chemicals	59,867.75	800	1,840	3,123,571	5,351	2,561.3
TOTAL					**48,957.2**	**7,635.3**

Appendix III: Solar Vendor Comparison and Finalization

PARAMETERS	VENDOR 1	VENDOR 2	VENDOR 3
Solar panel - Make	Vikram/Waree/Renewsys	Canadian	Canadian
Solar panel - Wp	325/330	340	340
Panel Efficiency	17.01	17.14	17.14
Inverter make	Solar EDGE	ABB	Solar EDGE
Inverter efficiency	98.3	97.4	98.3
Panel warranty	10	10	10
Panel performance warranty	25	25	25
Inverter warranty	12	5	12
Warranty and after sales service provider	Havels	EDGE	EDGE
AC cable—ACDB to termination point—50 m	Included	Not included	Not included
Walkways	Yes	Yes	Yes
Safety rail	Yes	Yes	Yes
Free first year maintenance with panel cleaning	Yes	Yes	Yes
Project cost	35.5	30	36
AMC cost	2.25%	2.67%	2.22%

ENDNOTE

1. The depreciation benefit allows commercial and industrial users to take tax benefits on solar installations in India. Currently, the rate is 40 percent for the first year.

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ABOUT THIS SERIES

Drastic emissions cuts and significant efforts on energy transformation across key geographies, including India, will be required to meet the consensus to hold global warming to below 2°C. The Indian government has issued a series of renewable energy support policies and ambitious targets, which have seen traction among state governments. These are "push" efforts aimed at primarily increasing the supply of renewables. However, several barriers (technical, financial, information, regulatory, and policy) continue to restrict and limit both the integration of these technologies in the grid and their adoption by end users.

The World Resources Institute's Green Power Market Development Group Initiative seeks to draw attention to and focus on the complementary "pull" side. It focuses on groups of end consumers looking for clean energy solutions that are aggregated to enjoy the economies of scale and, therefore, come with lower project and transaction costs. We worked with key stakeholders in these "natural aggregators" to procure renewable energy and energy efficiency products and services, and to put them on greenhouse gas (GHG) emission reduction pathways.

This practice note captures our experiences from our pilot efforts with aggregating demand for Micro, Small and Medium-Sized Enterprise (MSME) clusters. By focusing on the end-user demand side and on energy intensive consumers, we expect to multiply the benefits of the supply-side efforts of the Indian government. We believe that sustained efforts with energy intensive end consumers to scale clean energy adoption can accelerate ambitious transformation towards a low-carbon economy.

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ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

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We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

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COUNT IT
We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT
We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

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