ZOFNASS PROGRAM
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Graduate School of Design
Harvard University

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Harvard University
George Gund Hall
48 Quincy Street
Cambridge, MA 02138
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MOQUEGUA PHOTOVOLTAIC PLANT – PERU

Figure 01: General view
Sources: Solarpack

Cristobal Fuentes prepared this case study under the supervision of Cristina Contreras ENV-SP and Judith Rodriguez as part of the Harvard-Zofnass program directed by Dr. Andreas Georgoulias by initiative of IDB for the purposes of research and education. Editing and Proofing: Jiyoo Jye

Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective project design or implementation.

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1. PROJECT DESCRIPTION & LOCATION

The Moquegua photovoltaic plant is a 134,4 hectares solar installation located in southern Peru. At the time this document was redacted its construction process was on the initial stages. The plant is located in the District of Moquegua, which is part of the Mariscal Nieto Province in the Moquegua department. The project is being built at an elevation that goes from 1,035 to 1,066 meters above sea level next to an existing photovoltaic plant, Panamericana Solar 20TS. The plant will produce 16 MW of energy using polycrystalline silicon photovoltaic technology with horizontal axis solar trackers that can operate at a low irradiance minimum value of 80 W/m2. The plant, which is connected to the Peruvian national grid, is located in the isolated desert area of the Moquegua district in southern Peru. The area has up to 10 hours of sunlight per day and minimum solar radiation varies between 6.5 and 7 KWh/m2.

The plant has been designed to provide an energy output of 16 MW to the Peruvian national network. The generated energy will be transmitted using the existing electrical substation Panamericana Solar. The plant will be built and operated by Moquegua FV S.A.C. with an implementation cost of US $42,800,000.

In 2008 the Peruvian government published a legislative decree promoting the investment in the production of electricity with renewables energies. In 2011, the governmental organization in charge of supervising investments in energy and mining (Osinergmin) along side the ministry of Energy and Mining (MEM), authorized a second group of investments in the production of electricity with renewable energy. Moquegua FV was among those projects authorized that year.

The infrastructure is being built on public land by a private investor under a concession. This is a remote area where the closest urban settlement is Chimera located almost 20 kilometers away from the plant. The population of the District of Moquegua is 49,419 inhabitants, and most of them (94.3%) live in urban areas far from the plant location. The population distribution according to sex is 49.7% male and 50.3 % female. 85% of the houses in the district have access to electricity but only 1.97% uses electricity to cook since gas is the predominant option (60,91 %). 33,21% of the homes have only one or none electrical equipment.

In the area where the project is located, the sunlight period extends up to 10 hours per day and the solar radiation varies between 6.5 and 7 Kilowatts hour / m2. According to the national renewal energy laboratory, the annual average of solar radiation in the area of the project is 6,331 Wh/m2/day. The minimum value of irradiance that the plant requires to operate is between 50W/m2 and 80 W/m2 which means that the plant could operate all year long. The

photovoltaic plant does not use any water in the production of electricity, which is very appropriate as the average annual precipitation in the area is 300 mm. The project will generate carbon credits under the Kyoto protocol and will produce energy with a smaller impact in the environment compared to conventional systems.

Moquegua's project has been divided into four separate stages, planning, construction, operation and closing.
The preparation work prior to the construction consist of leveling and compaction of the site, the construction of a storage and a waste accumulation area, modular bedrooms, showers, locker rooms and a dining area, parking spaces and energy generators in a surface of 3.9 hectares. The construction phase involves earthmoving, the building of 16,940 piles foundations for the structures that support the solar panels. The phase also includes creating access road with a width between 5 and 15 meters and a length of 1,458 meters, a subterranean electrical line that will connect the plant with the existing electrical substation, additional installations needed for the construction and a fence closing the perimeter. This phase has been scheduled to begin in April 2014 and the plant is scheduled to begin operations at the end of December of the same year. Once this phase has ended, a procedure to remove all the temporary installations, heavy machinery, pollutants and other unwanted materials are being considered.

The operation phase has been calculated to last 25 years, as that is the lifespan of the solar panels used in the project. Although, the developers predict that this lifespan could be extended to 30 or 35 years. The closing stage involves the dismantling of the plant, as well as the restoration and rehabilitation of the site.

2. APPLICATION OF THE ENVISION RATING SYSTEM

The Envision ™ system is a set of guidelines that aid in optimizing the sustainability of an infrastructure project during the planning and preliminary design phases, as well as a means to quantify the relative sustainability of the project. In this case study, the infrastructure to be assessed is the Moquegua Photovoltaic Plant, Moquegua, Peru.

Envision consists of 60 credits grouped into five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. Each credit pertains to a specific indicator of sustainability such as reducing energy use, preserving natural habitat, or reducing greenhouse gas emissions. Those credits are rated on a five-point scale referred to as a 'level of achievement': 'improved', 'enhanced', 'superior', 'conserving', and 'restorative'. Evaluation criteria are provided to determine if the qualifications for each level of achievement have been

met for a particular credit. In each of the five categories there is a specific credit called "Innovate or exceed credit requirements". This is an opportunity to reward exceptional performance that applies innovative methods within the subjects that Envision evaluates.

The criteria for the levels of achievement vary from credit to credit, but generally an 'Improved' level of achievement is awarded for performance that slightly exceeds regulatory requirements. 'Enhanced' and 'Superior' levels indicate additional gradual improvement, while 'Conserving' often indicates performance that achieves a net-zero or neutral impact. 'Restorative' is the highest level and is typically reserved for projects that produce an overall net positive impact. The Envision system weighs the relative value of each credit and level of achievement by assigning points. Credit criteria are documented in the Envision Guidance Manual, which is available to the public on the ISI[1] and Zofnass Program[2] websites.

3. QUALITY OF LIFE CATEGORY

Envision's first category, Quality of Life, pertains to potential project impacts on surrounding communities and their respective wellbeing. More specifically, it distinguishes infrastructure projects that are in line with community goals, clearly established as parts of existing community networks, as well as consider the long-term community benefits and aspirations. Quality of Life incorporates guidance related to community capacity building and promotes infrastructure users and local members as important stakeholders in the decision making process. The category is further divided into three sub-categories: Purpose, Wellbeing, and Community.

Purpose

There are indications of the good performance expected from the plant. The most important is the fact that the photovoltaic plant will inject energy to the Peruvian national network using a process that does not burn fossil fuels thus, not generating noxious emissions or use of water. This will protect the country's hydric resources and improve the quality of life of the citizens of Moquegua and all of Peru. The plant is located on a very isolated location more than 10 kilometers away from the nearest urban area and approximately 40 kilometers away from the closest city. Therefore, it does not have a community in its close vicinity. The plant will engage with the people living in the surrounding settlements by educating them on the benefits of solar power and by organizing tours to the plant once every six months. These groups will be able to interact with the plant using mailboxes that will be installed both in the plant and in a nearby municipal building.

[1] www.sustainableinfrastructure.org
[2] www.zofnass.org

During the construction process, 130 jobs will be needed and 80% of these jobs will be for workers without qualifications. According to the documents, the project will prioritize local workers for these positions. These workers will receive some training while working on the plant. During operations, the plant will generally require 7 workers to operate. Out of the 7, only 5 will be for qualified personnel and 2 for security guards.

The plant could improve in this subcategory by incorporating more inclusive participatory methods that will take into account the characteristics, language and access to means of communication of the population. These participatory instances should start prior to the construction, that way the inputs received can be incorporated into the overall design.

The plant could also provide more in depth training sessions to the local workers, creating knowledge that can be utilized to improve their life.

Community

In this subcategory, the project has been able to identify potential risks and has designed processes to deal with those risks. A positive measurement that the plant has incorporated is the inclusion of stimulus to contractors and workers who work towards improving the plant safety. However, there is still room for improvement in this area. The risks identified do not focus on the fact that the plant is using solar panels, which is a newer technology that may have undiscovered implications on the health of the workers and the population. The plant will also feature periodic noise monitoring studies, conducted every three months. The plant could improve its noise levels by measuring them constantly. This is very important during construction since measuring once every 3 months may leave some processes unanalyzed. Another positive aspect of this plant is the effort to reduce the amount of light features used. Since this plant generates energy using sunlight, it cannot operate during the night, because of this the plant facility does not have any lighting features on the exterior. Only building will have lights inside. If the plant is to improve more in this area, it could include elements that control how much light escapes from the building areas to the exterior.

Due to the isolated location of the plant, it will not alter the mobility and access of the nearest communities. Although, it might increase traffic on the Panamericana highway during construction. The distant and isolated location is also the reason the plant has not focused on encouraging the use of alternative modes of transportation. The plant will include signage that will cite accessibility and safety. It could be beneficial to include signage that will improve wayfinding around the area.

Wellbeing

By conducting an initial study before the beginning of the construction stage, the plant has identified that there are no archaeological remains in the area. The project has continued to make periodical analysis once a month, keeping an archaeologist on site to make sure there are no archaeological remains in the location. A possible improvement to this effort is to restore damaged historical and

cultural resources that might exist in the area. Since none of the resources have been detected on site, the project has not been able to restore them. The project has also worked to reduce any negative impact the plant may have on the environment. In an attempt to do so, the project will paint some of its elements in colors that will merge with the tones of the surrounding landscape. Other efforts include utilization of materials and building typologies found in the region and to create visual barriers with natural elements.

The project is located at least 10 kilometers away from the nearest human settlement and does not contemplate the creation of public spaces neither on the location of the plant or in another area. To improve, the plant could help develop public spaces in the highway near the plant that can be used to educate the community on the benefits of photovoltaic energy.

4. LEADERSHIP CATEGORY

Leadership evaluates project team initiatives that establish communication and collaboration strategies early on, with the ultimate objective of achieving sustainable performance. Envision rewards stakeholder engagement as well as encompassing a holistic, long-term view of the project's life-cycle. Leadership is distributed into three sub-categories: Collaboration, Management, and Planning.

Collaboration

The project has a system management oriented towards sustainability with high levels of the organization embedded in the structure. Included in provided documentations, there are statements that indicate a commitment from the company to sustainability, these comments are not specific to the project but they are a series of principles that the company intends to implement in all their projects. The project could benefit from more specific and localized overview statements backed by examples of previously performed activities.

Many of the tasks needed to achieve the desired sustainability levels declared in the documents will be performed by third party contractors and not by the company designing and operating the plant. It is here where the company needs to put special attention in communicating and incorporating these other companies into Moquegua view on sustainability, as it is mandatory to have all parties involved working towards the common goal of sustainability. For this purpose the company will have a sustainability manager on site during construction.

There are plans to incorporate the views and opinions of relevant stakeholders to the process during construction. Eight different stakeholders have been identified including 2 governmental agencies, an NGO that works with vulnerable members of the community (selected and financed by the company), Moquegua's municipal government, the local communities, educational institutions, suppliers and constructors and the project workers. The company intends to interact with them by having meetings with all relevant stakeholders once every three months. These instances for interaction are positive

because they provide important ways to receive feedback that can improve the design. Impacts that the plant may have on the environment and on the local communities that inhabit the settlements located closer to Moquegua PV are also evaluated. These meetings have to take into account the characteristics, needs and limitations that the participants might have. Certain measurements will have to be put into place to resolve the possible conflicts that might arise.

Management

There is a very positive coordination between the two plants on infrastructure integration. Moquegua PV plant will share the access road with Panamericana Solar 20 TS an initiative that not only helps the plant reduce its costs, but also reduces the surface area that has to be compacted and treated to allow for vehicular transit. Moquegua also will use some of the neighboring plant's infrastructure to inject its power into the national grid. Both plants could also coordinate its efforts to improve other related community infrastructure or interaction elements; there could be coordinated systems to transport supplies, resources, water and workers

Moquegua FV has identified the elements and materials that will be discarded and has identified some of them as eligible for reuse but no further plans have been made for said elements. The plant could improve by developing a more detailed plan that can identify where and how the materials will be reused, helping to reduce emissions and lowering costs for future projects. The plant is located next to an existing photovoltaic plant, Panamericana Solar, managed by the same conglomerate. To further improve the plants sustainable practices, coordinations could be made between the two plants to use by products and discarded materials from one plant to the other. Panamericana Solar could have lended out materials and services to the Moquegua plant especially at the beginning of construction. One element that Panamericana could have also supplied Moquegua during construction is electricity.

Planning

In terms of planning, the company indicates that with adequate maintenance they can extend the life of the solar panels 5 to 10 years, although the details on how this can be done has not been provided in the documents. There are plans to reuse some of the equipments of the plant on a different location once the project has to vacate the land given in concession by the Peruvian Government. However, the project team has not designed a detailed plan to relocate these elements for there is not a location defined for such purpose nor a place identified for the storage. In this aspect, designing the structure that holds the panels in place and allows them to move in a way that could be easily dismantled, reused or recycled could help improve the plant's score in this subcategory. Dividing up recyclable/reusable materials from non recyclable/reusable materials is a procedure that should be implemented on future projects.

There is no indication that there were any conflicting issues with the Peruvian policies and regulations. In fact, documents provided indicate that the construction of the plant was made possible among other reasons, through the Peruvian law for the promotion of the investment on the generation of electricity using renewable energy. This is a possible indicator that the Peruvian government may develop more

similar projects. It would be useful for the project and for the evaluation, to further analyze the regulatory framework focusing on conflicting issues, providing detailed information on how the process was addressed and ideally resolved. Meetings should be held with local officials, letters should be sent and all documentation should be archived to prove that said efforts were conducted.

5. RESOURCE ALLOCATION CATEGORY

Resource allocation deals with material, energy, and water requirements during the construction and operation phases of infrastructure projects. The quantity and source of these elements, as well as their impact on overall sustainability, is investigated throughout this section of the Envision rating system. Envision guides teams to choose less toxic materials and promotes renewable energy resources. Resource Allocation is divided into three subcategories: Materials, Energy, and Water.

Materials

In this Subcategory, the plant could improve by creating a plan to conserve energy by reducing the net embodied energy of project materials over the lifespan of the plant. The monitoring of necessary energy which produces the required elements to build and operate the plant can help measure and reduce its overall effect on the environment.

The plant is performing well by using manufactured products from at least 2 providers, Yingli Solar and General Cable. Both have been certified by renowned third party institutions as incorporating sustainable practices into their procedures as a positive initiative. However, provided documents do not present the calculated percentage of total materials these sustainable companies provided.

Another area where the plant can improve is in providing adequate measurement of percentage of materials that are recycled and how much of the used materials are from a local origin. Using recycled materials reduces the overall impact of the plant while regional materials can also improve the overall efficiency and accessibility.

Another area where the plant performs well is in the diversion of waste materials from landfills. Moquegua PV has clearly identified the amount of waste it will produce during construction and has developed a plan to deal with its waste where out of the total waste produced, 37% will be recycled. All that percentage is composed of cardboard material.

The plant also shows positive efforts to reduce the excavated materials taken off site. The project was able to prove that out of the 942,317.18 cubic meters of materials that the project

needs to excavate, only 44,931 cubic meters will not be used in other parts of the plant. In this aspect, reducing the amount of excavated materials taken off site, either by selecting a location that needs less earthmovings or by finding more ways to reuse the excavated materials, could improve the plant's overall performance. The design of the plant and it structures is not completely focused on easy dismantling. The project does indicate that with adequate maintenance, they will be able to extend the life of the solar panels used. This will allow for the panels to be reused on a different project and the same can be said for other equipment used in the plant with the exception of the structures. It is advisable to include a detailed plan indicating where and how those elements will be reused.

Energy

The project excelled in this category by reducing the energy consumed up to the point that it is able to produce more energy than it needs, the plant will generate energy using photovoltaic panels a technology that does not require the use of fossil fuels or water to produce energy. During operations the plant will be self sufficient consuming part of the energy it produces and injecting the rest to the Peruvian national network. The plant will generate 16 MW of photovoltaic energy using solar modules produced by Yingli Solar with a maximum power Wp of 290. However during construction the plant will have to rely on fuel burning generators to supply the energy. Those generators will need 49,500 liters of fuel that will be delivered to the plant using trucks, increasing even more the amount of noxious gases generated at this stage. The plant could do better if it planned to reduce its impact by finding new, cleaner ways to power the machinery during construction. One option in this case could be to coordinate with the neighboring photovoltaic plant Panamericana Solar, the distribution of energy generated using renewable sources for the construction process.

The plant should focus on conducting detailed analysis that can indicate if there is still room for improvement in the reduction of energy consumption in the operation and maintenance of the constructed works. In addition, a third party monitoring company is the recommended way to measure these possible improvements. The study should be able to determine the amount of energy (in BTU) that the plant is using during operations and maintenance, which should demonstrate the amount of energy that the plant reduces, expressed in percentages and compared to the industry norms.

Water

The plant has performed well by being able to protect fresh water supply to a certain extent. The plant has estimated the amount of water that will be used and calculations have been made to determine the amount of water that will be need for operation and consumption. Due to the plant's isolated location and poor connection to the water network, it will be required to

transport all the water to the plant via trucks as needed. This allows the project to control and limit the water that will be used which is a positive factor. But, it will also generate a negative impact by having to burn fossil fuels to transport the water to the plant and by augmenting the traffic and surface wear on the highway that connects the photovoltaic plant with the nearest urban centers. Despite the small amount of water used for human consumption during operations, the plant could still implement systems that monitor water consumption inside the plant and provide information on how the water is being used.

The project could seek to improve the plants performance on sustainability by implementing strategies that would apply the reuse of water for other functions. For example, clean water already used for bathrooms could be used in other process of the plant, particularly in keeping the roads wet to reduce the amount of dust in the air during construction which uses a large volume of water. The project could look into other ways to collect water, ways that do not rely on trucks nor have negative effects associated with transportation. The available methods for sourcing water from the location, like fog collectors or rain collectors, could be installed to reuse water.

6. NATURAL WORLD CATEGORY

Natural World focuses on how infrastructure projects may impact natural systems and promotes opportunities for positive synergistic effects. Envision encourages strategies for conservation and distinguishes projects with a focus on enhancing surrounding natural systems. Natural World is further divided into three sub-categories: Siting, Land and Water, and Biodiversity.

Siting

The team was successful in their decision to build the plant on an area located far away from any protected ecological sites. The land where the plant sits has been classified as non-productive, an area with almost no vegetable species present. According to the studies conducted by the project team, 4 wildlife species of high conservation value could inhabit the area. Despite being far from any protected area, the plant does not need to create buffer zones to protect species of flora or fauna since they are absent from the landscape. In order to improve this category, the plant should seek not only avoid development on valuable ecological areas, but also restore already damaged habitat.

Because the photovoltaic plant is located in an arid area located in the Moquegua department of southern Peru- with no masses of surface water or wetlands in its vicinity, it is not possible to evaluate the performance of the project in the protection of the aforementioned natural areas. The same thing can be said about preserving prime farmland because the plant is located in an area not apt for farming, classified as non productive. While these credits may not be applicable in this case, it is very important for any infrastructure project to always focus on preserving these valuable environments. The plant will

also seek to preserve floodplain functions by removing soils compacted during construction and by keeping most of the surface of the plant unpaved.

Moquegua PV is located on area with slight changes in elevation (Desert plain with undulations), meaning that there are no steep slopes in the area. However, modifications to the site via earthmovings will be required although an ideal site would not need any modifications to the surface.
The plant is located on a greenfield or undeveloped area with landscape features. A more sustainable approach would be to install the plant on a greyfield or brownfield area.

Land & water

The project is located on an arid area with 300 mm of precipitation on average per year. The plant performs well in this subcategory by keeping most of the surface unpaved- a feature that will help the soil absorb water. The plant could improve its storm water management by conducting simulation models using TR-55 CNs or other continuous simulation modeling systems that determine the initial, final, post development and target water storage, infiltration, evaporation water harvesting and or cistern storage capacities. An ideal storm management project should seek to exceed 100% water capacity, mitigating the impact of adjacently developed sites.

The project also aims to eliminate the amount of pesticides and fertilizers to 0. The project will not include any vegetable species in the project as no landscaping features are included in the design of the plant. It will not use any pesticides or fertilizers, a very important sustainability feature that minimizes ground and surface water contamination. The plant also prevents water contamination with features that can contain possible leaks and spills that might contaminate the soil and water in the area inside the storage areas. In addition, a spill and leak detection policy has been designed to control possible contamination in other areas of the plant. A more sustainable solution to this problem is to design the elements of the plant in a way that will eliminate spills and leaks completely. Other solutions include cleaning up previously contaminated land restoring wellhead protection, installing land use controls to prevent future contamination, removing storage piles and by rerouting surface runoff or restoring groundwater infiltration patterns.

Biodiversity

The project has addressed the preservation of species diversity in the area by studying the species that could be found in the area and its conservation status. This is a very positive initiative that recognizes the value of the local flora and fauna. 4 of the species found in the area have been classified with some degree of conservation danger according to the Peruvian law. The 4 animal species include the Andean Cat (endangered) the Andean Condor (endangered), the Jergón de la Costa snake (Vulnerable), and the Puma (almost threatened).

There is room for improvement in this aspect by coming up with solutions that would improve the local habitat, preserving biodiversity. Another aspect where Moquegua PV could do better is in the control of invasive species. The plant performs well in this regard by not including any invasive plants into the

project. Improvements to the photovoltaic plant could include a comprehensive project dedicated to eliminate all the invasive species, animal or vegetal, even the ones that existed in the area prior to the construction of the plant.

The project team performed better in the planning for restoration of disturbed soils. The project aims to restore the disturbed soils both after construction and once the operation phase concludes. In both instances, the team will remove soils polluted with fuels and lubricants, which is a positive strategy as it is important to try to restore the soil as close to the original conditions as possible. In this subcategory, one of the credits attempts to evaluate how the team has collaborated on the maintenance of wetland and surface water functions. However, because the plant is located in an arid area with no such features, the credit is inapplicable. If surface water or wetlands were present in the area, the project should seek to preserve them, creating buffer zones that would protect the habitat

7. CLIMATE & RISK CATEGORY

Envision aims to promote infrastructure development that are sensitive to long-term climate disturbances. Climate and Risk focuses on avoiding direct and indirect contributions to greenhouse gas emissions, as well as promotes mitigation and adaptation actions to ensure short and long term resilience to hazards. Climate and Risk is further divided into two sub-categories: Emissions and Resilience.

Emissions

In this category, the project performed very well as it emits carbon credits under the Kyoto Protocol Clean Development Mechanism to reducing 30,983 ton CO2/year. Moquegua PV will contribute to diversify Peru's energy matrix as well as displace electricity generation from thermal power plants which is expected to result in Greenhouse Gas (GHG) emissions. The project includes a list of machinery that will be used during the 10 months of construction and that will generate emissions and has also calculated the amount of fuel that these machinery will use, estimated to 49,000 liters of fuel. During operations, the plant will not use fossil fuels to generate electricity. However, due to the isolated location of the plant and to the fact that the plant is not connected to any basic services, it will transport all personnel and materials (including water) using motorized vehicles.

Because the operation of the solar power plant will help to reduce the thermal power plant operations in the national electricity grid (SEIN), an improvement in the air quality is anticipated since it will indirectly push for reduction in the thermal power plants emission of local pollutants such as NOx, SOx and PM. The air quality impact is considered negligible considering that the largest impact pertains to the construction phase and the project will contribute indirectly to the reduction of air pollutants emissions. More efforts could also be placed on the monitoring of air quality to follow the California Ambient Air Quality Standards (CAAQS). During operations and construction, the plant will have to comply with the norms that the Peruvian legislation has regarding clean air. These norms analyze the same pollutants but ones that are in some aspects less strict than the CAAQS. There is no information

that indicates the amount of pollutants that the plant is producing as only baseline level studies have been provided.

Resilience

For this subcategory, the team performed well in risk assessment and planning by providing information of a comprehensive list with potential risks. Risks analyzed have been separated into 11 different categories. The documents also indicate that procedures to respond to those hazards have also been created. However, there is still a lot of room for improvement in this area. The plant should focus on addressing climate threats in a more detailed way, taking into account how these threats can change during the period that the plant will be operative. The project should also focus on long term adaptability preparing infrastructure systems to be resilient to the consequences of long term climate change and to perform adequately under altered climate conditions or to adapt to other long term change scenarios. The project should try to put emphasis on evaluating the presence of traps, vulnerabilities and risks due to long term changes such as climate change that could create high, long-term cost for the affected communities. The design of the plant should reflect these analyses as well as to focus on the preparations needed for long-term adaptability. It is important to prepare infrastructure systems to be resilient to the consequences of long term climate change and to adapt to variable scenarios and for short-term adaptability to hazards. An adequate plan should include plans oriented to the possible recovery from long-term climate change related events and to restore environments that reduce risk. Managing heat islands is another concern that every project should be concerned with. Solar reflectance index studies should be conducted and 100% of all the heat producing surfaces should be reduced. This last recommendation is particularly important for a plant that is located on an area with high exposure to the sun and that intentionally locates itself in a place where no shades exist.

8. SUMMARY AND CONCLUSION

The evaluation of Moquegua Photovoltaic Plant has demonstrated the benefits of generating energy using photovoltaic energy, a technology that does not burn fossil fuels or use water to produce energy. At the same time, the evaluation has also pointed out which categories of analysis provide great opportunities for improvement.

In the quality of life category, the project has demonstrated the importance of engaging the community and other relevant stakeholders to the process; this involvement needs to be included into all stages of the plant, especially at the beginning where the design is being discussed. The participatory interactions should consider the experience, knowledge, language, education and interest of all stakeholders, and the plant should facilitate the menas that will help overcome any difficulty such conditions may generate. It is in this last part where Moquegua PV should seek to improve more if the plant wants to effectively improve the quality of life of the citizens located in nearby areas.

A sustainable infrastructure should seek to improve the local community adding operational, recreational and cultural capacities, stimulating growth and development, creating new jobs that will go to the local population, improving local productivity, and restoring assets in the natural and built

environment. The local workforce should be able to expand their knowledge through their work at the plant and through newly developed capabilities in order to grow and develop. While Moquegua will provide training for its workers, it is not clear if the training will truly improve local skills and capabilities. Another factor is the small number of workers needed for construction, which is around 300, and even fewer needed during operations where 2 positions will not require high levels of education. A project of such magnitude as Moquegua should also have a positive impact on the quality of life by improving public health and safety not just for the workers but also for the whole community. They achieve this by identifying risks, particularly those connected with the use of new and/or uncommon technologies such as photovoltaic panels.

If the plant wants to achieve a high sustainability ranking, it is important to reduce its impact on the area where it is located. The plant should create as little noise and vibration as possible and seek to reduce light pollution by restoring the night sky. Areas where there is light directly directly upwards should be pointed downwards if not serving a specific purpose. The reduction of negative impact on the area also considers human activities. Sustainable practices should be implemented to improve the way people, workers and non-workers move. Traffic should be reduced, walkability and the use of alternative methods of transportation should be encouraged. Accessibility, wayfinding and safety should all be addressed as well as the preservation, restoration and conservation of local historical sites, cultural resources, views and public spaces. Due to Moquegua plant's isolated location, some aspects of these concepts mentioned have been overlooked. However, the plant can still make efforts to transform communities in a positive way, including interventions outside the area where the project is expanding in the radius of influence.

Regarding the leadership category, it is clear that the plant intends to address the benefits of sustainability incorporating into the processes not just the workers, but members with higher positions within the organization. The leadership and management systems are positive and manage to include collaboration between the participants and to promote teamwork. However, they need to be more detailed and specifics and they should actively try to incorporate relevant stakeholders, not just to inform, but to receive feedback that can improve the overall design. Using the neighboring photovoltaic plant Panamericana solar as an ally in all the process is a very good initiative. Sharing the access roads and some other elements of the infrastructure needed to transmit energy are positive examples of collaboration. Further efforts should be made to enhance these interactions.

There are maintenance policies designed for the plant. There are indication that parts of Moquegua could have a longer life cycle because of well performed maintenance a process that will improve the overall sustainability of the project. It is not clear if there are conflicting regulations and policies in the Peruvian legislation that might unintentionally interfere with the sustainable goals that the plant has proven.

In the resource allocation category, the plant needs to conduct studies to determine the total net embodied energy of the materials. Understanding how much energy has been used over the lifecycle of the products can help the plant determine better ways to build, operate and maintain the facility,

allowing the plant to select different providers. Moquegua has selected providers that have certified that they have put sustainable methods into practice, demonstrating its commitment to sustainability, however the amount of elements that come from these sustainable providers have not been determined. The same can be said for the use of recycled materials and for the use of regional materials. Both sources can help reduce the embodied net energy of the whole project. Local materials help reduce emissions from transport and also provide ways for the local community to develop.
In this photovoltaic plant, there has been an effort to reduce the amount of waste that goes to landfills as the plant will recycle more that 25 % of the waste created during construction, a sustainable project should ideally be able to recycle or reuse 100% of the waste it produces.

Moquegua has been able to reduce the amount of excavated materials taken off site by reusing more than 50% of the earthmovings on a different excavation, filling and leveling process on the site. Some equipment used for the plant can be reused after the plant concludes its operation phase, an important sustainable practice where the plant could extend this positive impact by including the deconstruction efforts on the design of the plant, allowing for an even bigger number of elements to be reused and recycled. The plant could also make further efforts to reduce its energy consumption when compared with the industry norm.

Because the project is a photovoltaic plant, it will generate a significant surplus amount of renewable energy. Measurements should be made to monitor the energy systems of the plant in the long term.
Since the plant is located in a very arid and isolated location, it will have to carry all the water it will use from outside of the plant using means of transportations that burn fossil fuels. This situation, although it has the negative component of increasing emissions, can be utilized to effectively control the amount of water used. One of the measurements the plant should engage in is water recycling, a sustainable practice very useful in such an arid setting.

Regarding the Natural world category, the plant is located far from any ecological protected areas. The land where the plant is has been classified as unproductive. Moquegua PV avoids development on prime habitat areas but could improve by trying to restore the habitat despite it not being present. Since the photovoltaic plant is located on a desert area in land classified as unproductive, there is no farmland nor wetlands or areas with surface water to protect making the credits that analyze those factors applicable. The plant avoids adverse geology as studies have shown and no buffer areas have been created. The plant is located on an area with slight undulations, where no steep slopes can be found. Even though the area does not have steep slopes, the project team will still need to perform earthmovings to level out the surface. In an ideal location no earthmovings will be required.
The plant is located on a greenfield, a natural undeveloped area. In this aspect, the way to achieve high sustainability levels is to develop the site on a brownfield. If that is not possible in brownfields, for future projects, the company should prioritize locations with those characteristics as it will allow to conserve areas of the planet unaltered. Even though the project is located on an area with little rainfall, the project intends to manage stormwater by leaving most of its surface unpaved, allowing infiltration.

Moquegua will not use pesticides or fertilizers thus not incorporating in the environment dangerous

substances that may modify the ecological balance, achieving the ideal situation in terms of sustainability. Another way the plant tries not to affect the environment is by controlling spills and leaks and focusing on the prevention of them occurring. Ideally, the plant could take this idea further by designing source elimination and remediating existing contamination. The project has identified species that may be found in the area, but has not implemented any plans to improve the habitat of these species. Moquegua PV will incorporate any vegetal species into the project, non-local and non invasive species but something beneficial for the environment as the introduction of invasive species can have very negative consequences. A committed sustainable policy includes the elimination of any invasive species present in the area. After construction and also after operation, the plant will perform a restoration of compacted and polluted soils, which is an important initiative.

In the climate and risk category, the project has demonstrated big commitments to sustainability, particularly in reducing greenhouse emissions as the project is carbon negative and a Clean Development Mechanism, as it sequesters more carbon equivalent emissions that it produces. In addition, the project is expected to have negligible impact on the air quality considering that the largest impacts are short term and pertain to the construction phase. The Moquegua PV will contribute indirectly to the reduction of air pollutants emissions. The plant has also shown an important commitment towards air quality and will monitor its emissions every 3 months. The plant will follow Peruvian air quality standards, these standards measure the same gases that the California Ambient Air Quality standards does; the standard accepted for this evaluation, but have different thresholds.

The plant should try to improve how it will behave regarding climate threats and other long term and short-term hazards, focusing on how these events might be modified over time. It should also put more attention into avoiding traps and vulnerabilities that could create high long-term costs and risks for the affected communities.

In the evaluation, an important number of credits were classified as No Score. This can be explained by more than one reason. The first one is that some of the credits were assessed that way because there was not enough information provided that could help the evaluator determine how the plant behaved. The second one is because some of the credits were not applicable to a plant with the characteristics and the location of Moquegua PV.

This report evaluates the sustainability performance of the Moquegua Photovoltaic Plant project according to the Envision™ Rating System. The report identifies areas in which the project scored highly, as well as low-scoring areas that represent opportunities for which the project team can learn and improve on in future projects, as they strive to achieve sustainable project design and construction methodologies.

APPENDIX:
APPENDIX A: PROJECT PICTURES AND DRAWINGS

Figure 02: Overview of the plant
Sources: Solarpack

Figure 03: Overview of the plant
Sources: Solarpack

Figure 04: General picture
Sources: Solarpack

Figure 05: Location map.
Sources: Environmental Impact Assessment , 167.

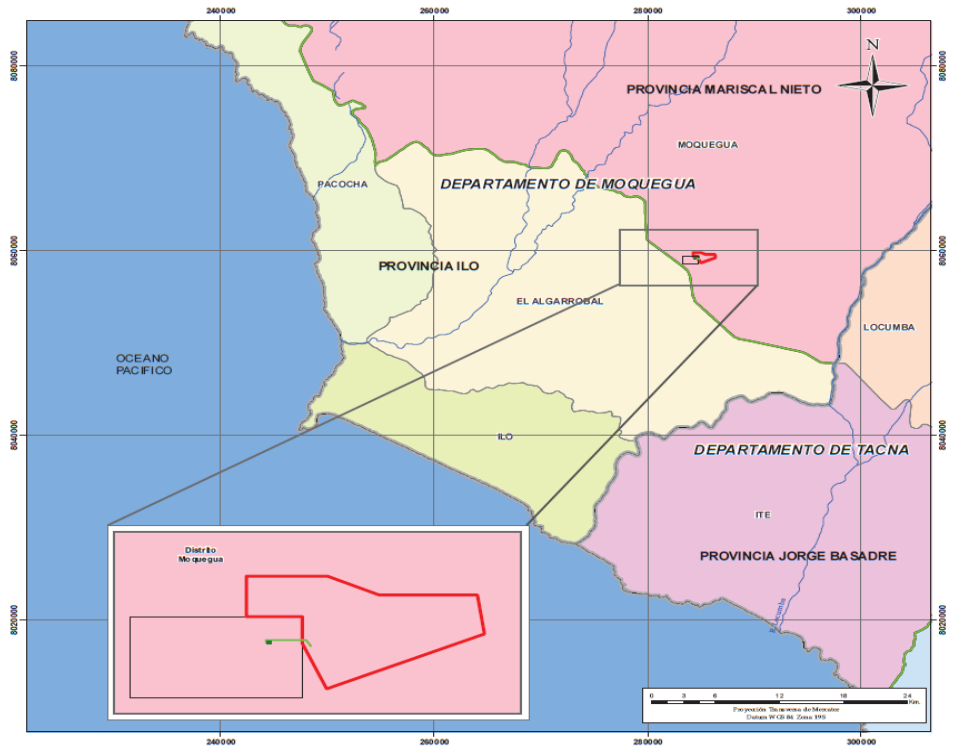


Figure 06: Project location
Sources: Environmental Impact Assessment, p 167

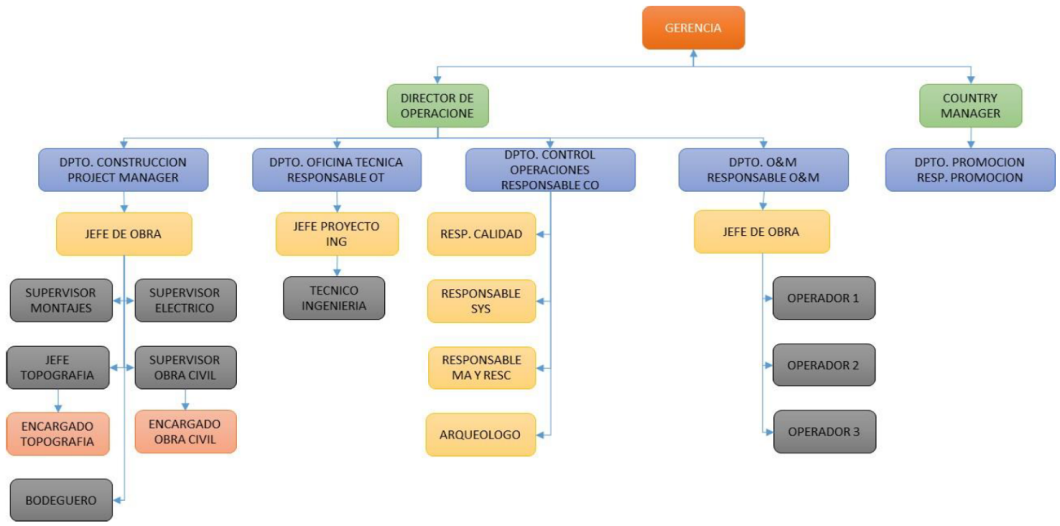


Figure 07: Project organizational structure
Sources: Solar Pack, Environmental and social integral plan, Plan integral de manejo ambiental y social (2014) 13

Figure 08: Air quality monitoring station
Sources: Corporación de laboratorios ambientales del peru S.A.C. , Air quality and ambient noise monitoring, preliminary evaluation of solar photovoltaic plant Moquegua (Peru, 2012), 23

Figure 09: Buses used by contractors to transport workers
Sources: Solarpack

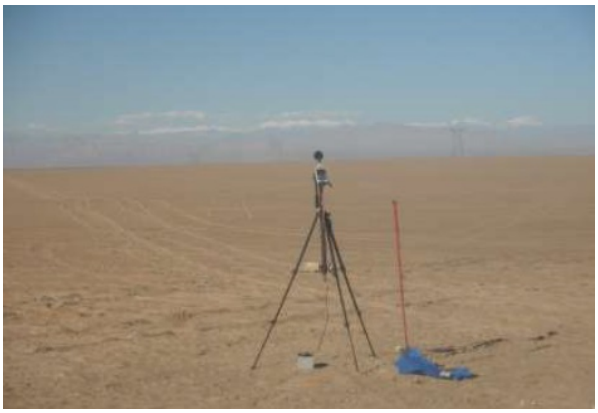


Figure 10: Noise monitoring station
Sources: Corporación de laboratorios ambientales del peru S.A.C. , Air quality and ambient noise monitoring, preliminary evaluation of solar photovoltaic plant Moquegua (Peru, 2012), 25

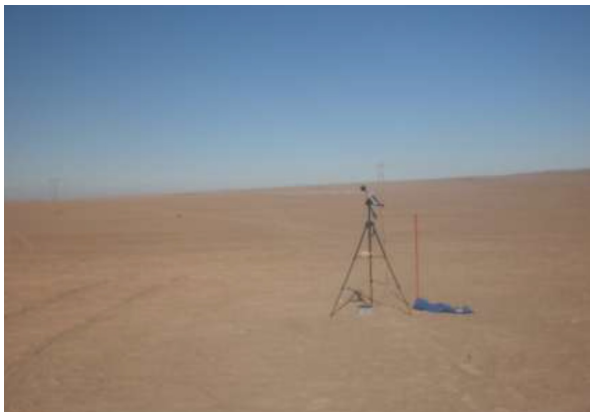


Figure 11: Noise monitoring station
Sources:Corporación de laboratorios ambientales del peru S.A.C. , Air quality and ambient noise monitoring, preliminary evaluation of solar photovoltaic plant Moquegua (Peru, 2012), 25

Figure 12: Safety warnings at the entrance of the construction. site
Sources: Solarpack

Figure 13: Safety warnings inside the plant
Sources: Solarpack

Figure 14: Permeabilized Concrete pool to prevent soil and water contamination
Sources: Solarpack

Figure 15: Waste Separation
Sources: Solarpack

Figure 16: Waste Separation
Sources: Solarpack

APPENDIX B: ENVISION POINTS TABLE

CREDIT SCORING

				IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
1	QUALITY OF LIFE	PURPOSE	QL1.1 Improve community quality of life	2	5	10	**20**	**25**
2			QL1.2 Stimulate sustainable growth and development	1	2	5	13	**16**
3			QL1.3 Develop local skills and capabilities	1	2	5	12	**15**
4		COMMUNITY	QL2.1 Enhance public health and safety	2			**16**	
5			QL2.2 Minimize noise and vibration	1			8	**11**
6			QL2.3 Minimize light pollution	1	2	4	8	**11**
7			QL2.4 Improve community mobility and access	1	4	7	**14**	
8			QL2.5 Encourage alternative modes of transportation	1	3	6	12	**15**
9			QL2.6 Improve site accessibility, safety and wayfinding		3	6	12	**15**
10		WELLBEING	QL3.1 Preserve historic and cultural resources	1		7	**13**	**16**
11			QL3.2 Preserve views and local character	1	3	6	11	**14**
12			QL3.3 Enhance public space	1	3	6	11	**13**
						Maximum points possible:		**181**
13	LEADERSHIP	COLLABORATION	LD1.1 Provide effective leadership and commitment	2	4	9	**17**	
14			LD1.2 Establish a sustainability management system	1	4	7	**14**	
15			LD1.3 Foster collaboration and teamwork	1	4	8	**15**	
16			LD1.4 Provide for stakeholder involvement	1	5	9	**14**	
17		MANAGEMENT	LD2.1 Pursue by-product synergy opportunities	1	3	6	12	**15**
18			LD2.2 Improve infrastructure integration	1	3	7	13	**16**
19		PLANNING	LD3.1 Plan for long-term monitoring and maintenance	1	3		**10**	
20			LD3.2 Address conflicting regulations and policies	1	2	4	**8**	
21			LD3.3 Extend useful life	1	3	6	**12**	
						Maximum points possible:		**121**
22	RESOURCE ALLOCATION	MATERIALS	RA1.1 Reduce net embodied energy	2	6	12	**18**	
23			RA1.2 Support sustainable procurement practices	2	3	6	**9**	
24			RA1.3 Use recycled materials	2	5	11	**14**	
25			RA1.4 Use regional materials	3	6	9	**10**	
26			RA1.5 Divert waste from landfills	3	6	8	**11**	
27			RA1.6 Reduce excavated materials taken off site	2	4	5	**6**	
28			RA1.7 Provide for deconstruction and recycling	1	4	8	**12**	
29		ENERGY	RA2.1 Reduce energy consumption	3	7	12	**18**	
30			RA2.2 Use renewable energy	4	6	13	16	**20**
31			RA2.3 Commission and monitor energy systems		3		**11**	
32		WATER	RA3.1 Protect fresh water availability	2	4	9	17	**21**
33			RA3.2 Reduce potable water consumption	4	9	13	17	**21**
34			RA3.3 Monitor water systems	1	3	6	**11**	
						Maximum points possible:		**182**
35	NATURAL WORLD	SITING	NW1.1 Preserve prime habitat			9	14	**18**
36			NW1.2 Protect wetlands and surface water	1	4	9	14	**18**
37			NW1.3 Preserve prime farmland			6	12	**15**
38			NW1.4 Avoid adverse geology	1	2	3	**5**	
39			NW1.5 Preserve floodplain functions	2	5	8	**14**	
40			NW1.6 Avoid unsuitable development on steep slopes	1		4	**6**	
41			NW1.7 Preserve greenfields	3	6	10	15	**23**
42		LAND & WATER	NW2.1 Manage stormwater		4	9	17	**21**
43			NW2.2 Reduce pesticide and fertilizer impacts	1	2	5	**9**	
44			NW2.3 Prevent surface and groundwater contamination	1	4	9	14	**18**
45		BIODIVERSITY	NW3.1 Preserve species biodiversity	2			13	**16**
46			NW3.2 Control invasive species			5	9	**11**
47			NW3.3 Restore disturbed soils				8	**10**
48			NW3.4 Maintain wetland and surface water functions	3	6	9	15	**19**
						Maximum points possible:		**203**
49	CLIMATE & RISK	EMISSIONS	CR1.1 Reduce greenhouse gas emissions	4	7	13	18	**25**
50			CR1.2 Reduce air pollutant emissions	2	6		12	**15**
51		RESILIENCE	CR2.1 Assess climate threat				**15**	
52			CR2.2 Avoid traps and vulnerabilities	2	6	12	16	**20**
53			CR2.3 Prepare for long-term adaptability				16	**20**
54			CR2.4 Prepare for short-term hazards	3		10	17	**21**
55			CR2.5 Manage heat islands effects	1	2	4	**6**	
						Maximum points possible:		**116**
								803

**The five innovation credits are bonus points and not included in total point tallies*

APPENDIX C: GRAPHS

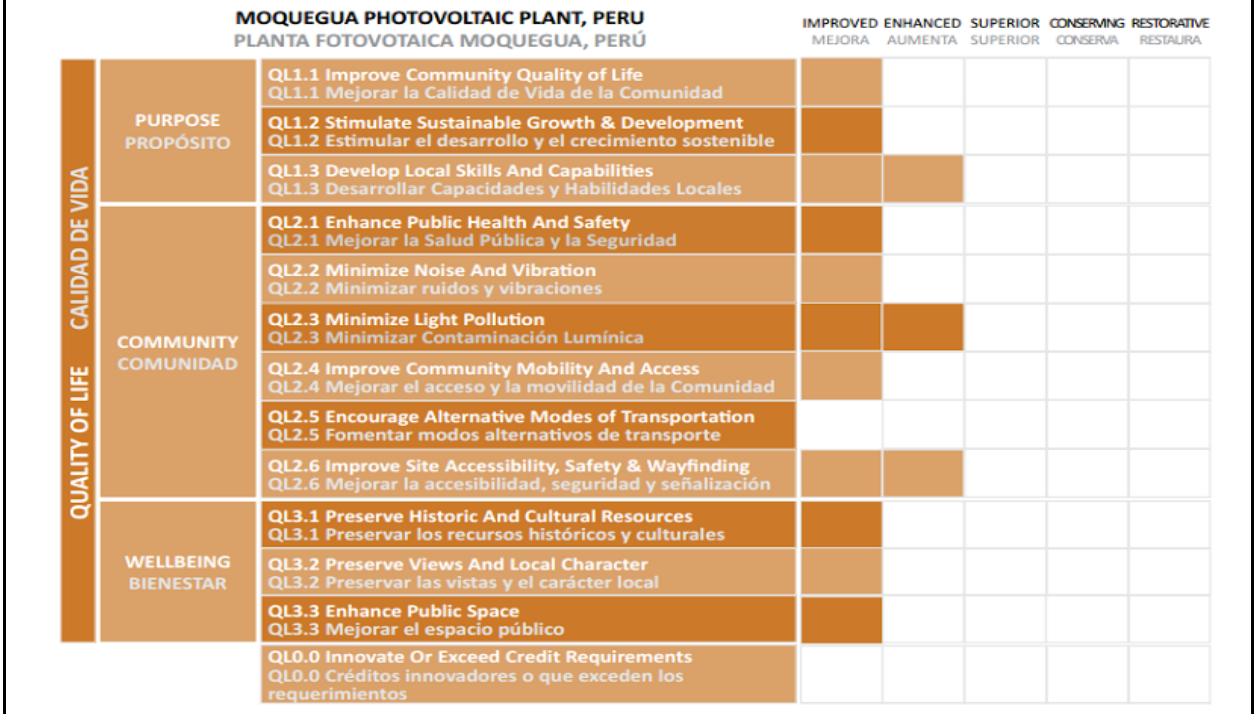


Figure 17: Quality of Life category_ Summary of results

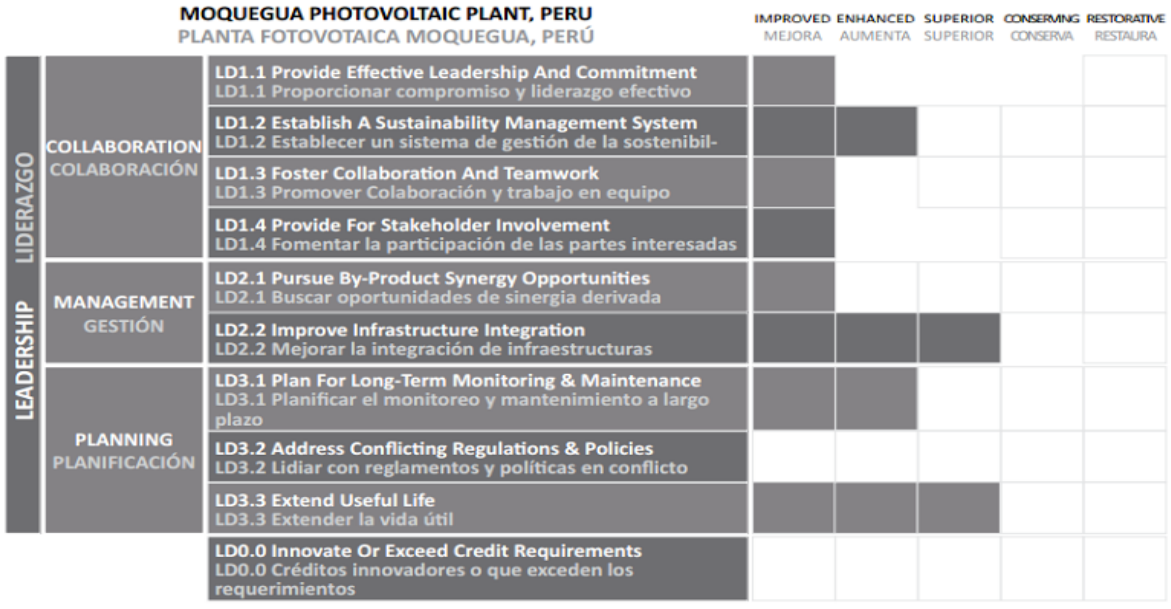


Figure 18: Leadership category_ Summary of results

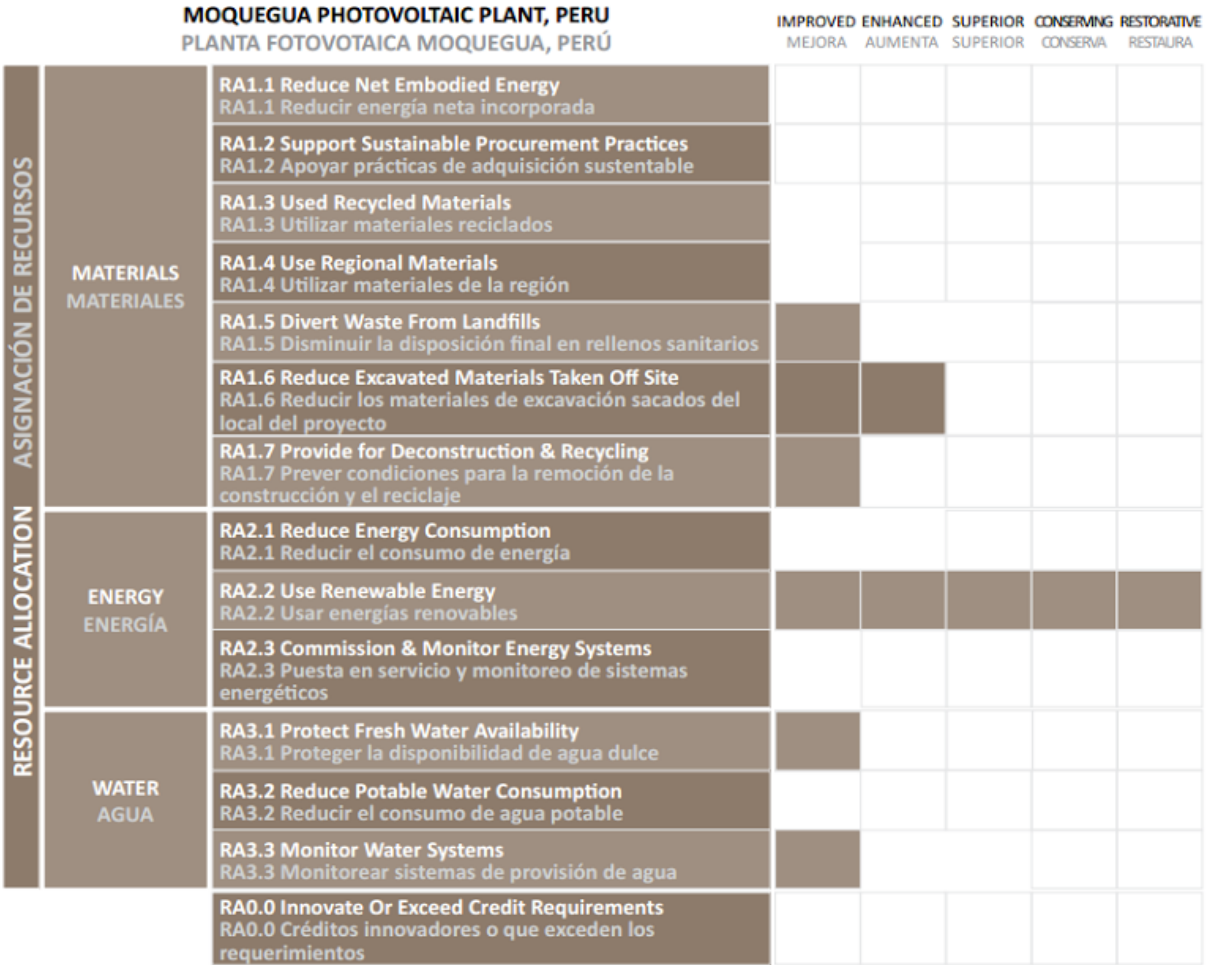


Figure 19: Resource Allocation category_ Summary of results

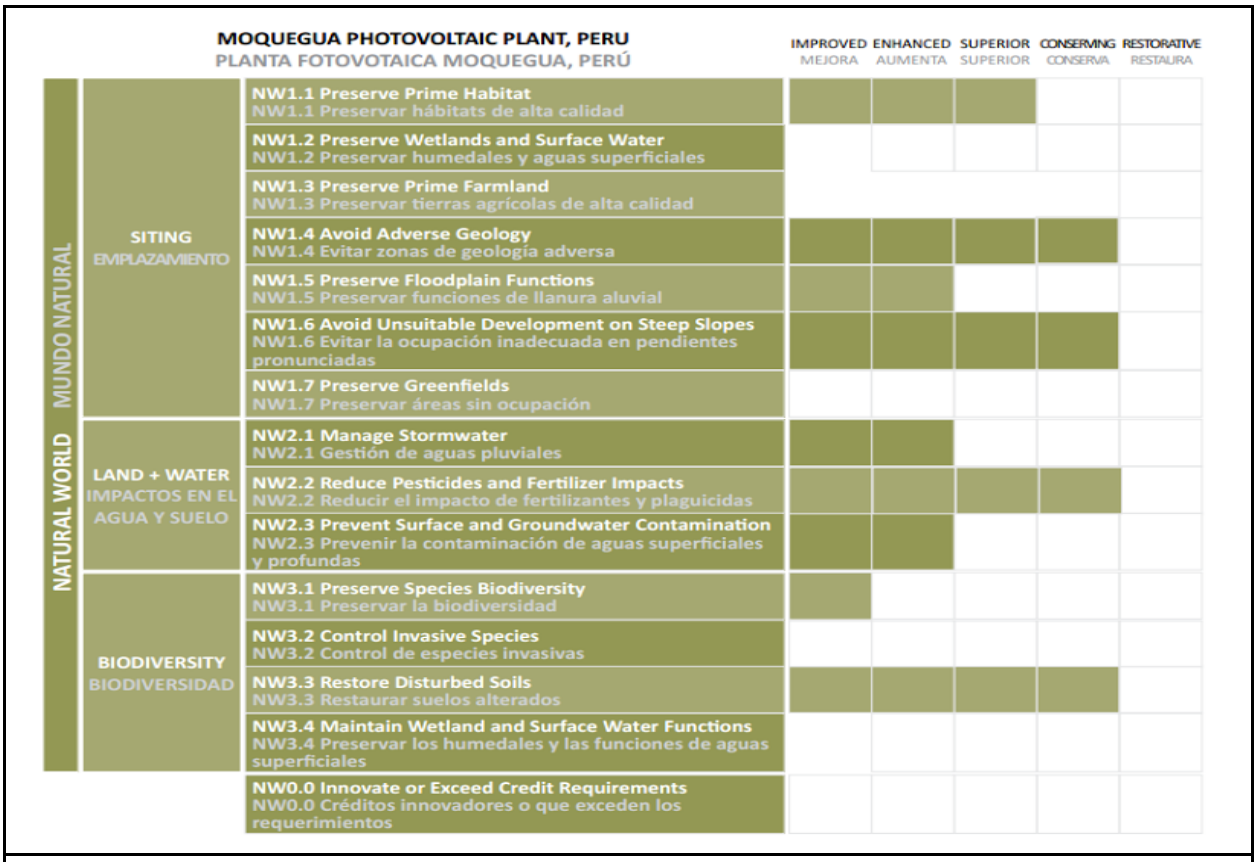


Figure 20: Natural World category_ Summary of results

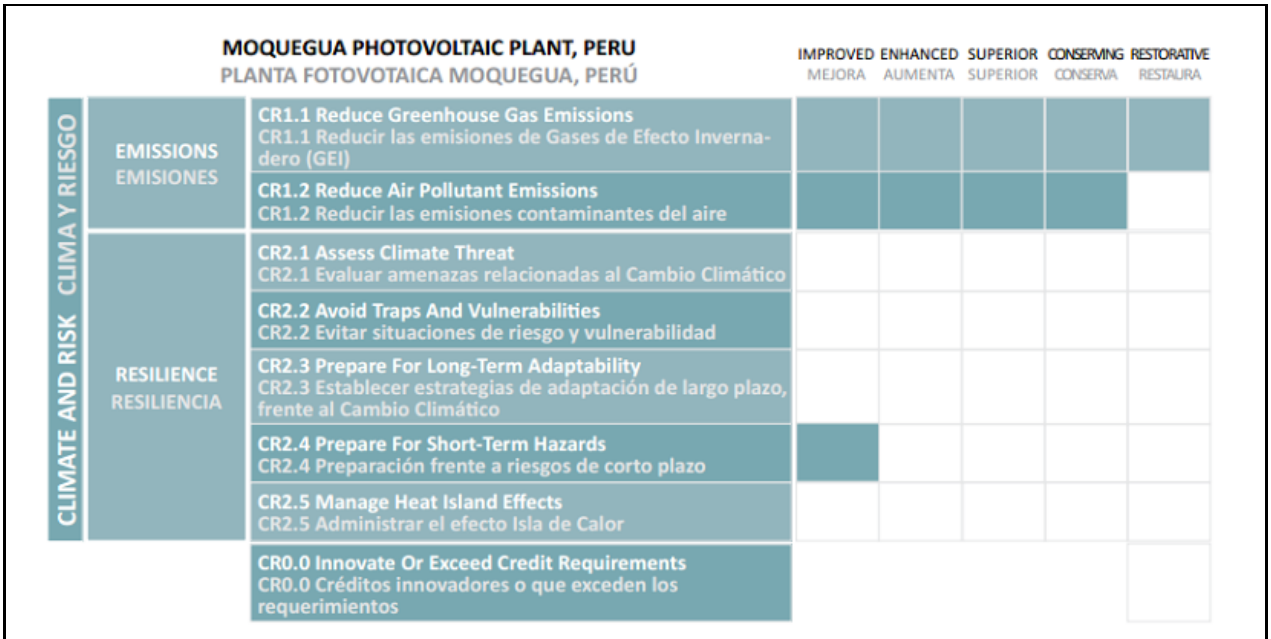
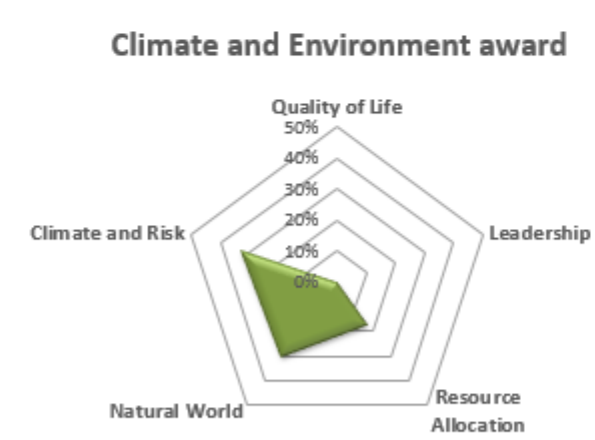


Figure 21: Climate & Risk category_ Summary of results

Figure 22: People & Leadership award Summary of results



igure 23: Climate & Environment award Summary of results

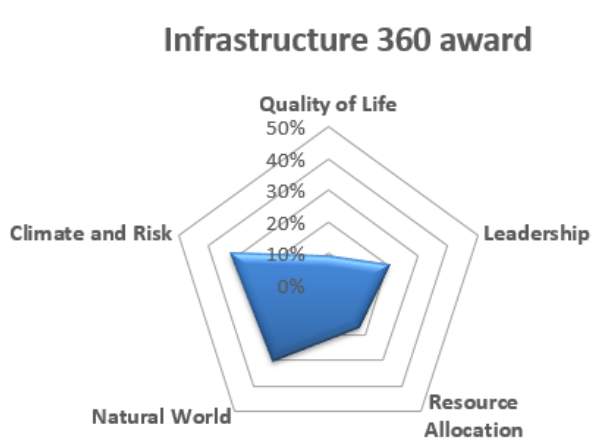


Figure 24: Infrastructure 360 award Summary of results

			MOQUEGUA PHOTOVOLTAIC PLANT, PERU	PT.	Performance
1	QUALITY OF LIFE	PURPOSE	QL1.1 Improve Community Quality of Life	2	Improved
2			QL1.2 Stimulate Sustainable Growth & Development	1	Improved
3			QL1.3 Develop Local Skills And Capabilities	2	Enhanced
4		COMMUNITY	QL2.1 Enhance Public Health And Safety	2	Improved
5			QL2.2 Minimize Noise And Vibration	1	Improved
6			QL2.3 Minimize Light Pollution	2	Enhanced
7			QL2.4 Improve Community Mobility And Access	1	Improved
8			QL2.5 Encourage Alternative Modes of Transportation	0	No score
9			QL2.6 Improve Site Accessibility, Safety & Wayfinding	3	Enhanced
10		WELLBEING	QL3.1 Preserve Historic And Cultural Resources	1	Improved
11			QL3.2 Preserve Views And Local Character	1	Improved
12			QL3.3 Enhance Public Space	1	Improved
			QL0.0 Innovate Or Exceed Credit Requirements		
			QL	17	
			MOQUEGUA PHOTOVOLTAIC PLANT, PERU	**PT.**	**Performance**
13	LEADERSHIP	COLLABORATION	LD1.1 Provide Effective Leadership And Commitment	2	Improved
14			LD1.2 Establish A Sustainability Management System	4	Enhanced
15			LD1.3 Foster Collaboration And Teamwork	1	Improved
16			LD1.4 Provide For Stakeholder Involvement	1	Improved
17		MNGMT.	LD2.1 Pursue By-Product Synergy Opportunities	1	Improved
18			LD2.2 Improve Infrastructure Integration	7	Superior
19		PLANNING	LD3.1 Plan For Long-Term Monitoring & Maintenance	3	Enhanced
20			LD3.2 Address Conflicting Regulations & Policies	0	No Score
21			LD3.3 Extend Useful Life	6	Superior
			LD0.0 Innovate Or Exceed Credit Requirements		N/A
			LD	25	
			MOQUEGUA PHOTOVOLTAIC PLANT, PERU	**PT.**	**Performance**
22	RESOURCE ALLOCATION	MATERIALS	RA1.1 Reduce Net Embodied Energy	0	No Score
23			RA1.2 Support Sustainable Procurement Practices	0	No Score
24			RA1.3 Used Recycled Materials	0	No Score
25			RA1.4 Use Regional Materials	0	No Score
26			RA1.5 Divert Waste From Landfills	3	Improved
27			RA1.6 Reduce Excavated Materials Taken Off Site	4	Enhanced
28			RA1.7 Provide for Deconstruction & Recycling	1	Improved
29		ENERGY	RA2.1 Reduce Energy Consumption	0	No Score
30			RA2.2 Use renewable energy	20	Restorative
31			RA2.3 Commission & Monitor Energy Systems	0	No Score
32		WATER	RA3.1 Protect Fresh Water Availability	2	Improved
33			RA3.2 Reduce Potable Water Consumption	0	No Score
34			RA3.3 Monitor Water Systems	1	Improved
			RA0.0 Innovate Or Exceed Credit Requirements		N/A
			RA	**31**	

			MOQUEGUA PHOTOVOLTAIC PLANT, PERU	PT.	Performance
35	NATURAL WORLD	SITING	NW1.1 Preserve Prime Habitat	9	Superior
36			NW1.2 Preserve Wetlands and Surface Water	0	No Score
37			NW1.3 Preserve Prime Farmland NW1.3 Preserve Prime Farmland	0	No Score
38			NW1.4 Avoid Adverse Geology	5	Conserving
39			NW1.5 Preserve Floodplain Functions	5	Enhanced
40			NW1.6 Avoid Unsuitable Development on Steep Slopes	6	Conserving
41			NW1.7 Preserve Greenfields	0	No Score
42		L & W	NW2.1 Manage Stormwater	4	Enhanced
43			NW2.2 Reduce Pesticides and Fertilizer Impacts	9	Conserving
44			NW2.3 Prevent Surface and Groundwater Contamination	4	Enhanced
45		BIODIVERSITY	NW3.1 Preserve Species Biodiversity	2	Improved
46			NW3.2 Control Invasive Species	0	No Score
47			NW3.3 Restore Disturbed Soils	8	Conserving
48			NW3.4 Maintain Wetland and Surface Water Functions	0	No Score
			NW0.0 Innovate or Exceed Credit Requirements		N/A
			NW	52	
			MOQUEGUA PHOTOVOLTAIC PLANT, PERU	**PT.**	**Performance**
49	CLIMATE	EMISSION	CR1.1 Reduce Greenhouse Gas Emissions	25	Restorative
50			CR1.2 Reduce Air Pollutant Emissions	12	Conserving
51		RESILENCE	CR2.1 Assess Climate Threat	0	No Score
52			CR2.2 Avoid Traps And Vulnerabilities	0	No Score
53			CR2.3 Prepare For Long-Term Adaptability	0	No Score
54			CR2.4 Prepare For Short-Term Hazards	3	Improved
55			CR2.5 Manage Heat Island Effects	0	No Score
			CR0.0 Innovate Or Exceed Credit Requirements		N/A
			CR	40	
			Total points	**165**	**0**

APPENDIX D: CREDIT DETAIL

NAME OF THE PROJECT: CREDIT SPREADSHEET WITH DETAILS		
CATEGORY I, PEOPLE AND LEADERSHIP		
SUB CATEGORY: QUALITY OF LIFE		
	Score	**Moquegua Photovoltaic Plant**
QL1.1 Improve Community Quality of Life	**2**	**Improved**
		The project will improve quality of life for all the citizens of Peru by producing energy without burning fossil fuels and reducing the country's fossil fuel footprint without using water, conserving the hydric resources. This energy will be supplied to the national network, benefiting the whole country. The project was initially shown to the community prior to the construction via publication of documents on a governmental website. A more effective instance of communication with the local population would have allowed them to state their opinions and provide an understanding of the community needs, if any, to modify the design accordingly. The isolated location of the project means that there are no settlements in the immediate vicinity of the project. The project team hypothesizes that because there is a long distance separating the plant from the closest urban center it will not affect said communities in any way. Moquegua Fv declares that a mailbox to receive complaints during the construction and operation be installed in one of the nearby towns municipality. Organized visits to the plant will be organized once every six months.
		Source: Environmental Resources Management, Evaluación Preliminar de la Planta Solar Fotovoltaica FV – 16 MW (2012), 57. (hereafter cited as EP)
		RECOMMENDATIONS *Further efforts could be made to make sure that the local community was aware of the project and its impacts before construction. Only showing the documents to the community prior to the construction via a government agency website is not enough, particularly when only 0.07% of all the homes in the district of Moquegua have access to the internet. The local community could be more involved in the project, their input used to improve the design of the plant and efforts could have been made to invigorate and elevate the community awareness and pride.*
QL1.2 Stimulate Sustainable Growth & Development	**1**	**Improved**
		The construction of the project will result in new job openings. The documents provided indicate that 130 jobs will be created during construction of the plant and that preference will be given to workers from local communities if their qualifications are up to the company's standards, 80% of the new jobs will be for workers without qualifications. Only 7 workers will be needed for the operation of the plant (5 qualified personnel and 2 night guards). The project team may consider collaborating with other NGO developing projects to help the local communities, although money allocated for this particular purpose is limited to US 30,000 (0.007% of the project expected budget).
		Source:EP, 33-34, 83-85 *Solar Pack, Programa de Relaciones Comunitarias (Peru, 2014), 22-23 (hereafter cited as RC)*

		RECOMMENDATIONS *Provide documents detailing what has the NGO done, and what is it planning to do to help local communities.* *Provide documents that detail what are the companies requirements for the jobs created.* *Considering the workers will be hired by contractors and not by Moqugua FV active measurements should be made to ensure this companies will select the local population for the new jobs.*
QL1.3 Develop Local Skills and Capabilities	**2**	**Enhanced** The project plans to hire local personnel and local companies for the construction process 300 positions will be created. It is not clear whether there was a specific outreach pertaining to certain skills. Some training will be given to the workers but this will not be in specialty areas. *Source: EP, 34* *SolarPack, Programa de Medidas de Prevencion y MItigacion Ambiental, Peru, (2014) , 35 (hereafter cited as MA)* *RECOMMENDATIONS* *Provide documents that prove how many local workers were finally hired during the construction phase The documents provided indicate that workers will receive training in different areas, it would be advisable to describe in more detail the content of said training to determine how in depth it really is. Provide documents that demonstrate that the local workers have received the instructions described in the environmental prevention and mitigation measurements document.* *Deeper collaboration with local firms is advisable as they can help the design integrate better with it's location.*
QL2.1 Enhance Public Health And Safety	**2**	**Enhabced** Credit detail Documents describe that the plant does not use exterior lighting. Since the plant needs solar energy to operate during the night it will close its doors limiting the light only to indoor spaces. There is no mention of if and how the plant be illuminated during the construction phase. *Source:Solar Pack, Plan de Seguridad y Salud Ocupacional, (Peru, 2014) 1 - 190 (hereafter cited as SH) EP, 71 - 77.* *RECOMMENDATIONS* *More efficient equipment could be used on the interior lightning,* *Solutions such as motion sensors would decrease energy consumption in the project* *Efforts could be made to reduce the amount of lightning that escapes from the interior to the exterior.*
QL2.2 Minimize Noise And Vibration	**1**	**Improved** The plant is located on an isolated area. Coordination has been made with the adjacent photovoltaic plant, Panamericana Solar 20 TS, to share the same access road from the nearest highway. The isolated location of the plant leads visitors and workers to travel long distances from the nearby urban areas. It is safe to assume that because of the construction of the plant, traffic will increase in the highway that connects the plant with the nearby urban centers. The plant will use 6 buses to transport workers during construction. Because of the plant's distant location, almost 20 kilometers away from the closest urban area, it is unlikely that it will promote mobility and access. The long distance to other urban centers, and the lack of basic services in the area makes it difficult to inhabit the area near the plant. *Source: EP,37 - 38* *MA, 23.* *Corporación de laboratorios ambientales del peru S.A.C. , Informe de monitoreo de calidad de aire y ruido ambiental evaluación preliminar planta solar fotovoltaica Moquegua (Peru, 2012), 2 -7, 10 -11, 17-18, 20,24,26-36 (hereafter cited as AN)* *RECOMMENDATIONS* *Provide documents that can help evaluate the impact of the plant in more detail, documents that indicate how many workers will sleep at the plant, how many will arrive by bus, how many using pickup trucks,how many using other means of transportation.* *Further coordination can be made with the adjacent photovoltaic plant, Panamericana 20TS. Sharing*

		transport solutions with the adjacent plan can reduce the amount of traffic that the plant generates during operations.
QL2.3 Minimize Light Pollution	**2**	**Enhanced**
		Documents describe that the plant does not use exterior lighting. Since the plant needs solar energy to operate during the night it will close its doors limiting the light only to indoor spaces. There is no mention of if and how the plant be illuminated during the construction phase.
		Source: Ingeteam, Estudio Lumínico del CTIN (2014) , 1-25
		RECOMMENDATIONS *More efficient equipment could be used on the interior lightning,* *Solutions such as motion sensors would decrease energy consumption in the project* *Efforts could be made to reduce the amount of lightning that escapes from the interior to the exterior.*
QL2.4 Improve Community Mobility And Access	**1**	**Improved**
		The plant is located on an isolated area. Coordination has been made with the adjacent photovoltaic plant, Panamericana Solar 20 TS, to share the same access road from the nearest highway. The isolated location of the plant leads visitors and workers to travel long distances from the nearby urban areas. It is safe to assume that because of the construction of the plant, traffic will increase in the highway that connects the plant with the nearby urban centers. The plant will use 6 buses to transport workers during construction. Because of the plant's distant location, almost 20 kilometers away from the closest urban area, it is unlikely that it will promote mobility and access. The long distance to other urban centers, and the lack of basic services in the area makes it difficult to inhabit the area near the plant.
		Source: EP 18
		RECOMMENDATIONS *Provide documents that can help evaluate the impact of the plant in more detail, documents that indicate how many workers will sleep at the plant, how many will arrive by bus, how many using pickup trucks,how many using other means of transportation.* *Further coordination can be made with the adjacent photovoltaic plant, Panamericana 20TS. Sharing transport solutions with the adjacent plan can reduce the amount of traffic that the plant generates during operations.*
QL2.5 Encourage Alternative Modes of Transportation	**0**	**No Score**
		Provide information that describe how workers are going to arrive to the plant, during operations, construction and closing. Considering that due to the isolated location of the plant, most. if not all, the transportation will be made using motorized vehicles ways to reduce the number of vehicles and the distance they are covering must be found. Among the alternatives one is to limit the amount of parking space available at the plant, for that it is recommended to provide documents that indicate how many parking spaces is the plant contemplating.
		Source: EP, 20
		RECOMMENDATIONS Provide documents that can help evaluate the impact of the plant in more detail, documents that indicate how many workers will sleep at the plant, how many will arrive by bus, how many using pickup trucks,how many using other means of transportation. *Further coordination can be made with the adjacent photovoltaic plant, Panamericana 20TS. Sharing transport solutions with the adjacent plan can reduce the amount of traffic that the plant generates during operations.*
QL2.6 Improve Site Accessibility, Safety & Wayfinding	**3**	**Enhanced**
		The project's safety and health plan indicates that the plant will have clear signage indicating probable risks during construction and operation. The topics of accessibility and wayfinding are not addressed in the signage proposal. The signs will be in spanish with simple icons and four different colours according to the information they are trying to communicate. The signage will be located within the boundaries of the project.
		Source: *SH, 53 - 63* *EP, 51*

		RECOMMENDATIONS Considering that 11.61% of the population of the district speak Aymara as a first language and that 5.02% speak Quechua, the signage of the plant could include the two other languages. Signage in the 3 languages could be installed with educational information to inform the benefits of renewable energy. They could be located inside the plant to educate the public and outside, near the main highway to educate travelers. *The project could make an effort to include signage outside of its area that could also improve the safety of those not directly involved in the plant, as an example signage could be installed in the nearby highway promoting safety and educating the population. This interventions should integrate with the plant's surroundings and should include the input of the population from the nearby towns.*
QL3.1 Preserve Historic and Cultural Resources	**1**	**Improved** In terms of preserving historic and cultural resources, the project has conducted a study to determine the presence of archeological remains in the area. The documents presented indicate that the study has been conducted and is pending approbation by the Peruvian ministry of culture. Documents provided indicate that an archeologist will be at the plant during construction in the case any remains are found. The team has also provided documents indicating that Archaeological inspections have been carried during the construction process, generating a monthly report. Reports provided indicate that no evidence of archaeological material has been found during the process. *Source:* *MA, 30* *Moquegua FV, Evaluación Preliminar de la Planta Solar Fotovoltaica FV – 16 MW: Levantamiento de Observaciones (2012).* *RECOMMENDATIONS* *Include the approved document that certifies that there are not any archaeological remains in the area.* *Interaction with the community can provide valuable information on what are the items that they think are valuable and need special protection.*
QL3.2 Preserve Views and Local Character	**1**	**Improved** The project addresses its impact on the area views in two different ways. The first way is reducing its intervention by only performing earthmovings within the boundaries of the plant and not intervening any space outside. The second way is by mitigating its impact by painting its buildings in colors that can merge with the landscape. Because the plant is situated on a remote location separated at least 10 kilometers from the closest inhabited area, the project considers that the community will not be affected *Source: EP, 37, 62, 66* *RECOMMENDATIONS* *Even though the closest individuals are located several kilometers away it is still important to engage them in community participation. This will help the project to better understand their local character and opinions on the issue. Information that might help the project merge in an even less invasive way with the landscape.* *In order to merge better with the environment and the surroundings of the plant the constructed elements should use some of the local materials, building typologies and construction techniques.* *Include landscape architects on the design team as their knowledge can help reduce the impact the plant has on the views.* *Utilize the earthmovings needed to construct the plant to reduce the view of the plant by simulating topographic elements that will act as visual barriers hiding the plant as much as posible.*
QL3.3 Enhance Public Space	**1**	**Improved** The project is situated far away from any public space, thus not affecting directly any of them The project does not contemplate the creation of a public space in the plant nor does it consider creating one in any of the other towns located in the area. *Source: EP, 31, 77* *RECOMMENDATIONS* *The project could include an intervention that can be used by the public; visitors and travelers could use a space in the vicinity of the plant. A project of said characteristics could not also be useful for humans but also for the local wildlife. Wildlife refuges in the vicinity of the plant, can help local animal feed and reproduce improving the overall quality of the area and by extent improving livability.* *These interventions could be done in conjunction with the adjacent photovoltaic plan that is operated*

		by the same conglomerate, Panamericana Solar, to reduce the impact of both facilities.
QL0.0 Innovate Or Exceed Credit Requirements		
	17	
SUB CATEGORY:LEADERSHIP		
	Score	**Moquegua Photovoltaic Plant**
LD1.1 Provide Effective Leadership And Commitment	**2**	**Improved**
		The company states in their environmental policy that they are fully committed to sustainability, however, the way in which they plan to address the issue is not completely clear. The company's environmental policy is general and not specific enough and fails to describe in detail the procedures that the company will take to ensure the achievement of sustainability. Many stages of the construction will be performed by a third party in agreement to supervise contractors who will follow the company's standards for sustainability. Although, it is very difficult to guarantee the compliance of these enforced sustainability practices by the third party contractors.
		Source: *Solar Pack,Plan integral de manejo ambiental y social (2014) 6-7 (Hereafter cited as SA). 3-22*
		RECOMMENDATIONS *Provide documents that show in detail what practices are going to be put into place to achieve sustainability. For example, is not enough to say that environmental education will be given to the workers through participatory methods, it is necessary to indicate what is going to be taught and what participatory methods are going to be implemented.* *In many cases the described sustainable policies do not do anything else other that obey the law or do a little bit more than that. To truly achieve a high level of sustainability it is necessary to have a proactive role in the process.*
LD1.2 Establish A Sustainability Management System	**4**	**Enhanced**
		The project has a system management oriented towards sustainability. However, the tasks described are sparse and generic. This is particularly true in the high levels of management. According to the documents provided, high level employees do not have an active role in the process, their actions are mostly limited to the provision of resources necessary for the implementation of the company's environmental policy.
		Source: *SA, 13-18.*
		RECOMMENDATIONS *A project of this complexity needs to identify more specific and proactive task focused on sustainability. This tasks must be incorporated into high levels of the operation management,*
LD1.3 Foster Collaboration And Teamwork	**1**	**Improved**
		"There is a discourse focused on sustainability, but the design of the plant itself its not particularly focused on it. Most of the sustainable results are the product of the system characteristics and not of the conscious efforts to improve sustainability. The design process, the operation, and the construction of the plant will be performed by the same company. Third party contractors will also be used. The organizational structure seems to be mostly designed with the construction phase in mind. Even though the plant emits its energy to the national network, there is no indication that extensive coordination has been made to improve sustainability with the other elements and actors of this network. The project relies on its isolated location and its identification as a photovoltaic plant as a means to achieve and justify sustainability and is less concerned about the design elements."
		Source: SA, 13-22

		RECOMMENDATIONS *Redesigning the collaborative internal structure of the company with a broader view, Early instances of communication between the design team and the rest of the company will most certainly improve the results of the project. Including the concepts of sustainability not just in the policies, but also on the design of the plant and structures will definitely improve the desired results*
LD1.4 Provide For Stakeholder Involvement	**1**	**Improved**
		Efforts have been made to identify relevant stakeholders. The project identifies 8 different groups as the main stakeholders including 2 governmental agencies, an NGO that works with vulnerable members of the community, Moquegua's municipal government, the local communities, educational institutions, suppliers and constructors and the project workers. Ways to interact with the defined stakeholders have been defined.
		Source: S *olar Pack, Programa de relaciones comunitarias (2014), 10 -13, 18 -38* *EP, 55 -56*
		RECOMMENDATIONS *A better system should be implemented to gather the complaints of the community. In order to do this, the community characteristics should be kept in mind. Their level of education, their distribution in the territory, their language, the access to certain means of communication and their income should all be taken into account when proposing a communication system. A message box inside the plant facility, and email address and a phone number are not adequate means of communication for projects located in isolated areas, where the community have limited access to the communication systems- In Moquehua 33% of the population of the district do not have access to a communication system at home and only 0.07% of the households have internet access.* *Communication strategies should be put in place prior to the construction initial date. An effective communication channel with the relevant stakeholders works both ways, it allows to deliver information but it also allows to receive feedback from the stakeholders. This feedback can be used to improve the overall design of the project, generating benefits for all the parties involved.* *Considering the short period of construction the frequency of the meetings could be increased. Having a meeting once every three months with most of the stakeholders does not guarantee that their concerns and needs will be addressed in time.* *Communication with the relevant stakeholders should start during the design process or sometimes even before that, that way the opinions of the stakeholders can be taken into account at the early stages and can modify the project accordingly.* *Provide documents that explain with details how the project is planning to improve the economical development of the local communities in the long run.*
LD2.1 Pursue By-Product Synergy Opportunities	**1**	**Improved**
		The project has identified the materials and elements that will be discarded after construction and operation. The documents indicate that there is a plan to retire and relocate some elements that could be recycled once the plant has completed its life cycle. These elements are electrical parts and solar panels needed for the operation of the plant. Although it has not been mentioned explicitly in the documents, some of the installations where offices and equipment will be kept are modular buildings that can be easily transported and if needed could be relocated and reused on another project The location where these elements could be reinstalled has not been determined at this point.
		Source: EP, 89

		RECOMMENDATIONS *Provide documents that indicate if the modular buildings used during constructions will be used on another project* *It is understandable that due to the long life cycle of the plant it is complicated to anticipate where the elements that are going to be retired but still usefull could be reinstalled. But in a period closer to the finishing stages of the plant the plan should be revised with a focus on determining the definitive place where this objects will resume its function.* *Considering that adjacent to the plant is another photovoltaic plant, Panamericana Solar 20 TS, with similar characteristics further some coordination could have been had between the two to improve by product synergy.*
LD2.2 Improve Infrastructure Integration	**7**	**Superior**
		The plant is located in an isolated location next to an existing photovoltaic plant named Panamericana Solar 20TS. There is some coordination between the plants as Moquegua FV will use some of the existing infrastructure to inject the energy into the national grid.The two plants, Moquegua PV and Panamericana Solar 20TS, will also share the access road that connects them with the nearest existing highway.
		Source: EP, 4, 22, 31, 89, anex 2A, anex 2H
		RECOMMENDATIONS *Stronger coordination could be had with the adjacent plant, particularly during operation. Efforts could be made to integrate some procedures and services needed by both plants, such as transportation of resources such as water and workers.*
LD3.1 Plan For Long-Term Monitoring & Maintenance	**3**	**Enhanced**
		The project team has designed a maintenance plan for the plant focusing on the elements that need to be periodically inspected and maintained. The solar panels that the plant will use require minimum levels of maintenance, the biggest concern is to keep them free of water and dust. This can be prevented with regular clean ups using a solution composed mostly of water. Another important part of the maintenance process is the lubrication of the components that allow the panels to move following the position of the sun. The project team has also detailed the consequences the maintenance process may have on the environment.
		Source: EP 29 - 32, 62 -67 *SA 18 -37.*
		RECOMMENDATIONS *Provide documents that detail how much of the plants budget will be dedicated to maintenance processes.* *Provide documents that demonstrate that maintenance is being conducted during operations.*
LD3.2 Address Conflicting Regulations & Policies	**0**	**No Score**
		There is no indication in the provided documents regarding any laws, standards, regulation or policies that may unintentionally create barriers to the implementation of sustainable infrastructure. There are no indications that the designers, owners or builders have had to work with officials to address said regulations. The construction of the plant was possible among other reasons because of a Peruvian law which promotes investment on the generation of electricity that uses renewable energy.
		Source: EP, 3
		RECOMMENDATIONS *Provide documents that indicate if there are policies, requirements or laws that unintentionally create barriers to the implementation of sustainable infrastructure. If such policies are present, it is advisable to find ways to resolve the issue. Save all the documents that prove that the team has made substantial effort to resolve the issue, Documents such as letters, memorandums, proof of meetings and submit them to the evaluating team.*
LD3.3 Extend Useful Life	**6**	**Superior**
		The company indicates that maintenance procedures have been devised to elongate the intended life

		cycle of the plant as indicated by the manufacturer of the solar panels and other equipment. According to the manufacturer of the equipments, the useful life (period of guaranteed yield) is 25 years. The project team estimates that the useful life of the project could be extended to more than 35 years with adequate maintenance. Documents provided also indicate that panels and other equipment can be reused after the plant closes.
		Source: EP, 30-31, 70.
		RECOMMENDATIONS *The plant could be designed from the beginning having the idea that some of its components might last longer that the initial concession. Strategies either to extend the concession period or to move the components to a new location should be created and detailed in much more depth , said documents should be provided to the evaluation team.* *The project could include a plan in case a future expansion or transformation of the plant is to be needed*
LD0.0 Innovate Or Exceed Credit Requirements		*N/A*
	25	
CATEGORY II: CLIMATE AND ENVIRONMENT		
RESOURCE ALLOCATION		
	Score	**Moquegua Photovoltaic Plant**
RA1.1 Reduce Net Embodied Energy	**0**	**No Score**
		Documentation of a plan to conserve energy by reducing the net embodied energy of project materials over the lifespan of the plant has not yet been found. An embodied energy study should focus on identifying the total sum of energy required to produce an element throughout its lifecycle. This includes the energy used for material extraction, transportation, refinement, manufacture and the undertaken processes leading to when the material is ready to be transported to the construction site. The study should focus on the element needs for construction and also on the necessary maintenance.
		Source:
		RECOMMENDATIONS *Provide documents that indicate if the team has come up with a plan to conserve energy by reducing the net embodied energy of project materials over the lifespan of the plant. Detail the percentage of reductions compared to the industry norms.*
RA1.2 Support Sustainable Procurement Practices	**0**	**No Score**
		Provided documents indicate that the project team has chosen to work with providers like Yingli solar and General Cable who foster strong sustainable practices. However, with the limited information provided, it is impossible to determine the exact percentage of materials (total weight volume or cost), purchased from these sustainable providers. Therefore, the credit has been assessed with no score.
		Source:
		RECOMMENDATIONS *Provide documentation that indicate clearly what percentage of the total materials purchased, either by weight, volume or cost,comes from sustainable providers.*
RA1.3 Used Recycled Materials	**0**	**No Score**
		The project is located on what was previously an empty plot of land on an isolated area, absent from existing infrastructure or materials that can be incorporated into the project. There is no documentation indicating how much recycled material will be used in the project therefore, it is impossible to assess the credit as the evaluation is conducted in percentage terms.
		Source:

		RECOMMENDATIONS *Provide documentation that indicate clearly what percentage of the materials used in the construction come from recycled or reclaimed materials*
RA1.4 Use Regional Materials	**0**	**No Score**
		Documentation was not found to indicates how many regional materials and how much of them will be used in the project.
		Source:
		RECOMMENDATIONS Provide documentation indicating the percentage of the total materials that have been sourced locally. Sourcing locally it is important because it minimizes the transportation costs and retains regional benefits through specifying local sources.
RA1.5 Divert Waste From Landfills	**3**	**Imporved**
		Documents indicate that wastes will be separated during construction. Containers to separate organic materials, paper, glass and plastic will be located in 4 different areas inside the plant. Organic materials, paper and glass will be disposed at a location authorized by Moqueguas municipality, but there is no indication that materials will be recycled in these explicit locations. During construction, the project will generate 205.4 tons of waste per year plus 3,770 meters of cable, out of which a total of 63.3 tons of cardboard will be recycled. This represents 37% of the total amount of waste. Remnants of cables, construction materials, debris and excavated materials will be sent to authorized accumulation areas. Other wastes such as lubricants, oils and greases, all considered to be dangerous waste, will be handled by a different company. Paper, Glass and organic residues will be separated from dangerous wastes during operation however, these items will be discarded at an authorized place where there is no indication as to whether they will be recycled. Lubricants will be handled by a different company.
		Source:
		RECOMMENDATIONS *Provide documents indicating the percentage of waste that will be reused and or recycled both during construction and operation.* *It is recommended to monitor the work of the companies that are managing and transporting the separated waste making sure it is being kept separated and delivered at places where it will be recycled.*
RA1.6 Reduce Excavated Materials Taken Off Site	**4**	**Enhanced**
		Documents provided indicate that the project will attempt to remove as little material as possible from the site to level out the area. The project will require the earthmoving of 92,376 square meters of material. Out of that total, 47,445 m3 will be used for other parts of the plant and 43,056 m3 of the remaining excess materials will be used for construction. The leveling and compaction of the access road (4.389 m3) will be used in the ditches required by the plant which leaves an excess of 44,931 m3 of material.
		Source: EP.17 ,19-24
		RECOMMENDATIONS *The excess material excavated from the site could be used to create interventions that could benefit the plant and the community, such as the creation of visual barriers that will help mitigate the impact the plant has on the views of the area.*
RA1.7 Provide for Deconstruction & Recycling	**1**	**Improved**
		The project team states that once the the plant is closed, the elements that compose the plant will be removed from the site and transported to a different location to be recycled or reutilized. The names, characteristics and numbers of equipments that can be reused/recycled have not been provided yet. Since there isn't a detailed inventory, the percentage of components or prefabricated units that can easily be separated for reuse cannot be determined. Documents provided also indicate that with adequate maintenance, the life span of the panels could expand 5-10 years beyond the 25 years proposed by the manufacturer. The project has already determined that those panels will be removed and stored in a designated area. The project will use 17 prefabricated sheds, measuring 13 x 2.50 x 3.00 meters, to be used as offices and storage areas to protect some of the equipment. There is no mention as to whether or not there

		is a plan to further utilize these installations once the plant closes.
		Source: EP, 22,30 - 31, 70, 88 -90.
		RECOMMENDATIONS *Incorporate in the design features that will allow for an easy disassemblement of the plant.* *Create a detailed inventory with the elements that could be reused and recycled indicating which percentage of the total materials they represent either by weight or volume. This inventory should consider the effect that time and use will have on the materials before determining the feasibility of recycling or utilizing them.* *The design of the plant should make an effort not to adhere non recyclable materials to recyclable ones.* *Provide documentation showing that the recommendations listed above have been put into practice.*
RA2.1 Reduce Energy Consumption	**0**	**No Score**
		No documents were provided to confirm whether the planning stages or design reviews have been conducted to identify and analyze options for reducing energy consumption, in the operation and maintenance of the constructed works. There is no indication that the project team conducted a feasible cost analysis to determine effective methods for energy reduction. The documentation does not provide a baseline for which they can compare the percentage of the reduced energy consumption.
		Source:
		RECOMMENDATIONS *Perform calculations for the projects estimated annual energy consumption over the life of the project, taking into account the industry benchmark. If energy reduction is achieved, provide documents that indicate the percentages of the energy reduction that the plant has accomplished throughout the whole plant cycle, with more emphasis on operations and maintenance, when compared with the industry norms. Convert all energy sources to BTU for calculations*
RA2.2 Use Renewable Energy	**20**	**Restorative**
		The project is a photovoltaic plant that will generate 16 MV of energy using panels that move on a single axis to follow the sun using a 60 Hz electric motor. The Plant uses modules manufactured by Yingli solar with a maximum power Wp of 290 and 72 cells. The energy produced will be injected to the national network using the infrastructure of the adjacent photovoltaic plant, Panamericana Solar. During construction however, the plant will use fossil fuel powered generators that will burn 49,500 liters of fuel.
		Source: EP,31, 65.
		RECOMMENDATIONS *It is advisable to utilize renewable energy in all the phases of the plant, this includes construction.* *Considering Panamericana Solar, another solar plant, is adjacent to Moquegua FV, its energy could have been used during the construction to power all the necessary equipment*
RA 2.3 Commission & Monitor Energy Systems	**0**	**No Score**
		It is not possible to determine if monitoring of the energy systems has been commissioned to a third party with the current documentations provided.
		Source:
		RECOMMENDATIONS *Provide documents that indicate if there has been a third party monitoring of the electrical and mechanical systems. Include in the design advanced monitoring.* *Include in the project long term energy consumption monitoring systems for at least 80% of the energy used that could enable more efficient operations.*
RA3.1 Protect Fresh Water Availability	**2**	**Improved**
		The plant is not connected to a water network so all the water is to be transported to the plant using trucks. The amount of water that will be used during construction has been measured. For consumption, it is

		estimated that 5 liters per person will be needed daily for 130 workers (650 liters per day). For domestic use, the plant will use 13 m3 per day and another 44,000 m3 will be used for terrain compaction. During operations, the plant will use 25 liters of water per day for human consumption and 0.5 m3 of water per day for domestic use and for its sanitary installations. Solar panels will be cleaned with water once every six months where a total of 122 m3 of water will be used for this purpose. There are no plans to reuse this water for other processes since all excess will be absorbed by the soil. Waste water during construction will be sent to treatment plants using a contractor. During construction and operation, interior roads will be kept wet to reduce the amount of dust in the air.
		Source: EP, 19, 29, 32-34, 65. *SA,18*
		RECOMMENDATIONS *Incorporate design features that minimize the long term negative net impact on ground and surface water source quality and quantity. It is not advisable to wet the roads as a system that reduces the amount of dust on the air. This system does not just waste water in an arid area, but also increases traffic and pollutants as that water has to be delivered by truck* *In order to properly evaluate the impact that the plan has it is necessary to provide documents that will indicate where are the companies that supply the water getting the element from.*
RA3.2 Reduce Potable Water Consumption	**0**	**No Score**
		It is not possible to evaluate the credit as the information provided does not allow a proper estimate of the consumption percentage of potable water that will be reduced. The plant is located in an isolated location disconnected from a water supply source, therefore all the water that the plan uses will have to be transported to site using trucks or other means of transportation. Documents have been provided indicating that the plant has an authorization that will allow it to extract non potable water from a stream for a period of sixty days between the months of July and September 2014, to be used in the plant. In return the plant will take care of the access road to the stream and will provide elements to the community that have not been identified. The project team has estimated the amount of water the plant will use. During construction the plant has estimated that for consumption it will need 100 liters per day per worker which in total amounts to 13 cubic meters of water a day. For compacting of the terrain the project will use 44,000 cubic meters of water and another unspecified amount will be need for the mixing of concrete. In this stage the plant will try to reduce its water consumption by using chemical toilets (porta potties), and by urging workers to shower at home. During operations, the project expects to use 25 liters per day per worker for consumption and 0.5 cubic meters for sanitary installations for 5 workers. For the maintenance and cleaning of the panels the plant will use 122 square meters of water every year (0.9 liter per panel every 6 months). Documents indicate that during both phases of construction and operation, water will be used as the solution to reduce the amount of dust in the air, by keeping interior roads wet.
		Source: EP, 32-24, 53, 65. *Junta de Usuarios Locumba, Authorization (Locumba Perú, 2014)*

		RECOMMENDATIONS *It is recommended to provide documents that indicate how much water is used regularly on a plant of the same characteristics and size as Moquegua PV. With those numbers in mind the team should design processes and features to reduce potable water usage, the savings accomplished should be documented and expressed in percentage terms.* *This is particularly relevant for Moquegua PV a plant that because of its isolated location will have to transport all its water.* *Documents indicate that in order to reduce water consumption in the plant workers will have to take a shower at home and not on their workplace this however does not reduce the overall water consumption, it only solves a problem for the company but not for the environment. Having the workers shower at the plant, even though it will have a higher cost, both monetary and in emissions due to transport, not only is more comfortable for the workers, but also can be used as an opportunity to educate them in-situ on the benefits of reducing water consumption. The fact that only 70% of the region's inhabitants has access to water in their homes should also be taken into account.* *It is not indicated if the water used for humidifying the roads is potable or not. Ideally another system that does not use water should be put into place, however if that plant will still use water it should try to reuse some water used at the plant or make sure that water is not potable and Ideally reused.*
RA3.3 Monitor Water Systems	**1**	**Improved**
		Water consumption is not necessary for energy production. During operations, the project will use water for human consumption, for bathrooms, for the purpose of keeping the roads wet in order to reduce the amount of dust in the air, and for solar panel cleaning. The plant is not connected to a water line so all the water that the plant will use has to be transported from somewhere else.
		Source:
		RECOMMENDATIONS *Considering that all the water needed will be brought using trucks, it should be easy to implement programs that can measure how much water is being used. With that information it is possible to design plans to optimize water consumption.*
RA 0.0 Innovate Or Exceed Credit Requirements		*N/A*
	31	

NATURAL WORLD		
	Score	**Moquegua Photovoltaic Plant**
NW1.1 Preserve Prime Habitat	**9**	**Superior**
		The land where the project is located has been classified as non productive, almost no plant species present and is not located near a protected area. Studies indicate that 4 wildlife species of high conservation value exist in the area. The same document indicates that there are not any protected areas in the plant vicinity.
		Source: EP 41, 45 - 47
		RECOMMENDATIONS *The fact that species animal species were not seen during the visit of the evaluator is not enough indicator to determine that such species are not present in the area*
NW1.2 Preserve Wetlands and Surface Water	**0**	**No SCore**
		According to the documentation provided, the area where the plant is located is classified as a super arid desert in Southern Peru with no wetlands in its proximity. Therefore, there has been no need to design a plan to protect wetlands or create a buffer zone.
		Source:

		RECOMMENDATIONS *If there were wetlands in the location of the project, a buffer zone should be created to protect the integrity of the wetland, the surrounding vegetation and soil. The buffer area should be of at least 50 feet.*
NW1.3 Preserve Prime Farmland	**0**	**No Score**
		The project has conducted a study to determine the quality of the soil. The results inform that the plant is located on a sandy area with rocks of volcanic origin. This land has been classified as non productive, with no vegetable cover. Because the area is not apt for farming purposes, the credit has been assessed as no score.
		Source: EP, 41, 46.
		RECOMMENDATIONS *Soils designated as prime farmland , unique farmland or farmland of statewide importance must be avoided as it is important to preserve them.*
NW1.4 Avoid Adverse Geology	**5**	**Conserving**
		Studies have been conducted to determine the geological qualities of the area where the plant is located and no buffer areas have been determined.
		Source: SLC Ingenieros,Final Geotechnical Study Report, Informe Final Estudio Geotécnico. Investigaciones Geotécnicas (Peru 2014) 1-68 (hereafter cited as GT) *EP, 17, 40-4, Annex 2J*
		RECOMMENDATIONS *Considering the risk of earthquakes is the biggest geological concern for this plant, and also considering that this is a risk that can not be accurately predicted regular drills should be perform in order to make sure that the workers are well prepare if a seismic event were to happen.*
NW1.5 Preserve Floodplain Functions	**5**	**Enhanced**
		After construction, the plant intends to remove all the material compacted from the use of heavy machinery in order to restore the soil to a state close to its initial condition. There are no paved areas in the project and internal roads are made of compacted dirt, leaving most of the area surrounding the plant untouched. The design of the project hypothesizes that the terrain will absorb and filter the water coming from the cleaning of the solar panels. The project also plans to keep the internal roads moist to avoid the amount of dust in the air.
		Source: EP, 33, 88.
		RECOMMENDATIONS *Considering this is a very dry area, and that the plant will use water to keep the roads moist to reduce the amount of dust in the air and to clean the solar panels, the project will infiltrate to the ground more water than the ground infiltrates in natural conditions.*
NW1.6 Avoid Unsuitable Development on Steep Slopes	**6**	**Conserving**
		The project is located in an area with slight changes in elevation. The project requires earthmovings to reduce the slope of the undulations that are present on the site. Geomorphically, the plant is located in an area classified as a desert plain with undulations (Llanura desértica de configuración ondulada). In the area where the project is located, with its arid nature, wind erosion is a much more prevalent process than water erosion.
		Source: EP, 17, 40 - 41, 75.
		RECOMMENDATIONS *The project should prioritize locations that do not include steep slopes, that do not require to perform earthmoving to flatten the surface. Areas with steep slopes should be avoided because they increase the exposure to risk and to erosion.*
NW1.7 Preserve Greenfields	**0**	**No Score**
		Greenfields are undeveloped land in a city or rural area being considered for urban development. This

		land may contain natural landscape, natural amenities, or agricultural land. The area where the project is located was an undeveloped rural area with natural landscape and qualifies as a greenfield, thus receiving no score since the project is on a greyfield area.
		Source: EP, 39 - 41
		RECOMMENDATIONS *The plant should prioritize areas that have been previously developed. Locating the plant in a grayfield area helps to preserve the areas of agricultural land, natural amenities and natural landscape even if it is considered a barren and arid area. Higher score hinges on documentation showing that the site of the project was previously developed.*
NW2.1 Manage Stormwater	**4**	**Enhanced**
		The area where the project is located has an average of 300 mm of precipitation. Documents indicate that for the greater part the surface of the plant will not be paved allowing infiltration.
		Source:
		RECOMMENDATIONS *Provide detailed documentation indicating initial, final post development and target water storage, infiltration, evaporation, water harvesting and, or cistern storage capacities using continuous simulation models such as TR-55 CNs.*
NW2.2 Reduce Pesticides and Fertilizer Impacts	**9**	**Conserving**
		Documentation provided indicate that the plant will not use Pesticides or fertilizers. There is also no indication that the project will include vegetal elements on its design.
		Source: EP, 45 -46.
		RECOMMENDATIONS *Provide documents that indicate that no pesticides or fertilizer will be used in the plant. If fertilizer and pesticides will be used, provide documents indicating which products will be used along with its levels of toxicity, the operational policies for application, if or how runoff controls will be designed*
NW2.3 Prevent Surface and Groundwater Contamination	**4**	**Enhanced**
		In order to avoid contamination, the project team prevents spills from reaching the ground and filtering into ground water sources during construction. The plant has incorporated several features to the dangerous waste storage area. The place will be designed to withstand physical and chemical damage and will be protected by a fence of at least 1.8 meters. It will also include a spill collector on its dangerous waste collecting area, a system designed to retain the contents inside the area, reducing spillage and allowing for easy clean up. After construction, the plant will enforce appropriate procedures for the removal of soil contaminated with fuel or lubricants at the closing stage of construction where contaminated soil up to a depth of 15 centimeters will be removed. During construction, decantation pools will be permeabilized and upon completion of the process, the material used to impermeabilize will be removed. During operations, the plant has designed a contingency plan to deal with spillages.
		Source: EP, 22 - 23, 33, 65 -67 88-89.
		RECOMMENDATIONS *Efforts should be made to reduce the amount of water dropped onto the soil, specially because the soil where the plant is located according to the geotechnical study performed prior to the plant construction is very rich in soluble salts that might dilute in presence of water reducing its resistance.* *Efforts should be made to reduce or replace potential polluters* *Include processes that will monitor the levels of pollutants in groundwater.*
NW3.1 Preserve Species Biodiversity	**2**	**Improved**
		The team has conducted a study to identify the species of animals that can be found in the area the project is located. Based on bibliographic studies, the team has determined that 4 of the species found in the area have been classified with some degree of conservation danger according to the Peruvian law. The 4 animal species include the Andean Cat (endangered) the Andean Condor

		(endangered), the Jergón de la Costa snake (Vulnerable), and the Puma (almost threatened). In order to preserve the habitat of the local fauna, the plant will only modify the area where the project is located. Documents indicate that the project will focus on not affecting the species of fauna that have economical importance for the local population. It also states that affecting the species with no economical value does not alter the well being of the population. There is no indication in the documentation provided that the plant will attempt to enhance the existing habitat.
		Source: EP, 44 - 4764, 66
		RECOMMENDATIONS *Efforts should be put in preserving all the species, not only those that have an economical value for the local population. Efforts could be made not only to preserve habitat, but also to improve it, Studies could be conducted to determine in detail the species present in the project area and its needs in order to create plans that could improve their habitat quality.*
NW 3.2 Control Invasive Species	**0**	**No Score**
		Documents provided do not indicate if vegetal species will be incorporated into the design of the plant. They also do not indicate if a study of invasive species has been conducted.
		Source:
		RECOMMENDATIONS *Provide documents showing that the presence of invasive species (animal and vegetal) has been studied within 1000 meters of the site. If invasive species are found provide a list of them. The project should focus on removing the invasive species, in creating a design that does not to create conditions that might favor the reappearance of invasive species and in restoring the area to a pre-invasive stage. If plants are going to be included they have to be non invasive , include documentation supporting the claim.*
NW3.3 Restore Disturbed Soils	**8**	**Conserving**
		Documents indicate that the project will restore disturbed soil paths post construction and after operation conclusion. After construction, the restoration will consist of the removal of areas polluted with fuels and lubricants and the remotion of the compacted areas due to the use of heavy machinery. During the closing of the plant, soil contaminated with oils will be removed up to a depth of 15 centimeters, put into hermetic containers and sent to an authorized waste collection facility.
		Source: EP, 65, 89.
		RECOMMENDATIONS *Provide calculations indicating that 100% of the soil will be restored. Provide documentation of the restorative activities.*
NW3.4 Maintain wetland and surface water functions.	**0**	**No Score**
		The plant is located on an arid desert area with no wetlands or surface bodies of water in its vicinity.
		Source: EP, 37 - 40, Annex 2J.

		RECOMMENDATIONS *If wetlands and waterbodies existed in the area where the project is located, the team should focused on maintaining, enhancing and restoring hydrologic connections, water quality, habitat and sediment transport.* *Provide documentation indicating in the case of streams rivers and lakes is connected to its riparian floodplain at a six month to two year frequency flow event. For wetlands provide documentation showing that structures that drain them will be removed.Provide documentation showing the current source of the waterway's normal flow, water quality of its source and how water quality will be maintained or enhanced. Conduct surveys to determine the species living in the area and create a plan to preserve and enhance the habitat for the aquatic and riparian species* *Include documents demonstrating that sediment transport will not be disrupted by the proposed project. Remove or mitigate any obstructions that might exist.*
NW 0.0 Innovate Or Exceed Credit Requirements		*N/A*
	52	
CLIMATE AND RISK		
	Score	**Moquegua Photovoltaic Plant**
CR1.1 Reduce Greenhouse Gas Emissions	**25**	**Restorative**
		The project is able to emit carbon credits under the Kyoto Protocol Clean Development Mechanism by reducing 30,983 ton CO2/year. Moquegua PV will contribute to the diversity of Peru's energy matrix as well as displace electricity generation from thermal power plants which is expected to result in Greenhouse Gas (GHG) emissions. The project has identified that during construction, CO and NOx gases from vehicles and machinery will be released to the atmosphere coming from the 49,000 liters of fuel that will be used to power equipment and machinery. According to the documents provided, the following machinery will be used during construction: 1 grader, 2 tanker trucks, 1 roller compactor of 10-15 tons. 4 backhoes, 7 diggers, 1 front loader, 1 bulldozer, 2 roller compactors of 700 kg. in weight, 2 crane trucks, 3 forklifts, 5 trucks, 20 pickup trucks, 6 buses, 1 40 ton crane, 1 telescopic forklift, and 100 kVA generator. Due to the nature of the plant, it will not generate greenhouse gas emissions during its operations. However, because the plant is on an isolated location, it will require transportation via trucks or buses for all the resources it will need, including water, thus indirectly releasing gas emissions to the environment.
		Source: *EP, 18, 20, 36.* *CDM Executive Board, Clean Development Mechanism Project Design Document Form (2006), 2-3.*
		RECOMMENDATIONS *Efforts should be made to reduce carbon emissions from transportation to and from the project, and provide calculations of percentage reduction.*
CR1.2 Reduce Air Pollutant Emissions	**12**	**Conserving**
		Credit detailThe power plant project has proven its commitment towards air quality and will continue to monitor its emissions every 3 months following Peruvian air quality standards. These standards measure the same gases as the California Ambient Air Quality standards but have different thresholds. In addition, the operation of the solar power plant will help reduce the thermal power plant operations in the national electricity grid (SEIN). The improvement in the air quality is anticipated since the operation will advocate reduction of local pollutants such as NOx, SOx and PM in the thermal power plants emission.

		Impacts to air quality are considered negligible in the operation phase as the largest impacts occur during the construction phase. In addition, the project is expected to contribute indirectly to the reduction of air pollutants emissions. During construction and operation, monitoring of the air pollutants will be performed once every 3 months and will be performed according to the parameters set by the Peruvian Laws (Supreme decreets number 003-2008-MINAMM and 074-2001-PCM). The pollutants analyzed are the same as the California Ambient Air Quality Standards (CAAQS) measures. Identified pollutants include CO, Pb, NOx, O3, PM 10 and PM 2.5, O3 and SO2 and two more H2S, and non-methane hydrocarbons. The averaging time for all the pollutants are the same except sulfur dioxide. The levels and forms change making CAAQS more strict. It is not possible to evaluate if the plant will reduce air pollutants as only baseline study results have been provided. The project has made efforts to reduce the amount of dust generated. During construction, efforts will be put not to exceed the trucks maximum cargo capacity as extra weight can release more particles. Another measure that will be implemented during construction and operations is to compact the access road with Bischofite and use water to keep the interior roads wet. Being a photovoltaic plant, the project will not burn fossil fuels to produce energy during operations.
		Source:
		RECOMMENDATIONS
CR2.1 Assess Climate Threat	**0**	**No SCore**
		Provided documents do not indicate that the plant has been designed with climate threat in mind. However, the plant will generate energy in a way that is much cleaner than other existing technologies, thus indirectly focusing on the issue.
		Source:
		RECOMMENDATIONS *Climate change can modify an area's climate in many ways, more in depth studies on the issue are recommended. Particularly the increase in sea temperature can have secondary effects that could affect the plant, among those effects stronger winds product of stronger storms could affect the projects tolerance, an increase in rainfall can affect the solar panels, and an increase in the amount of clouds product of higher evaporation can reduce the amount of sun that the plant is exposed thus reducing the overall effectivity of the project.*
CR2.2 Avoid Traps And Vulnerabilities	**0**	**No Score**
		The project team has not provided any documentation on the avoidance of traps and vulnerabilities that could generate high, long-term cost for the affected communities.
		Source:
		RECOMMENDATIONS *Provide documentation that indicates that work has been done to identify and assess possible changes in key engineering design variables.* *Provide documents that indicate the potential traps and vulnerabilities and associated costs and risks and to what extent the project concepts configurations and design have taken into account the need to reduce identified significant risks,traps and vulnerabilities with substantial cost and other negativities.*
CR2.3 Prepare For Long-Term Adaptability	**0**	**No Score**
		There are no explicit indications in the provided documents that long term adaptability has been considered during the plant's design process.
		Source:

		RECOMMENDATIONS *Provide documents that indicate whether or not long 'term adaptability has been important in the conception of the plant and how the design reflect that concern. Indicate which specific measurements taken address the potential consequences of long term climate change, intense, weather events, heat waves. The team could focus on designing elements that could create alternative supply options for water energy and other materials critical for operations.* *Provide plans, designs and/or documents that show restoration and rehabilitation efforts*
CR2.4 Prepare For Short-Term Hazards	**3**	**Improved**
		The team has provided a comprehensive list of probable risks. The risk listed are grouped into the following categories: mechanical, electrical, fire and explosions, chemical substances, physical, biological, ergonomic, psicosocial, natural phenomenons and others. The team has also classified them according to each category's probability and severity and devised measurements of control. Most of the measurements of control are policies that will be implemented rather than modifications to the design. These policies do not take into account the changes that the probable hazards may cause over time.
		Source: SH, 125 - 149.
		RECOMMENDATIONS *Hazards assessment should take into account that the probability of occurrence and intensity of some hazards might change during the lifespan of the plant. Conduct analysis to evaluate if the hazards that the plant might face surpass existing codes and regulations, provide documents that showcase those results.* *Design strategies that use environmental restoration to minimize the risks of natural hazards, such as restoring wetlands to accommodate flooding or to lessen the effects of hurricanes.*
CR2.5 Manage Heat Island Effects	**0**	**No Score**
		No information was provided indicating the reduction of localized heat accumulation and the management of microclimates.
		Source:
		RECOMMENDATIONS *Conduct analysis to determine the solar reflective index of the different areas of the plant according to the materials and provide documentation. Indicate results based on percentages of heat reduction.* *Present drawings showing all non roof non vegetated areas of the site including materials* *Provide documentation of all shaded areas assumed at noon on summer solstice.*
CR0.0 Innovate Or Exceed Credit Requirements		*N/A*
	40	
OVERALL:	**165**	**Moquegua Photovoltaic Plant**

APPENDIX E: SOURCES

DOCUMENTATION PROVIDED
General Information.
Environmental Resources Management, Evaluación Preliminar de la Planta Solar Fotovoltaica FV – 16 MW (2012)
Solar Pack, Programa de Relaciones Comunitarias (Peru, 2014), 22-23
SolarPack, Programa de Medidas de Prevencion y MItigacion Ambiental, Peru, (2014)
Solar Pack, Plan de Seguridad y Salud Ocupacional, (Peru, 2014)
Corporación de laboratorios ambientales del peru S.A.C. , Informe de monitoreo de calidad de aire y ruido ambiental evaluación preliminar planta solar fotovoltaica Moquegua (Peru, 2012)
Ingeteam, Estudio Lumínico del CTIN (2014)
Moquegua FV, Evaluación Preliminar de la Planta Solar Fotovoltaica FV – 16 MW: Levantamiento de Observaciones (2012)
Solar Pack,Plan integral de manejo ambiental y social (2014)
Junta de Usuarios Locumba, Authorization (Locumba Perú, 2014)
SLC Ingenieros,Final Geotechnical Study Report, Informe Final Estudio Geotécnico. Investigaciones Geotécnicas (Peru 2014)
CDM Executive Board, Clean Development Mechanism Project Design Document Form (2006)