Prepared For:

Energía del Pacífico

LNG to Power Project, El Salvador Cumulative Impact Assessment – *Draft*

December 2018

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ERM

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TABLE OF CONTENTS

ACRONYMS

AOI	area of influence
BOD	biochemical oxygen demand
CEPA	*Comisión Ejecutiva Portuaria Autónoma* (Autonomous Port Commission)
CIA	cumulative impact assessment
CO	carbon monoxide
COD	chemical oxygen demand
EHS	environmental, health and safety
ESIA	environmental and social impact assessment
EDP	Energía del Pacífico Ltda. de C.V.
FSRU	floating storage regasification unit
GHG	greenhouse gases
HRSG	heat recovery steam generators
IFC	International Finance Corporation
IUCN	International Union for the Conservation of Nature
km	kilometer
kV	kilovolt
LNG	liquefied natural gas
m	meter
MAG	*Ministerio de Agricultura* (Ministry of Agriculture)
MARN	*Ministerio de Ambiente y Recursos Naturales* (Environmental and Natural Resources Ministry)
MPA	Marine Protected Area
MW	megawatt
NOX	nitrogen oxides
PAC	project-affected communities
PM	particulate matter
PS	Performance Standards
PV	photovoltaic
SO2	sulfur dioxide
TL	transmission line
VEC	valued environmental component
VOC	volatile organic compounds

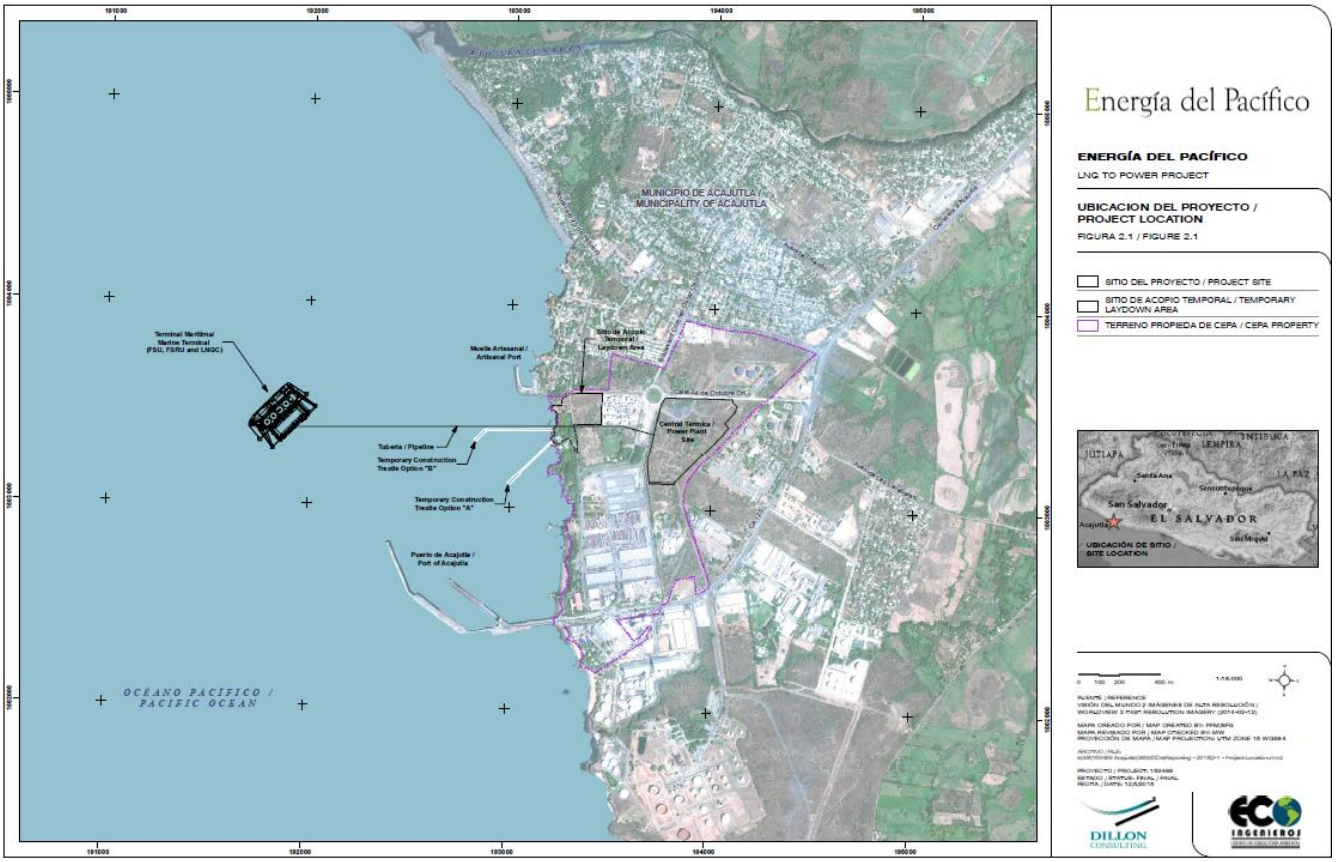
EXECUTIVE SUMMARY

To be completed for the Final version.

1. INTRODUCTION

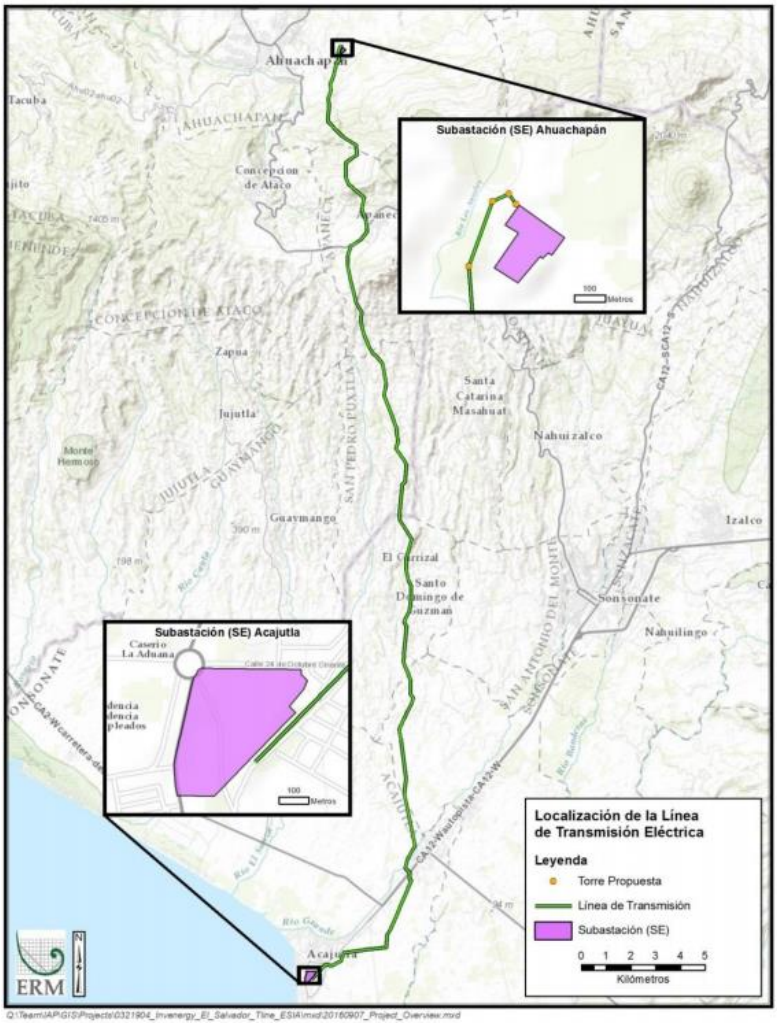
Energía del Pacífico Ltda. de C.V. (EDP) is seeking financing for the construction and operation of a liquefied natural gas (LNG) to power project in El Salvador (the Project). The Project will involve the construction and operation of:

- Power Plant (see Figure 1-1): a 378 megawatt (MW) thermal power plant at the Port of Acajutla in the Department of Sonsonate, a marine terminal for LNG delivery, storage, and regasification, and a natural gas pipeline that will run from a floating storage regasification unit (FSRU) to the power plant, and
- Transmission Line (TL) (see Figure 1-2): a 44 kilometer (km), 230 kilovolt (kV) TL and related substations to connect the Power Plant to the electrical network of El Salvador.



Source: EDP 2016.

Figure 1-1: Project Power Plant Location



Source: EDP 2017.

Figure 1-2: Project Transmission Line Location

This report discusses the cumulative impact assessment (CIA) conducted to evaluate the potential contribution of the Project towards the cumulative impacts on resources identified as Valued Environmental Components (VECs) by stakeholders.

This report follows the International Finance Corporation's (IFC's) *Good Practice Handbook—Cumulative Impact Assessment and Management: Guidance for Private Sector in Emerging Markets* ("the Handbook") (IFC 2013). The Handbook provides a methodology for identifying the most significant cumulative impacts. The methodology includes a desktop review of publicly available information and consultation with key stakeholders. This methodology focuses on environmental and social components referred to in the handbook as VECs, which are: (1) rated as "critical" by potential Project-Affected Communities (PACs)[1] and/or the scientific community; and (2) cumulatively impacted by the Project under evaluation, by other projects,

[1] PACs are defined as local communities potentially directly affected by the Project (consistent with IFC Performance Standard 1, paragraph 1 [IFC 2012a]).

and/or by natural environmental and social external drivers (IFC 2013). The methodology applied herein is generally consistent with the relevant IFC Performance Standards (PS), especially PS 1—Assessment and Management of Environmental and Social Risks and Impacts, and PS 6—Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC 2012).

2. OBJECTIVES AND SCOPE

The overall objective of this CIA is to identify and assess the contribution by the Project to cumulative impacts. The specific objectives are:

- Identify VECs that could be impacted cumulatively in the onshore and offshore areas potentially affected by the Project, considering input from stakeholders and potential PACs through consultation process;
- Identify other existing and planned projects and external environmental and social drivers that could cumulatively impact VECs;
- Undertake a high-level assessment of potential cumulative impacts on VECs, considering the Project and the other identified existing and planned projects and external drivers in the area, identifying the contribution of the Project to the cumulative impacts;
- Recommend a management framework for the integrated management of potential cumulative impacts.

3. METHODOLOGY

3.1. KEY TERMINOLOGY FOR THE CIA

The following are definitions for key terminology used in the CIA.

Cumulative Impact: Impacts that result from the successive, incremental, and/or combined effects of an action, project, or activity added to other existing, planned, and/or reasonably anticipated actions, projects, or activities. For practical reasons, the identification, assessment, and management of cumulative impacts are limited to those effects generally recognized as important on the basis of scientific concern and/or concerns of PACs.

CIA: Process to identify and evaluate cumulative impacts.

Other Projects: Existing, planned, or reasonably expected future developments, projects and/or activities potentially affecting VECs.

External Drivers: Sources or conditions that could affect or cause physical, biological, or social stress on VECs, such as natural environmental and social drivers, human activities, and external stressors. These can include climate change, population influx, natural disasters or deforestation, among others. These are typically less defined and planned than Other Projects.

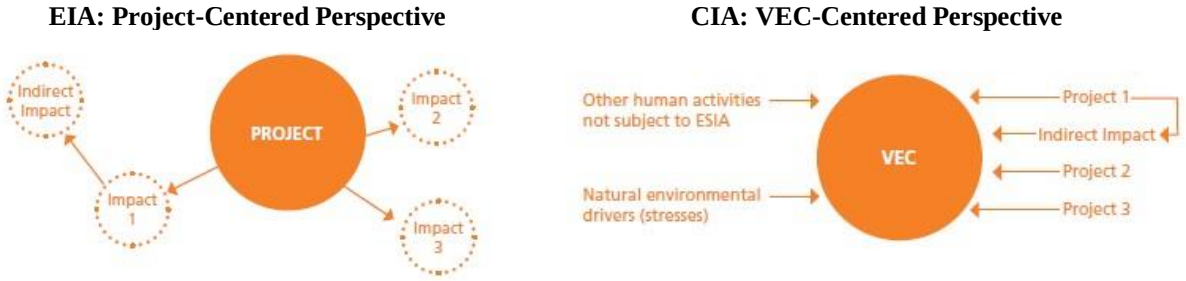
VEC: Environmental and social components considered as important by the scientific community and/or potential PACs. VECs may include:

- Physical features, habitats, wildlife populations (e.g., biodiversity, water supply);
- Ecosystem services (e.g., protection from natural hazards, provision of food);
- Natural processes (e.g., water and nutrient cycles, microclimate);
- Social conditions (e.g., community health, economic conditions); and
- Cultural heritage or cultural resources aspects (e.g., archaeological, historic, traditional sites).

VECs reflect the public and scientific community's "concern" or special interest about environmental, social, cultural, economic, or aesthetic values (IFC 2013). According to the IFC's methodology, VECs are considered the ultimate recipients of cumulative impacts because they tend to be at the ends of ecological pathways.

3.2. OVERALL CIA APPROACH

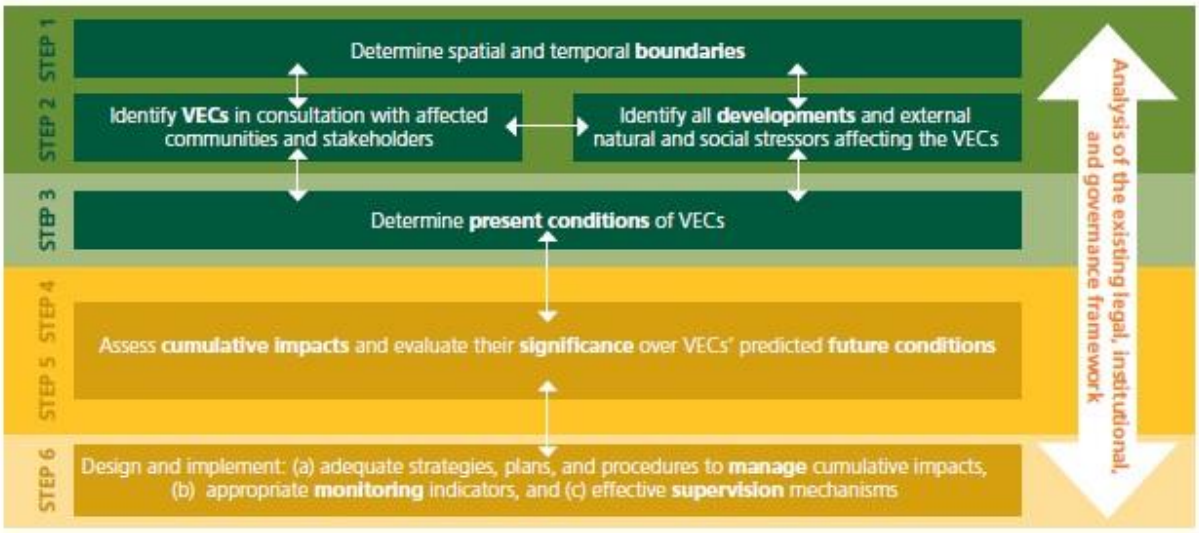
Unlike an ESIA, which focuses on a project as a generator of impacts on various environmental and social receptors, a CIA focuses on VECs as the receptors of impacts from different projects and activities (see Figure 3-1). In a CIA, the overall resulting condition of the VEC and its related viability are assessed.



Source: IFC 2013.

Figure 3-1: Comparing ESIA and CIA

The CIA was derived from desktop reviews of publicly available information, information obtained during the two Project Environmental and Social Impact Assessments (ESIAs) process (one for the Power Plant and one for the TL), post-ESIA supplemental studies, and information provided by EDP. The assessment follows the six steps for a CIA (see Figure 3-2). The process is iterative and flexible, with some steps having to be revisited in response to the results of others. For example, the VEC selection step usually needs to be adjusted after the potential impacts of the Project are identified. The steps are described in detail below.



Source: IFC 2013.

Figure 3-2: Summary of the Cumulative Impact Assessment Methodology

3.3. LIMITATIONS

The Handbook takes into consideration the limitations that a private developer may face carrying out a CIA. The limitations applicable to this CIA include: (1) incomplete information about other projects and activities (e.g., the information is not available in the public domain); (2) uncertainty with respect to the implementation of future projects; and (3) difficulty in establishing thresholds or limits of acceptable change for VECs, and therefore the significance of cumulative impacts.

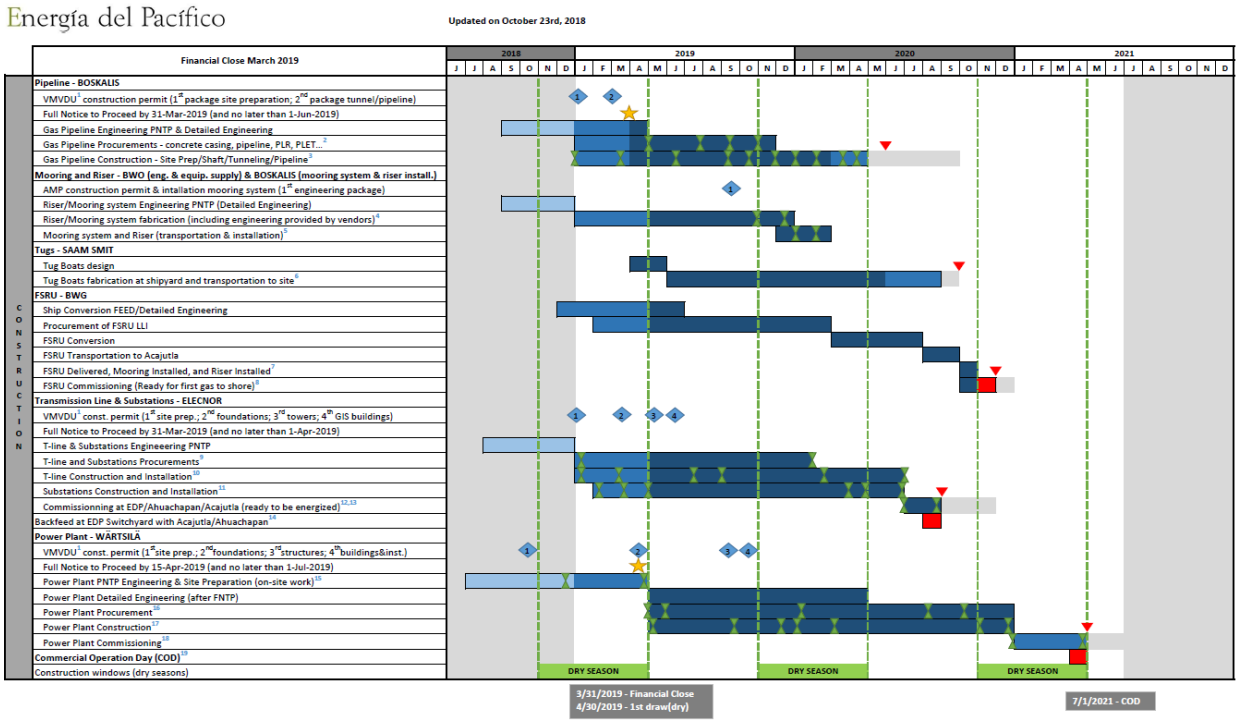
3.4. DETERMINATION OF SPATIAL AND TEMPORAL BOUNDARIES

The Project includes two main components: Power Plant and TL. The Power Plant includes both land (thermal power plant) and maritime (marine terminal and pipeline) components. The land components are located within the Acajutla Port boundary, in the Acajutla municipality. The marine terminal is located approximately 1,000 meters (m) off-shore, and the pipeline extends for the same distance. The TL will extend for 44 km, from the Ahuachapán sub-station to the new Acajutla sub-station, and crosses six municipalities: Ahuachapán, Apaneca, San Pedro Puxtla, Santo Domingo de Guzmán, Sonsonate, and Acajutla. The six municipalities are located within two departments: Sonsonate and Ahuachapán.

Based on an assessment of the VECs for the CIA, it was determined that using the departmental limits for the Sonsonate and Ahuachapán departments, plus a 1,500 m radius around the marine terminal, would be sufficient to serve as the spatial boundary of the CIA, in that it covers: (1) the extent of the selected VECs, and (2) the extent of the potential impacts from the Project, other projects, and external drivers. Acajutla and San Pedro Puxtla are the largest cities within the CIA area.

Figure 3-3: Spatial Boundary of the CIA

Temporal delimitation for a CIA is future focused and therefore frequently a challenge due to the uncertainty inherent to potential future projects. For this reason, good international industry practice suggests consideration of a three-year temporal boundary when conducting a CIA (IFC, 2013). Based on the expected timeline of the Project, construction of the TL would be completed by 2020, and construction of the Power Plant would be completed by 2021 (see Figure 3-4). The CIA uses an extended five-year temporal boundary, 2019 – 2023, to cover the Project construction and initiation of Project operation activities.



Source: EDP 2018

Figure 3-4: Project Schedule (Conceptual for CIA Purposes)

3.5. IDENTIFICATION OF VECS, OTHER PROJECTS, AND EXTERNAL DRIVERS

3.5.1. VECs

To be included in a CIA, a VEC must first be confirmed to be valued by some identifiable stakeholder group and/or the scientific community. With this objective, EDP and ERM conducted stakeholder interviews within the CIA area, which included the following stakeholders groups: local authorities such as municipality city halls, staff from health centers, private sector, and community members from the Project Area of Influence. The interviews took place between October 24 and October 31, 2018, and inquired about valued environmental components. Table 3-1 presents the stakeholder engaged for the CIA. These engagements allowed ERM to develop a list of preliminary VECs and to establish the value or importance of receptors to the interviewed stakeholders.

Table 3-1: Key Stakeholder Groups Interviewed

Municipality	Department	Stakeholder Group	Number of persons interviewed	Date
Acajutla	Sonsonate	Local authorities, health center staff and community members	29	October 24, 2018
Ahuachapán	Ahuachapán	Local authorities, private sector and community members	14	October 29, 2018
Apaneca	Ahuachapán	Local authorities, private sector and community members	6	October 29, 2018
San Pedro Puxtla	Ahuachapán	Local authorities and community members	17	October 31, 2018
Santo Domingo de Guzmán	Sonsonate	Local authorities and community members	21	October 31, 2018
Sonsonate	Sonsonate	Local authorities and community members	10	October 31, 2018

VECs must also be reasonably expected to be affected by both the project under evaluation (i.e., Power Plant and/or TL) and some combination of other projects and external drivers. Section 5.1 presents the VEC selection results.

3.5.2. Other Projects

Through a thorough review of publicly available information and interviews with EDP personnel and stakeholders (see Table 3-1), ERM identified existing and future planned projects located within the spatial and temporal boundaries of the CIA, having the potential to result in cumulative impacts on identified VECs. The sources researched to identify other existing or planned projects for this CIA included:

- Interamerican Development Bank (IDB) website
- World Bank Group website
- OPIC website
- Bnamericas website
- GlobalEnergyObservatory.org
- El Salvador Ministry of Agriculture (MAG) website
- El Salvador Ministry of Environment and Natural Resources (MARN) website
- Local newspaper: www.elmundo.sv

Section 4.1 describes the other projects identified.

3.5.3. External Drivers

Regionally present external drivers and stressors were identified through ESIA-generated information and publicly available information. Section 4.2, External Drivers, provides a description for each one.

3.6. DESCRIPTION OF VEC CONDITIONS

Based on publicly available information and the data presented in the existing conditions sections of the two Project ESIAs (Power Plant and TL), the baseline conditions of the selected VECs were briefly described (see Section 5.2, VEC Description). The VEC baselines provide information on the VECs' current conditions, the anticipated resilience against external stressors and potential impacts (cumulative impacts and sources of stress), and thus provide an indication of their viability and sustainability.

3.7. ASSESSMENT OF CUMULATIVE IMPACTS ON VECS

CIAs are future-oriented and Project contributions are assessed as the difference between the expected future condition of the VEC in the context of all possible known stressors and that condition plus the Project under evaluation. This step of the CIA assesses the future conditions of the VECs, considering the impacts from the Project, other projects, and external drivers. The potential impacts to VECs were established from the results of the two Project ESIAs and other available information. If the potential impact significance on a VEC was rated as minor or higher for at least one potential impact associated with the Project (Power Plant and/or the TL) in the Project ESIAs, the VEC was identified as potentially eligible for the CIA. If no impact information was available (e.g., for other projects), ERM assumed common sector-based impacts.

The results of the CIA are presented in tabular format in Section 6, Assessment of Cumulative Impacts on VECs. The significance of cumulative impacts is not evaluated in terms of the magnitude of change but in terms of VEC response and the resulting condition and sustainability. If cumulative impacts do not exceed the VEC threshold, the development of the project under assessment is considered acceptable. Given the intrinsic limitations of Project-driven CIAs, the present assessment was not intended to obtain sufficient baseline information to establish thresholds of the selected VECs and therefore establish the significance of the cumulative impacts. Instead, based on the publicly available information and the findings of the stakeholder interviews, cumulative impacts were categorized by priority using the following definitions:

- **High Priority:** The VEC is expected to be adversely impacted by other projects and/or external drivers and the future addition of the Project could incrementally contribute to the adverse impact. Actions should be implemented in the short term to mitigate potential adverse cumulative impacts on the VEC.
- **Medium Priority:** The VEC could potentially be impacted by other projects and/or external drivers, and the Project could potentially contribute to the adverse impact. Actions should be

implemented in the medium term to mitigate potential adverse cumulative impacts on the VEC.

- **Low Priority:** The VEC could potentially be impacted by other projects and/or external drivers, but the Project would not be expected to contribute to the adverse impact or its contribution is expected to be negligible. No actions are required to mitigate potential adverse cumulative impacts on the VEC.

3.8. CUMULATIVE IMPACT MANAGEMENT FRAMEWORK

Internationally recognized good practices for managing cumulative impacts include:

- Effective application of the mitigation hierarchy (avoid, reduce, and remedy) in the environmental and social management of the specific contributions of a project to expected cumulative impacts; and
- Undertaking best efforts to engage, leverage, and/or contribute in multi-stakeholder collaborative initiatives or discussion groups to implement management measures that are beyond the capacity and responsibility of any individual project developer. (IFC 2013)

The embedded controls and management measures included in the two ESIAs (Power Plant and TL) provide a means to mitigate the specific contributions of the Project to effects on VECs, following the mitigation hierarchy. Supplementing these controls and management measures, the CIA provides recommendations for EDP to apply in the context of the Project to manage potential cumulative impacts on these VECs.

4. OTHER PROJECTS AND EXTERNAL DRIVERS

4.1. OTHER PROJECTS

Eleven existing and planned other projects were identified as relevant with respect to the potential for their impacts to interact with Project impacts on VECs within the CIA spatial and temporal boundaries. This section provides a brief description of each project (see Table 4-1). The approximate location of the other projects (for which we found specific geographical information such as coordinates) are displayed in Figure 4-1.

Table 4-2 provides a summary of the expected impacts from the other projects organized by sector. The potential impacts were based on available information and cover environmental, occupational, health, and safety (OHS) and social aspects. Because the information available for each of the other projects did not have the same level of detail regarding their specific potential impacts, the impacts from project with little to no information were based on industry-specific impacts identified in the IFC´s Environmental, Health and Safety (EHS) Guidelines for each sector.

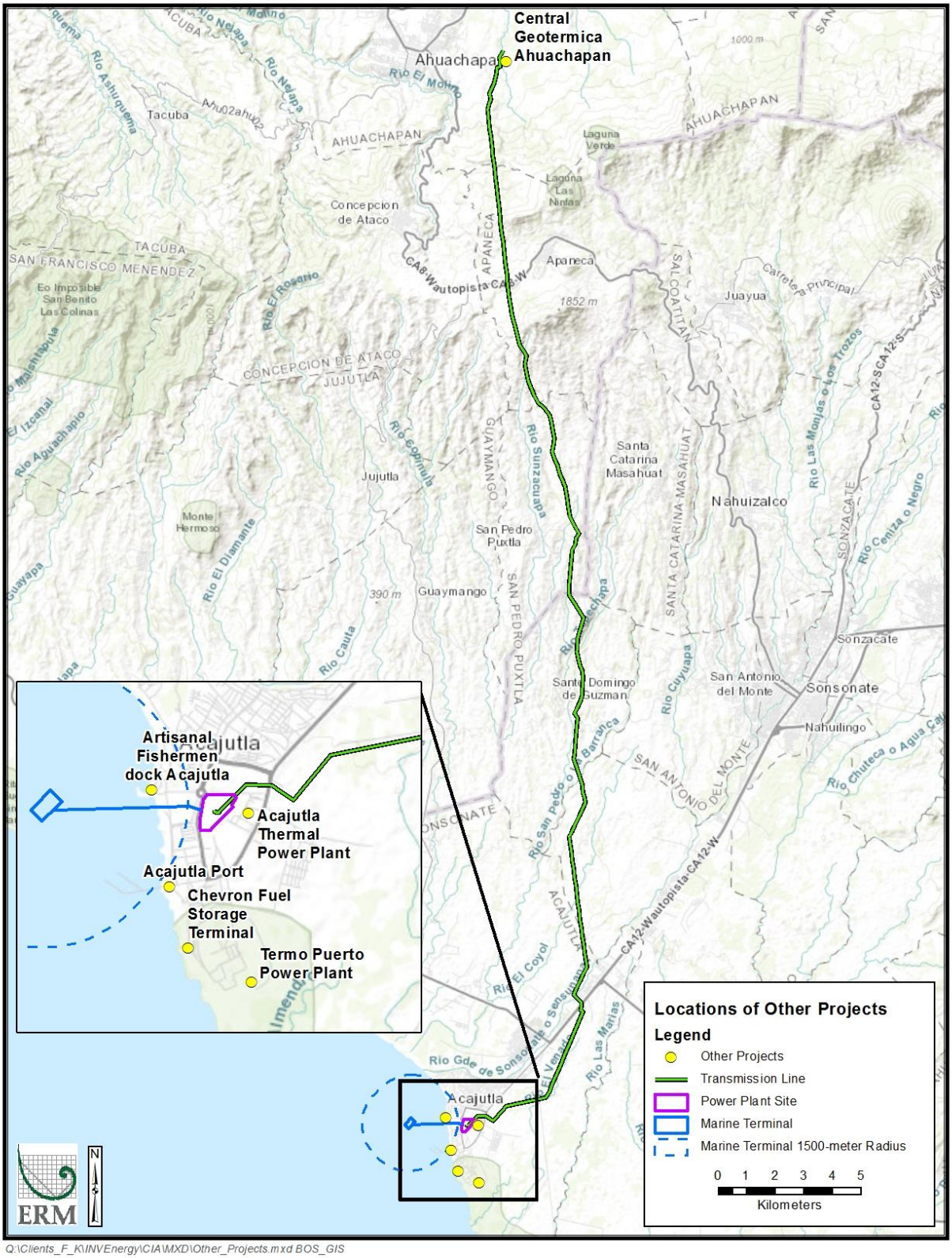


Figure 4-1: Locations of Other Projects

Table 4-1: Other Projects

Project Name / Company	Approximate Location / Nearest Project Component	Status	Project Summary	Industry / Sector
Bósforo Solar Photovoltaic Project - Phase II / AES El Salvador y Corporación Multi Inversiones (CMI)	Department of Sonsonate / TL	Planning / Pre-Construction	The Bósforo photovoltaic (PV) solar project involves the construction of 10 plants in different parts of the country. Phase II includes the construction of four 10-MW PV solar plants, one of them in the Sonsonate Department. Construction is expected to begin in 2018 and be completed in 2019.[2] Summary of the project's environmental and social screening (OPIC 2017)[3]: • A desk and field review based due diligence assessment indicates the project does not have significant adverse impacts with respect to pollution, community health and safety, land acquisition and resettlement, biodiversity, indigenous peoples and cultural heritage. • The main environmental and social issues associated with solar energy projects include the need for health and safety measures and an environmental and social management system for construction and operation including solid waste disposal, hazardous materials management and treatment and disposal of wastewater.	Renewable Energy - Solar
Remedios and Sonsonate Solar / Real Infrastructure Capital Partners, LLC	Municipalities of Acajutla and Sonsonate; Department of Sonsonate / TL	Construction	Development, construction, and operation of two solar PV plants with a combined capacity of 30 MW in Acajutla and Sonsonate. The project received its construction permit in July 2017, and is expected to start operations by the end of 2018. Summary of the project's environmental and social screening (OPIC 2017):	Renewable Energy - Solar

[2] URL: https://www.bnamericas.com/project-profile/en/proyecto-solar-fotovoltaico-bosforo-fase-ii-proyecto-solar-fotovoltaico-bosforo-fase-ii
[3] URL: https://www.opic.gov/opic-action/all-project-descriptions

Project Name / Company	Approximate Location / Nearest Project Component	Status	Project Summary	Industry / Sector
			• The plants are not located in or near sensitive areas and unlikely to have significant negative impacts associated with biodiversity, indigenous peoples, cultural heritage, and land acquisition. The project does not involve resettlement. • The main environmental and social issues associated with solar energy projects include the need for appropriate health and safety measures and a robust environmental and social management system for day-to-day aspects of construction and operations including solid waste disposal, hazardous waste management and disposal and wastewater treatment and disposal. • The project´s Environmental Management Plan includes provisions for the re-establishment of native vegetation removed for site preparation.	
Trinidad and Márquez Project / Real Infrastructure Capital Partners, LLC	Municipality of Acajutla; Department of Sonsonate / TL	Operations	Development, construction and operation of one 8 MW and one 6 MW solar PV plants, including the substation and transmission lines, in Acajutla. The project started construction in January 2017, and is expected to start operations in November 2018[4]. Summary of the project's environmental and social screening (OPIC 2017): • The plants are not located in or near sensitive areas and that are unlikely to have significant negative impacts associated with biodiversity, indigenous peoples, cultural heritage, and land acquisition.	Renewable Energy - Solar

[4] URL: https://elmundo.sv/preparan-12-nuevos-proyectos-renovables-que-daran-energia-a-700000-hogares/

Project Name / Company	Approximate Location / Nearest Project Component	Status	Project Summary	Industry / Sector
			• The main environmental and social issues associated with the project include the need for appropriate health and safety measures and a robust environmental and social management system for day-to-day aspects of construction and operation including solid waste disposal, hazardous materials management and disposal and wastewater treatment and disposal. • The project does not displace or restrict any person from their home, job or livelihood. The Project will not have impacts on indigenous peoples. • A few vulnerable and threatened fauna and flora species were identified at the Marquez and Trinidad plants, which will be protected and rescued as per the flora and fauna management plan in the ESIAs. Water will be trucked to the sites or obtained via the municipal water distribution system, for construction activities. Portable toilets, biodigestors and septic tanks will be used during construction and operations and they will be serviced by a certified service provider.	
Acajutla Thermal Power Plant / Orazul Energy (former Duke Energy)	Municipality of Acajutla, Department of Sonsonate (Lat: 13.5834, Long: -89.8239)[5] / Power Plant	Operations	The Acajutla Thermal Power Plant is a mix of steam and combustion turbines. The first unit was commissioned in 1966 and the last in 2007. It is comprised of the following units: - Planta Acajutla Gas (95.2 MW) - Planta Acajutla Vapor (60 MW)	Thermal Power

[5] URL: http://globalenergyobservatory.org/geoid/43614

Project Name / Company	Approximate Location / Nearest Project Component	Status	Project Summary	Industry / Sector
			- Planta Acajutla Diésel (143.9 MW) - The diesel engine/boiler is a Wartsila IC 9 units 18V46.	
Termo Puerto Power Plant / Termo Puerto Limitada de C.V.	Municipality of Acajutla, Department of Sonsonate (Lat: 13.56329, Long: -89.82467) / Power Plant	Operations	The Termo Puerto Power Plant (70 MW) started operations in 2013. It is a bunker-fueled power generation plant located in Acajutla port. The plant does not need storage or deposit tanks because of its strategic location in Acajulta, which is a port that borders Sonsonate and Ahuachapán departments. Capacity will eventually rise to 100 MW through a 30 MW second phase expansion. No estimated timeframe for the expansion was found.	Thermal Power
Chevron Fuel Storage Terminal Expansion Project / Chevron-Texaco	Municipality of Acajutla, Department of Sonsonate / Power Plant	Operations / Planning	The existing fuel storage terminal has six tanks for diesel and gasoline, with a storage capacity of 300,000 gallons. The terminal serves as a fuel storage and distribution facility in Acajutla. The expansion would add another 150,000 barrels of storage capacity. Construction for the expansion is expected to start by the end of 2018.	Crude Oil and Petroleum Product Terminal
Schafik Jorge Hándal Fuel Storage and Distribution Plant / ALBA Petróleos de El Salvador	Municipality of Acajutla, Department of Sonsonate / Power Plant	Operations	The plant has a capacity for 335,000 barrels of diesel, and serves as a fuel storage and distribution facility in Acajutla. It started operations in May 2011.	Crude Oil and Petroleum Product Terminal

Project Name / Company	Approximate Location / Nearest Project Component	Status	Project Summary	Industry / Sector
Acajutla Port / Comisión Ejecutiva Portuaria Autónoma (CEPA)	Municipality of Acajutla, Department of Sonsonate / Power Plant	Operations	The Acajutla Port is managed by the Autonomous Port Commission (*Comisión Ejecutiva Portuaria Autónoma* – CEPA), and has been in operation since the 1960´s. Throughout the years, there have been a number of expansions to the Port. Today it consists of eight berths distributed in three modern docks, and it is equipped for the arrival of various types of ships. Recently, the Acajutla Port facilities were upgraded through a modernization project, and the new facilities were inaugurated in April 2017. The upgrades included infrastructure projects, and the acquisition and installation of new operations equipment, including: a new radar; Closed Circuit Television; new scale for cargo trucks, placement of two hoppers; rehabilitation of 1,178 meters of perimeter fencing; and lighting improvement for Pier B. CEPA also remodeled the offices and warehouses and renewed its working vehicle fleet.	Ports, Harbors and Terminals
Acajutla Artisanal Fishermen Dock Remodel Project / Ministry of Agriculture (*Ministerio de Agricultura* – MAG)	Municipality of Acajutla, Department of Sonsonate / Power Plant	Operations / Planning	In February 2018, the Minister of Agriculture and Livestock announced[6] plans to remodel the Acajutla Artisanal Fishermen Dock, in support of the economic activities of the fishing sector. The project of more than 30 million dollars, is intended to improve the Productive Corridor in the coastal marine belt. No estimated timeframe was found.	Ports, Harbors and Terminals

[6] URL: http://www.mag.gob.sv/muelle-artesanal-de-acajutla-sera-remodelado-en-beneficio-de-los-pescadores/

Project Name / Company	Approximate Location / Nearest Project Component	Status	Project Summary	Industry / Sector
Aquaculture Center in Los Cóbanos / MAG	Municipality of Los Cóbanos, Department of Sonsonate / Power Plant	Construction and Operations	In February 2018, the Minister of Agriculture and Livestock also announced[7] that MAG will be supporting the Aquaculture Center in Los Cóbanos, located about 6.5 km south of Acajutla. The Center is working to increase their capacity to grow shrimp larva. The Center currently has a production capacity of approximately 21 million shrimp larvae per year, and it is expected to produce some 50 million larvae to supply the shrimp farmers of the country in 2018. The production capacities are being strengthened at the laboratory level. MAG is going to support the Center with its plans to cultivate snapper fish in ponds. No timeframe for the fish ponds project was found.	Aquaculture
Ahuachapán Geothermal Power Plant / LaGeo Grupo Cel	Municipality of Los Ausoles, Department of Ahuachapán / TL	Operations	The plant started commercial operation in September 1975 with 95 MW installed capacity, with two units that use steam at 5.6 bar, and one unit which differs from the first two because, in addition to steam at 5.6 bar, it uses steam of 1.6 bar produced in the vaporizers with water separated from the producing wells[8]. The area of the geothermal field in which the producing wells are located is approximately 2.5 km², the depth of the wells varies between 600 and 2,750 m, and currently has 56 wells drilled between producers, re-injectors, monitoring and others. The plant is located approximately 2.7 km away from Ahuachapán.	Renewable Energy - Geothermal

[7] URL: http://www.mag.gob.sv/muelle-artesanal-de-acajutla-sera-remodelado-en-beneficio-de-los-pescadores/
[8] URL: http://www.lageo.com.sv/?cat=1007

Table 4-2: Potential Impacts from Other Projects by Sector

Sector / Status	Other Projects	Main Sector-Specific Impacts
Crude Oil and Petroleum Product Terminals[9] / Operations	• Chevron Fuel Storage Terminal Expansion Project • Schafik Jorge Hándal Fuel Storage and Distribution Plant	**Environmental** **Air Emissions** – Emissions of volatile organic compounds (VOCs) may result from evaporative losses during storage, from operational activities such as filling, withdrawal, additive blending, and loading / unloading of transport links, and due to leaks from seals, flanges, and other types of equipment connections. **Wastewater** - Effluent from sewage and process wastewater. Process wastewater consists mainly of tank bottom draining (liquid effluent of oily water), and contaminated stormwater runoff (tank leaks and spills that collects in hydrocarbon contaminated secondary containment). Other possible sources of wastewater include oil contaminated water from washing tanker trucks and railcars. **Hazardous Materials and Oil** - Potential for leaks or accidental releases from tanks, pipes, hoses, and pumps during loading and unloading of products. **OHS** **Chemical Hazards Fire** – Occupational exposures may be most likely related to the dermal contact with fuels and inhalation of fuel vapors during fuel loading and unloading. **Explosions** – Fire and explosion hazards at crude oil and petroleum product terminals may result from the presence of combustible gases and liquids, oxygen, and ignition sources during loading and unloading activities, and/ or leaks and spills of flammable products. Possible ignition sources include sparks associated with the buildup of static electricity, lightning, and open flames. **Confined Spaces** – Confined spaces in crude oil and petroleum product terminals may include storage tanks, some secondary containment areas, and storm water/ wastewater management infrastructure. **Community Health and Safety / Social** **Public exposure to spills, fires, and explosions** – Community health and safety issues associated with the operations of terminal facilities may include potential public exposure to spills, fires, and explosions

[9] IFC (International Finance Corporation). 2007. Environmental, Health and Safety Guidelines: Crude Oil and Petroleum Product Terminals.

Sector / Status	Other Projects	Main Sector-Specific Impacts
		although the probability of large magnitude events directly associated with storage operations in well designed and managed facilities is usually low. **Visual Impacts** – One of the most significant visual changes attributable to crude oil and petroleum product terminals is the size of bulk storage tanks.
Ports, Harbors and Terminals[10] / Construction and Operations	• Acajutla Port • Acajutla Artisanal Fishermen Dock Remodel Project	**<u>Environmental</u>** **Air Emissions -** Mainly from diesel engines combustion exhaust emissions. In addition, air emissions are generated from land-based activities involving the use of vehicles, cargo handling equipment, and other engines and boilers. **Terrestrial and Aquatic Habitat Alteration and Biodiversity** - Alteration of coastlines for construction of breakwaters, shipyards, dockyards, wharves, piers, and vessel berths; and the transformation of the seabed through dredging. These activities, may result in alteration of terrestrial, freshwater, brackish and marine habitats, with impacts to flora and fauna and related biodiversity. Other adverse changes can include land erosion, sediment transport and deposition, and coastal inundation profiles. **Water Quality** - Construction and operation activities (i.e. maintenance dredging, ship maintenance, and ship effluent disposal) can result in increased turbidity via suspension of sediment in the water column. **Wastewater (Port Sewage, Stormwater, and Ship Wastewater)** - Wash water from land- and sea-based activities may contain oily residues. Ship sewage and wastewater contains high levels of biochemical oxygen demand (BOD), total suspended solids, and coliform bacteria, and typically low pH levels (due to chlorination). Bilge water may contain elevated levels of BOD, chemical oxygen demand (COD), dissolved solids, oil, and other chemicals that accumulate because of routine operations. **Hazardous Materials and Oil Management -** Spills may occur due to accidents (e.g., collisions, groundings, fires), equipment failure (e.g., pipelines, hoses, flanges), or improper operating procedures during cargo transfer or fueling.

[10] IFC (International Finance Corporation). 2017. Environmental, Health and Safety Guidelines: Ports, Harbors and Terminals.

Sector / Status	Other Projects	Main Sector-Specific Impacts
		Waste - Inert solid waste from cargo packaging and from administrative offices, as well as hazardous or potentially hazardous waste associated with vehicle maintenance operations (paint, scrap metal, used lubricating oils, engine degreasing solvents). Wastes originating from ships may include oily sludge (addressed above under "Wastewater"), inert materials such as food packaging, and food waste. **Noise and Vibration** – *Terrestrial Noise* - Generated during land-based port and terminal construction activities (blasting, piling, dredging, reclamation, construction of breakwaters and access/internal roads). Excessive noise may also result from cargo handling, vehicular traffic, and loading/unloading of containers and ships. *Underwater Noise* - Generated from offshore pile driving, dredging, and ship traffic, during ports' construction and operational phases. Noise from these activities may adversely impact aquatic habitats and the health and behaviors of aquatic life, including fish, marine mammals, and sea turtles. **OHS** **Physical Hazards** – The main sources of physical hazards at ports are associated with cargo handling and the use of related equipment, machinery, and vehicles. **Chemical Hazards** – Port workers may be exposed to chemical hazards, especially if in direct contact with fuels or chemicals (including pesticides and fumigants), or depending on the nature of bulk and packaged products transferred in port activities. Work with fuels may present a risk of exposure to VOC via inhalation or skin contact during normal use or in the case of spills. Fuels, flammable liquid cargo, and combustible dust (e.g. from grain or coal) may also present a risk of fire and explosions. **Confined Spaces** – The potential for accidents among port workers varies among port facilities and activities: confined space hazards may arise in ship cargo holds, silos, sewage tanks, and water tanks. **Exposure to Organic and Inorganic dust** – Potential exposure to fine particulates is associated with handling dry cargo (depending on type of cargo handled, e.g., china clay, grain, and coal) and from roads. Occupational health and safety impacts associated with nuisance dust in ports are similar to those for other industries. **Exposure to Noise** – Noise sources in ports may include cargo handling, vehicular traffic, and loading/unloading containers and ships.

Sector / Status	Other Projects	Main Sector-Specific Impacts
		Community Health and Safety **Port marine safety** – Port operators have certain key responsibilities for the safe operation of ships, ranging from passenger safety to the safe access and maneuvering of chemicals and oil transporting ships inside the harbor and port areas. **Port security** – Port operators should have a clear understanding of their responsibilities, including international legal and technical obligations to provide security to passengers, crews, and personnel in port. **Visual Impacts** – Permanent and temporary installations and ships can make visual changes to the landscape. One of the most significant changes attributable to ports is nighttime illumination, depending on the proximity of the port and associated bulk storage facilities to sensitive land uses such as residential or tourist areas, excessive illumination may also result in changes to invertebrate flight paths and settlement/breeding patterns.
Thermal Power[11] / Operations	• Acajutla Thermal Power Plant • Termo Puerto Power Plant	**Environmental** **Air Emissions** - Emissions from the combustion of fossil fuels or biomass: sulfur dioxide (SO2), nitrogen oxides (NOX), particulate matter (PM), carbon monoxide (CO), and greenhouse gases (GHG). Heavy metals (e.g., mercury, arsenic, cadmium, vanadium, nickel), halide compounds (including hydrogen chloride and hydrogen fluoride), dioxins and furans, unburned hydrocarbons and other VOCs may be emitted in smaller quantities, but may have a significant influence on the environment due to their toxicity and/or persistence. SO2 and NOx are also implicated in long-range and trans-boundary acid deposition. Natural gas (LNG)-fired plants generally produce negligible quantities of PM and sulfur oxides, and levels of NOx lower than those from coal plants. **Water Consumption and Aquatic Habitat Alterations** - Combustion facilities using once-through cooling systems require large quantities of water which are discharged back to receiving surface water with elevated temperature. Withdrawal of such large quantities of water has the potential to compete with other important water uses such as agricultural irrigation, drinking water sources or maintaining other ecosystems

[11] IFC (International Finance Corporation). 2017. Environmental, Health and Safety Guidelines: Thermal Power Plants.

Sector / Status	Other Projects	Main Sector-Specific Impacts
		services. Withdrawal and discharge with elevated temperature may affect aquatic organisms, including phytoplankton, zooplankton, fish, crustaceans, shellfish, and many other forms of aquatic life. Aquatic organisms drawn into cooling water intake structures can be impinged or entrained. In some cases (e.g., sea turtles), organisms are entrapped in the intake canals. **Effluents** – *Thermal Discharges* - Direct effects: change to temperature regime and; lethal and sub-lethal responses of water body organisms; stimulation in productivity resulting in increased respiration rates; reduction in the dissolved oxygen. Indirect effects: changes in distribution, composition and growth rates of fish and macroinvertebrates; and altered nutrient and carbon cycling. *Liquid Waste* - Contamination arises from demineralizers; lubricating and auxiliary fuel oils; trace contaminants in the fuel; and chlorine, biocides, and other chemicals used to manage the quality of water in cooling systems. **Solid Waste** - Ash residues, particulates removed from exhaust gases and sludge may contain significant levels of heavy metals and some organic compounds, in addition to inert materials. **Hazardous Materials and Oil** - Hazardous materials stored and used at combustion facilities include solid, liquid, and gaseous fuels; air, water, and wastewater treatment chemicals; and equipment and facility maintenance chemicals (e.g., paint, certain types of lubricants, and cleaners). **Noise** - Principal sources: turbine generators; boilers; coal pulverizers; reciprocating engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; circuit breakers; and cooling towers. **OHS** **Non-ionizing radiation** – Combustion facility workers may have a higher exposure to electric and magnetic fields (EMF) than the general public due to working in proximity to electric power generators, equipment (including magnetic separators for solid fuels), and connecting high-voltage transmission lines. High-voltage overhead power lines typically contribute the greatest electric field impacts at a thermal power plant site, as most other potential sources on site are shielded by metallic coatings and earthed, which isolates the electric field almost totally.

Sector / Status	Other Projects	Main Sector-Specific Impacts
		Heat – Occupational exposure to heat occurs during operation and maintenance of combustion units, pipes, and related hot equipment. **Noise –** Noise sources in combustion facilities include the turbine generators and auxiliaries; boilers and auxiliaries, such as pulverizers; diesel engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; circuit breakers; and cooling towers. **Confined spaces –** Specific areas for confined space entry may include solid fuel ash containers, turbines, condensers, and cooling water towers (during maintenance activities). **Electric hazards –** Energized equipment and power lines can pose electrical hazards for workers at thermal power plants. **Fire and Explosion hazards –** Thermal power plants store, transfer, and use large quantities of fuels; therefore, careful handling is necessary to mitigate fire and explosion risks. In particular, fire and explosion hazards increase as the particle size of solid fuel is reduced. Particle sizes of solid fuel that can fuel a propagating explosion occur within thermal dryers, cyclones, baghouses, pulverized-fuel systems, grinding mills, and other process or conveyance equipment. **Chemical hazards –** Thermal power plants utilize hazardous materials, including ammonia for NOX control systems, and chlorine gas for treatment of cooling tower and boiler water. **Particulate matter (PM) –** PM is generated in handing solid fuels, additives, and SFCW (e.g., ash). PM may contain silica (associated with silicosis), arsenic (skin and lung cancer), coal dust (black lung), biomass dust (asthma and cancer) and other potentially harmful substances. **Community Health and Safety** **Water Consumption –** Power plants may use a range of cooling methods depending on the availability of water, which can compromise the availability of water for personal hygiene, agriculture, recreation, and other community needs.

Sector / Status	Other Projects	Main Sector-Specific Impacts
		Traffic Safety – Operation of a thermal power plant will increase traffic volume, in particular for facilities with fuels transported via land and sea, including heavy trucks carrying fuel, additives, etc. The increased traffic can be especially significant in sparsely populate areas where some thermal power plants are located.
Aquaculture[12] / Operations	• Aquaculture Center in Los Cóbanos / MAG	**Environmental** **Biodiversity** – *During Construction*: conversion of natural habitats (e.g., removal of mangroves, alteration of natural hydrology of lagoons). *During Operations*: potential release of alien species into natural environment; potential loss of genetic resources due to collection of larvae, fry, or juveniles for aquaculture production; potential release of artificially propagated seed into the wild; and development of antibiotic resistance in pathogenic bacteria that could then spread from farms to wild stock. **Contamination of Aquatic Systems** – For pond-based systems, construction can potentially generate soil erosion and sedimentation. Operation of pond-based systems could release effluents (i.e. wastewater discharges), which typically contains a high organic and nutrient load, suspended solids, and may also contain chemical residues including feed supplements and antibiotics. Impacts include: eutrophic zones within receiving waters, increased fluctuation of dissolved oxygen levels, and creation of visible plumes. **Hazardous Materials** – The aquaculture sector may involve the handling and use of hazardous materials (e.g. oil, fertilizers, and other chemicals). **OHS** **Physical Hazards** – A number of hazards are connected with the daily working routines in aquaculture, including heavy lifts, electric shock, and drowning. **Exposure to Chemicals** – A variety of chemicals may be used in the operation of an aquaculture facility to treat and / or control disease organisms or to facilitate production (e.g. lime, diluted chlorine, or salt). Fertilizers are also generally caustic materials and care should be taken in their application.

[12] IFC (International Finance Corporation). 2007. Environmental, Health and Safety Guidelines: Aquaculture.

Sector / Status	Other Projects	Main Sector-Specific Impacts
		Exposure to Water borne disease – Workers may be directly or indirectly exposed to water-borne diseases due to frequent contact with water (ponds) and the close proximity of living quarters to surface water bodies. **Community Health and Safety** **Salinization of neighboring agricultural land** – Salt water intrusion can affect drinking and agricultural water supplies. **Effects on water resources** – Water resources used in aquaculture may include the sea, estuaries, rivers, lakes, and groundwater. The extraction of water from these resources may result in changes to the natural water regime, potentially affecting fish stocks and commercial / recreational activities (e.g. fisheries and recreational activities downstream of the extraction point), or the availability and quality of groundwater. Aquaculture operations may act as breeding grounds for different insects, especially the mosquito and tsetse fly, thus increasing the risk of insect-borne disease among communities in the region. **Food safety impacts and management** – The main veterinary drugs used in aquaculture are antibiotics, employed to prevent and treat bacterial diseases. Antibiotics are generally administered in feed, having either been added during manufacture or surface-coated onto the pellets by the manufacturer or the farmer. The development of antibiotic resistance by pathogenic bacteria may arise when bacteria acquire resistance to one or more of the antibiotics to which they were formerly susceptible. **Physical Hazards** – Communities may be exposed to a number of physical hazards, including drowning, associated with the presence of pond systems or other project infrastructure in proximity or in between community areas, requiring frequent crossing and physical interaction.
Renewable Energy - Geothermal[13] / Operations	• Ahuachapán Geothermal Power Plant / LaGeo Grupo Cel	**Environmental** **Effluents** - Drilling fluids may be water or oil based, and may contain chemical additives. Cuttings from oil-based mud contain oil-related contaminants and may necessitate special on-site or off-site treatment and disposal. Another potential source of effluent is the spent geothermal fluids, which consist of the reject

[13] IFC (International Finance Corporation). 2007. Environmental, Health and Safety Guidelines: Geothermal Generation

Sector / Status	Other Projects	Main Sector-Specific Impacts
		water from steam separators, and condensate derived from spent steam condensation following power generation. **Air Emissions** - Geothermal power plant emissions are negligible compared to those of fossil fuel combustion-based power plants. Hydrogen sulfide and mercury are the main potential air pollutants associated with geothermal power generation employing flash or dry steam technologies. **Solid Waste** - Geothermal technologies do not produce substantial amounts of solid waste. Sulfur, silica, and carbonate precipitates are typically collected from cooling towers, air scrubber systems, turbines, and steam separators. This sludge may be classified as hazardous depending on the concentration and potential for leaching of silica compounds, chlorides, arsenic, mercury, vanadium, nickel, and other heavy metals. **OHS** **Geothermal gases** – Occupational exposure to geothermal gases, mainly hydrogen sulfide gas, may occur during non-routine release of geothermal fluids (for example, pipeline failures) and maintenance work in confined spaces such as pipelines, turbines, and condensers. **Confined spaces** – Confined space entry by workers and the potential for accidents may vary among geothermal facilities depending on design, on-site equipment, and presence of groundwater or geothermal fluids. Specific and unique areas for confined space entry may include the turbine, condenser, and cooling water tower (during maintenance activities), monitoring equipment sheds (during sampling), and the well hole "cellar" (a subsurface depression created for drilling purposes). **Heat –** Occupational exposure to heat occurs during construction activities, and during operation and maintenance of pipes, wells, and related hot equipment. Non-routine exposures include potential blowout accidents during drilling as well as malfunctions of the steam containments and transport installations. **Noise –** Noise sources in geothermal facilities are mainly related to well drilling, steam flashing and venting. Other sources include equipment related to pumping facilities, turbines, and temporary pipe flushing activities. Temporary noise levels may exceed 100 dBA during certain drilling and steam venting activities. **Community Health and Safety**

Sector / Status	Other Projects	Main Sector-Specific Impacts
		Exposure to hydrogen sulfide gas – In addition to the exposure to hydrogen sulfide gas mentioned in the occupational health and safety above, the potential exposures could also affect members of the community. **Infrastructure safety** – Communities may be exposed to physical hazards associated with the wells and related pipeline networks. Hazards may result from contact with hot components, equipment failure, or the presence of active and abandoned well infrastructure which may generate confined space or falling hazards. **Impacts on water resources** – The extraction, reinjection, and discharge of geothermal fluids may affect the quality and quantity of surface and groundwater resources. Examples of specific impacts include the unplanned introduction of geothermal fluids into shallower productive aquifers during extraction and reinjection activities or a reduction in the flow of hot thermal springs due to withdrawal activities.
Renewable Energy - Solar[14] / Construction and Operations	• Bósforo Solar Photovoltaic (PV) Project - Phase II • Remedios and Sonsonate Solar PV • Trinidad and Márquez PV Project	**<u>Environmental</u>** **Impact on Habitat** - Solar PV projects use large amounts of land (typically at least five acres per MW). Long-term displacement and fragmentation of habitat may occur as a result of the installation of the solar array itself, construction of access roads, and power transmission line construction. The natural areas where solar projects are to be sited could be adversely impacted in the short-term from sedimentation and erosion caused during construction. **Panel Disposal** - While solar modules can last up to thirty years, a significant quantity of material needs to be disposed of at the end of the life of the modules. Because modules can contain potentially hazardous materials and many countries lack adequate disposal facilities, consideration should be given at the start of a solar PV project as to how units will be disposed of at the end of their useful life. Similarly, projects with battery storage must address disposal of batteries at the end of their useful life. **Visual Impacts** - Visual impacts associated with solar PV projects typically concern the appearance of the solar modules and their interference with the character of the surrounding landscape, particularly to nearby residential communities. Additionally, sometimes reflection from the module surfaces exacerbates visual impacts from a project.

[14] OPIC (Overseas Private Investment Corporation). 2012. Environmental Guidance Renewable Energy): Solar Projects

Sector / Status	Other Projects	Main Sector-Specific Impacts
		Occupational Health and Safety **Electric Shock** – There is a danger of electric shock related to combiner boxes, disconnect switches, inverters, or transformers; or otherwise coming in contact with voltages over 50 Volts. Another electrical hazard is an arc flash, which is an explosion of energy that can occur in a short circuit situation. This explosive release of energy causes a flash of heat and a shockwave, both of which can cause serious injury or death. **Fire** – Flammable components of PV panels include the thin layers of polymer encapsulates surrounding the PV cells, polymer back sheets (framed panels only), plastic junction boxes on rear of panel, and insulation on wiring. However, concern over solar fire hazards should be limited because as described only a small portion of materials in the panels are flammable, and those components cannot self-support a significant fire. **Community Health and Safety** **Hazardous materials concerns** – One of the more common concerns towards solar is that the panels consist of toxic materials that endanger public health. However, solar energy systems may contain small amounts of toxic materials, but these materials do not endanger public health. **Electromagnetic fields (EMF)** – Photovoltaic systems do not emit any material during their operation; however, they do generate electromagnetic fields (EMF), sometimes referred to as radiation. EMF produced by electricity is nonionizing radiation, meaning the radiation has enough energy to move atoms in a molecule around (experienced as heat), but not enough energy to remove electrons from an atom or molecule (ionize) or to damage DNA. Modern humans are all exposed to EMF throughout our daily lives without negative health impact. Someone outside of the fenced perimeter of a solar facility is not exposed to significant EMF from the solar facility. Therefore, there is no negative health impact from the EMF produced in a solar farm.

4.2. EXTERNAL DRIVERS

4.2.1. Climate Change and Natural Hazards

Climate change projections for El Salvador predict increased air and sea temperature, change in the precipitation intensity-frequency regime, and increasing sea levels. Climate variability poses economical and health concerns, including increased drought durations, decreased water quality, increase risk of disease, crop loss and failure, infrastructure damage, disruption of energy services, biodiversity loss, land degradation, increased erosion, and reduced mangrove habitat. Furthermore, El Salvador is prone to various natural hazards that have significant environmental, social, and economic impacts. Climate change has the potential to intensify the impacts from El Salvador's natural hazards, as well as those caused by the country´s extensive deforestation (e.g. severe soil erosion).

El Salvador's location makes the country prone to both Pacific and Atlantic hurricanes. Extreme climate events have become more frequent in El Salvador (MARN 2013; USAID 2017), and future events and impacts have been forecasted to intensify (ThinkHazard 2017). The coastal regions of El Salvador are the most susceptible to flooding (MARN 1998; ThinkHazard 2017), making the area vulnerable to extreme weather events. The seismic activity in the region can cause tsunamis, which not only lead to flooding but also damage ports and infrastructure. Furthermore, the coastal areas are vulnerable to sea level rise.

El Salvador is located in one of the active seismic regions of the world. Seismic activity accounts for the country's highest loss and damage, resulting in an annual average loss of US$ 175.93 million (0.70% of GDP) (The World Bank, 2016). While the entire country is at high risk of seismic activity (ThinkHazard, 2017), the Sonsonate and Ahuachapán departments have a particularly high risk of loss due to both vulnerable structures and earthquake intensity (The World Bank, 2016).

El Salvador also experiences volcanic activity, which release gases, lava, pyroclasts and lahars. Its most active volcanoes (Santa Ana and Izalco), and the volcanoes most likely to impact the Project are located approximately 24 km from the city of Ahuachapán, which is within range for receiving coal ash in case of an eruption. The TL is approximately 18 km from the Izalco volcano and 19 km from the Santa Ana volcano.

Landslides, which are induced by saturated soils and/or seismic movements, pose a hazard for areas in the hills, mountain slopes, and areas with alluvial formations. Changes in precipitation and temperature could alter the stability of soil and increase the frequency of landslides (MARN 2013). The Project is not located in high-risk areas, except for part of the TL that crosses through alluvial formations.

4.2.2. Coastal Solid Waste Pollution

Sonsonate coastal-marine ecosystems, in particular Acajutla beaches, experience high levels of solid waste pollution from several anthropogenic sources. The main sources of solid waste pollution are discharge of contaminated water and sediments from the Sensunapán River and

others, which transports municipal discharge and solid waste (i.e., garbage) from the cities of Sonsonate, Acajutla, and other populations in the watersheds (Juayúa, Salcoatitán, Sonzacate, San Antonio del Monte, Nahuizalco) (EDP 2016).

Local residents tend to dispose of their domestic waste in unofficial open-air waste dumps around the cities, and along the river beds. El Salvador´s Environmental and Natural Resources Ministry (MARN), in collaboration with the municipalities in Sonsonate Department, are taken action to clean up and eliminate open-air dumpsites, and promoting public education regarding waste management[15].

The Acajutla municipality has two garbage trucks and provides garbage collection services for the city. However, the majority of households (71.3%) do not have access to garbage collection services, which leads the improper disposal of garbage.

5. VEC SELECTION AND DESCRIPTION

5.1. SELECTION OF VECS

The major environmental and social concerns related to the Project include the potential for impacts on biodiversity (both marine and terrestrial systems); worker health and safety; and impacts related to land acquisition, air quality, and noise (OPIC 2017). A factor to consider is that the Power Plant is located within an already industrialized area, and within the same airshed as other fossil fuel burning power plants.

All potentially eligible VECs were analyzed against the following criteria: (1) confirmed to be valued by an identifiable stakeholder group; (2) reasonably expected to be impacted by the Project (i.e., at least one potential impact significance rating of Minor or above); ***and*** (3) reasonably expected to be potentially impacted by some combination of other projects and external drivers. To be included in the CIA, the VEC had to meet all three criteria. Table 5-1 presents the results of this analysis, and highlights the VECs that are selected in the CIA.

Table 5-1: Selection of VECs

VEC	Valued by Stakeholders	Potentially Affected by the Power Plant Component of the Project [a]	Potentially Affected by the Transmission Line Component of the Project [a]	Potentially Affected by One or More Other Projects	Potentially Affected by One or More External Drivers
Selected VEC					
Terrestrial Biota (flora and fauna)	Yes	Yes	Yes	Yes	Yes
Coastal-Marine Biota (flora and fauna)	Yes	Yes	No	Yes	Yes
Land Traffic	Yes	Yes	Yes	Yes	No
Livelihood from Artisanal Fishing	Yes	Yes	No	Yes	Yes
Air Quality	Yes	Yes	No	Yes	No

[15] URL: https://www.elsalvador.com/noticias/nacional/363875/alcaldia-y-marn-buscan-erradicar-botaderos-de-basura/

VEC	Valued by Stakeholders	Potentially Affected by the Power Plant Component of the Project [a]	Potentially Affected by the Transmission Line Component of the Project [a]	Potentially Affected by One or More Other Projects	Potentially Affected by One or More External Drivers
Selected VEC					
Noise and Vibration	Yes	Yes	Yes	Yes	No
Marine Water Quality	Yes	Yes	No	Yes	Yes
VECs not Selected for CIA					
Land use (i.e., agriculture)	Yes	No	No	Yes	Yes
Community Health	Yes	No	No	Yes	Yes
Surface Water Quality (freshwater)	Yes	No	No	Yes	Yes

[a] At least one potential impact significance rating of Minor or above.

Several environmental and social receptors or components were not selected as potentially eligible for the CIA, in all cases because they were not reasonably expected to be significantly impacted by the Project.

5.2. VEC DESCRIPTION

This section summarized the VEC conditions. Due to the geographical variability between the Power Plant and the TL areas, the VEC conditions are described for each of these Project areas (if relevant). The information provided here is mainly based on the baseline conditions described in the two Project ESIAs – Power Plant (Energía de Pacífico 2014), and TL (ERM 2017).

5.2.1. Terrestrial Biota (flora and fauna)

Power Plant

Flora

- Pipeline Area - The arboreal flora of the study site is composed of 21 species belonging to 12 taxonomic families, mostly trees cultivated for ornamental use and some fruit trees. The area is used by CEPA as a rest or recreational site for CEPA workers and includes also land without use. *Caesalpinia bonduc*, a national "Threatened" species was reported.
- Thermal Power Plant - Characterized by plant communities such as chaparral, scrub, and savannahs, as well as some species of trees that typify the transition zone between dry tropical forest and hot humid tropical forest. Among the species of trees, shrubs, and herbs that typify this transition zone and that have been found in the place of study are: morro (*Crescentia alata*), white wattle (*Acacia colinsii*), wattle (*Machaerium biovulatum*), wattle hawthorn (*Acacia polyphylla*), deer standing (*Bauhinia ungulata*), deer hull (*Bauhinia aculeata*), chestnut (*Sterculia apetala*), Ceiba (*Ceiba pentandra*), river almond (*Andira inermis*) among others. The arboreal flora is composed of 21 species belonging to 8 families. In this area, the national "Threatened" species, *Sterculia apetala* ("chestnut") and *Maclura tinctoria* ("palo de mora") were reported. The shrub and herbaceous flora is composed of 42 species belonging to 24 families. The "Endangered" species *Dalbergia chontalensis* was also recorded in the area.

In the land where the construction of the plant is projected, different anthropogenic actions, like traces of fires, burning of garbage, and the use of land as a waste dump decrease the quality of the natural forest and disrupt the quality of air and soil in the area. Likewise, it was possible to observe the presence of plant species that are typical of disturbed areas, either by anthropogenic action or by natural factors that occur over time, among this vegetation are: guarumo (*Cecropia peltata*), capulín (*Muntingia calabura*), izcanal (*Acacia hindsi*i), and coyolillo (*Cyperus tenerrimus*).

In addition, some well-known medicinal species can be mentioned, food or other, among them: "five negritos", "uña de gato", "squirrel tail", "cotton", "melon". The land is currently fenced, so residents of the neighboring areas are not taking advantage of these species.

Fauna

- Amphibians and Reptiles - In the case of the pipeline area, the site presents a high anthropogenic disturbance due to its current use of the site. The baseline reported nine species of herpetofauna, among them, a species of amphibian and eight species of reptiles. Within these, two species are registered in the "Threatened" criterion according to MARN (2017) and a species is registered as "Exotic". Within the Thermal Power Plant area, 16 herpetofauna species where reported, among them, one species of amphibian and 15 species of reptiles. Three species are registered in the "Threatened" criterion according to MARN (2017).
- Birds - 53 species are reported, distributed in 30 families. The family best represented in terms of species richness was Tyrannidae with seven species, followed by Columbidae, Emberizidae, and Icteridae with four species each. Due to their abundance, the dominant species were *Pelecanus occidentalis*, *Mycteria americana*, *Columbine inca*, *Tyrannus melancholicusy, Zenaida asiatica*, while 26 species presented the minimum frequency (one individual). According to its seasonality, six categories were registered, of which the category "Resident" represents the largest number of species recorded in the study site that represents 83%, followed by the category "Resident-migratory" with 7%, "Migratory" with 4% and the rest with 2%. A total of seven active nests belonging to resident species of *Icterus pustulatus* were found (3), *Pachyrampus aglaiae* (1), *Crotophaga sulcirostris* (1), *Melanerpes aurifrons* (1) and *Campylorhynchus rufinucha* (1). According to MARN's vulnerability status (2017), none of the reported species is found within any conservation category, and according to the International Union for the Conservation of Nature (IUCN, 2016) all species are found in the status of “Least Concern”.
- Mammals - In the sector where the pipeline from the coast will be located, used zones were identified as corridors for the fauna that inhabits it, through which they have access to other areas bordering the coast and the CEPA facilities mainly. In this area, nine species of wild mammals were reported, both by direct and indirect observation. Also, three species of domestic mammals are reported among which find the "cat" (*Felis catus*), the "muskrat" (unidentified sp.) and the "common rat" (*Rattus rattus*). On the other hand, in the sector of the location of the Thermal Power Plant, the baseline reports presence of eight species of wild mammals. All wild species reported in the study, both in the proposed area for the

pipeline as that of the Thermal Power Plant, are in a state of conservation of "Least Concern" or "Data Inadequate" according to the IUCN Red List (2016), are not included in the list of threatened species and in danger of extinction of the MARN (2017), nor appear in the CITES appendices. Most of the species reported in both areas are habitat generalists, therefore, the occurrence in areas altered by man and in areas where the state of regeneration is high, is a phenomenon observed during the baseline study.

Transmission Line

Flora

Based on Landsat satellite images, the University of Maryland has analyzed the global forest cover for 2014 (Hansen et al., 2013). For the TL area, these images have coverage according to the density of woody elements (trees and shrubs). In the satellite images, there are areas that appear to be natural forests but which are actually shaded coffee plantations under tree cover. In the available images, it is not possible to determine whether a forest is natural or a coffee plantation. Based on measurements of sections with Google Earth Pro images of 2016, it is estimated that the remaining natural forest area within the easement strip is less than 18 hectares (ha) in total.

According to the 2004 National Land Use Inventory, there were areas of coffee plantations, natural forests, pastures, and urban areas within the TL area of influence.

Vegetation structure within the TL area of influence:

- Coffee plantations with multiple crops - This category is characterized by trees that are not very tall (8-10 m), with a large number of young, fruit trees and timber trees introduced to provide shade for coffee plants. This type of plantation produces rich and diverse structures in species, with great variety of trees. However, they are not very complex in their physiognomy and include many introduced species that are not from the region.
- Coffee plantations with single crops - In this type of coffee farm, trees of one or two species are often planted to shade coffee trees. These farms have the simplest structures: with a density of 216 trees per ha, with an average height of 4.8 m, with thin trunks of 17.7 m in diameter on average, without epiphytes, with an average coverage of 65%. The density of coffee plants per hectare is the highest on farms, and can reach 4,300 individuals per ha.
- Grassland - In these areas, the original vegetation has been transformed into agro-ecosystems that are used as pastures and growing areas. The sites are dominated by herbaceous vegetation from the Poaceae, Euphorbiaceae and Asteraceae families, and some tree species.

Many of the trees identified in the baseline inventory were only located along streams. Trees such as the cold-ground anona (*Annona muricata*), chaperone (*Lonchocarpus rugosus* ssp. *apricus*), nixtamal (*Margarita nobilis*), chulumuyo (*Rollinia mucosa*) and palanco (*Sapranthus palanga*) were only found growing on or nearby the beds of streams. Others, such as *Crudia acuminata*, grow in other areas, but are more common in streams. Vines such as *Aristolochia grandiflora* were only observed at these sites. These observations indicate the importance of streams as a micro habitat for forest conservation and restoration.

Fauna

- Amphibians and Reptiles - The TL baseline recorded a total of 15 species of amphibians and reptiles distributed in 11 families and 14 genera. Most of the registered species are common, with a wide distribution nationwide and a high adaptability to spaces disturbed by anthropogenic activity. However, the second most abundant species was the black-eyed tree frog (*Agalychnis moreletii*), a nationally "Threatened" species that is on the IUCN Red List as "Critically Endangered". The habitat with the greatest abundance of individuals and diversity of species was crop areas and the habitat with the least abundance was natural forest patches.
- Birds - A total of 39 species of birds belonging to 26 families were recorded. The majority of registered species are common, with a wide national distribution and a high adaptability to spaces disturbed by anthropogenic activity. However, the baseline recorded four species with national "Threatened" status. The most abundant species during this study were *Zenaida asiatica, Cathartes aura, Quiscalus mexicanus* and *Brotogeris jugularis*. Most species showed intermediate abundance and some had only one observation. The greatest number of species and individuals was registered in the areas of agricultural crops with a high degree of anthropic activity. In the coffee plantation area, the species *Brotogeris jugularis* is the predominant species, followed by *Calocitta formosa*. The first is the only species with nationally "Threatened" status recorded in coffee plantations. Tree species that provide shade for coffee provide shelter, food and nesting, and rest areas for both resident and migratory species.
- Mammals (non-flying) - A total of 14 species belonging to ten families of mammals were recorded, of which none are threatened or endangered in national or international lists. The greatest number of species was found in areas of natural forest. However, a greater number of individuals was obtained in the agricultural areas sampled. These areas registered a high number of individuals due to being adjacent to small rivers and streams where the species of this group find good conditions for their subsistence.
- Bats – A total of 14 bat species were recorded. The most abundant species was *G. commissarisi*, a nectarivorous species. Nine of the recorded species are frugivorous, including species of the genus *Artibeus, Dermanura* and *Sturnira* considered tolerant or adaptable to disturbed environments, so it is considered that the zones could shelter bushes (genera *Solanum, Piper, Cestrum*) or trees (genera *Ficus, Inga, Cecropia, Psidium, Spondias, Persea* among others) that can provide food for frugivorous species.

5.2.2. Coastal-Marine Biota (flora and fauna)

Power Plant

The Los Cóbanos Marine Protected Area (MPA) is located 6 km south of the Acajutla Port, and within the Project´s AOI. Its coral reef is considered one of the most productive in the world.

Flora

The baseline for the Power Plant ESIA cites Molina 1984, 1994, and 2004 as reporting 20 species of macroalga in the coral reef ecosystem, with the following dominant species: *Hypnea cervicornis, Oscillatoria, Limba spp, Lithotamnium spp, Padina vickersiae* y *Acanthophora spp*.

The baseline also reports 81 species of Macroalgae for the Los Cóbanos MPA, belonging to the divisions Chlorophyta, Rodophyta, and Phaeophyta. The dominant division is Rodophyta, with a total of 42 species.

Fauna

The Los Cóbanos MPA is one of the most biologically diverse areas in the country. A total of 1,032 species are recorded among invertebrates, vertebrates and arboreal vegetation as a result of research carried out in the intertidal zone (ICMARES 2007a). For the specific case of Los Cóbanos MPA, the following are some species of conservation interest for marine biodiversity: *Pocillopora spp, Psamocora spp, Strombus galeatus, Epinephelus itajara, Rhincodon typus, Sphyrna lewini, Eretmochelys imbricata,* and *Dermochelys coriácea*.

- Crustaceans - 14 species are reported in the Los Cóbanos MPA and 4 in Acajutla. Of particular interest, due to its commercial importance are: *Panulirus penicillatus* (langosta roja), and *Panulirus inflatus* (langosta azul).
- Fish - In the Los Cóbanos MPA, a total of 163 species were recorded in intertidal pools, open waters and estuarine-riverine habits. The main families are Pomacentridae, Serranidae and Lujanidae; and the last two are groups of high commercial value. In the area of artisanal fishing, fish from 9 families, 14 genera and 16 species of commercial importance are reported: *Lutjanus peru* (pargo), *L. guttatus* (guachinango), *L. argentiventris* (pargueta), *Hoplopagrus guentherii* (sardo), *Euthinnus lineatus* (atún negro), *Katsuwonus pelamis* (barrilete), *Scomberomorus sierra* (macarela), *Haemulon flaviguttatum* (naguilla), *Anisotremus interruptus* (berruguete), *Balistes polylepis* (tunco), *Caranx caninus* (quínoa), *Elagatis bipinnulata* (salmón), *Sectator ocyurus* (pichel), *Bagre pinnimaculatus* (bagre), *Coryphaena hippurus* (dorado), *Pseudupeneus grandiquamis* (salmonete).

  Fish censuses conducted in the period 2008-2013 by the MARN, in the reef area, obtained 63 species; among which the families Pomacentridae, Labridae and Haemulidae stand out. Outstanding by its dominance *Chromis atrilobata, Halichoeres dispilus, Herichthys steindachner, Stegastes acapulcoensis, Stegastes acapulcoensis, Anisotremus caesius, Stegastes flavilatus*.

  Of the 48 recorded fish species, *Selene peruviana* "caballo" "papelillo" and *Lutjanus gutattus* (lunarejo) are the most abundant. The latter, had low sizes of 21 centimeters (cm) when its maximum size is 80 cm, like the corvina (*C. reticulatus*) that was shown an average size of 25 cm, when its maximum size is 90 cm.
- Benthos - The benthic invertebrate community was dominated by the Phylum Annelida with 21 species, followed by Mollusca (6) and Echinodermata (6). The Phylum that presented less species was Porifera with one species.

- Marine Turtles - Of the eight species of sea turtles that are found worldwide, four occur and nest in the coast of El Salvador: *Lepidochelys olivacea* ("olive ridley turtle"); *Chelonia mydas* ("black or brown turtle"); *Eretmochelys imbricata* ("hawksbill turtle"); and *Dermochelys coriacea* ("turtle baule"). The IUCN has the Olive Ridley turtle listed as "Vulnerable", the Brown Turtle listed as in "Danger of Extinction" (EN), while the Hawksbill Turtle and the Baule Turtle are listed as in imminent danger of extinction throughout the Eastern Pacific.

  Both the Los Cobanos Reef system and the Barra de Santiago mangrove-estuary system are emblematic sites in terms of marine turtle conservation. In the case of Los Cóbanos, this MPA, together with the Bay of Jiquilisco, harbor one of the last populations of nesting females and at the same time it is a foraging site (feeding) of adults and youngsters of the *Eretmochelys imbricata* ("hawksbill") at a national and of the Eastern Pacific Ocean. This situation deserves special attention due to the strong interaction between the different discharges of the Acajutla Industrial Complex and its potential impact on the hawksbill turtles. Investigations conducted by satellite transmitters in 2008-2009 period reflect that adult hawksbill populations circulate between the Salvadoran and Nicaraguan coast (Estero de Padre Ramos), Los Cóbanos, Bahía de Jiquilisco and Golfo de Fonseca are emerging as the main sites of foraging of this species.

5.2.3. Land Traffic

Power Plant

Transportation, storage, and communications services constitute an important aspect for the generation of employment and income in the locality. This happens because the most important and modern port in the country is located in the Acajutla municipality. The city of Acajutla is linked by the Litoral highway with the municipalities of Sonsonate, Jujutla, and Guaymango. Cantons and hamlets are linked by local roads to the municipal seat.

Acajutla has a strategic geographical position, which promotes economic, social and industrial development. It has a very important port infrastructure for the country and the Central American region; a series of activities are generated around the port that allow the implementation of the industrial zone.

There is no regulation in the transport of cargo and light within the municipality. During the Power Plant baseline study, light and heavy-duty vehicles were counted for 24 hours. There is a moderate flow of cargo and transit vehicles for the port of Acajutla, the roads therefore have sufficient capacity for the increase of traffic that the Project can generate.

At the national level, statistics present high rate of traffic accidents. In 2008, the Department of Sonsonate recorded 321 traffic accidents in the municipality of Sonsonate, with 146 victims. Pedestrians were the most affected by accidents (58%), followed by vehicle drivers (24%).

Transmission Line

In the last 10 years, El Salvador has managed to build a paved road network with reasonable levels of service. However, the distribution throughout the territory is not uniform, particularly in

the rural area. The state of the rural network becomes critical in the six months (May to October) of the rainy season of each year, reducing accessibility, limiting the development of productive activities or access to basic social services, as well as increasing transport costs and travel times. In relation to the internal routes of the municipalities of the Project AOI, most of the roads are in poor condition or are inaccessible at certain times of the year.

During interviews with local residents, the opinions regarding the vehicular flow were varied. In Acajutla they did not have nationally managed statistics in the municipality. However, according to their own calculations, 60% was industrial traffic, 25% was population traffic, 10% was collective services, and 5% corresponded to passenger cars. In Santo Domingo and in Sonsonate they did not have statistics or information on traffic and traffic flow, however traffic accidents were not deemed common.

There are no specific statistics of the Project area and access roads to this area. However, according to the information collected in the field, in the department of Ahuachapán there are approximately 35 traffic accidents per month. The vast majority of these accidents are minor collisions. The main causes of these collisions are excessive speed or drunk drivers. In the first three months of 2016, 148 accidents were reported in the department of Ahuachapán.

According to the information provided by the social promoter of the municipality of Acajutla, the majority of traffic accidents are caused by speeding, lack of respect to traffic signs, lack of road safety, and the imprudence of pedestrians.

5.2.4. Livelihood from Artisanal Fishing

Power Plant

In Acajutla, one of the most important economic activities for residents of the coastal-marine areas correspond to fisheries, in particular the extraction of marine fish, mollusks, and crustaceans.

As documented in the Power Plant ESIA, small-scale fisheries (artisanal fisheries) account for 50% of El Salvador's total fish production. It is estimated that the country has about 13,000 marine fishermen with 5,700 boats, as well as 34 cooperatives and two federations. The most commonly used boats have 18 to 25 feet in length with outboard motors. Fishing without boats (by immersion or by using floating equipment "Tuberos") is also practiced by local fishermen when fishing for shellfish, lobsters, and finfish.

The following are the fishermen cooperatives within the CIA spatial boundary:

- *Asociación Cooperativa de Producción Pesquera del Puerto de Acajutla* (ACOOPPAC DE RL);
- *Cooperativa de Produccion Pesquera Rederos de Acajutla* (ACPPRA DE RL), all of which are active fishermen (members share boat use - not all members own their own boat);
- *Asociación Cooperativa de Producción Pesquera Tiburoneros de Alta Mar* (ACPETAMAR); they carry out most of their fishing activities in the open sea, far from the Project area.

- *Asociación Cooperativa de Producción Agropecuaria y Pesquera Camaroneros de Acajutla* (ACOOPESCA), primarily engaged in shrimp fishing, in an area far from the Project area.
- Oyster fishermen, working in the near-shore swimming / diving areas; and
- Fishermen who use floats as a means of fishing up to 500 m from the coast ("Tuberos"). The Tuberos, as they are known, have the habit of "paddling" buoys (such as the Cenergica discharge installation buoys), where they can tie and fish.

The fishermen of the cooperatives that fish in boats travel up and down the coast to be able to fish. The main fishing area of this group is large, about 5 km to the south and about 25 km to the north, but they also carry out activities in the open sea, far from the coast. The fishermen pointed out that the southern part of their fishing areas is used more frequently. Through consultations carried out during the Power Plant ESIA process, fishermen indicated that in recent years, in general, catches have been reduced, and as a result, income has also been reduced.

5.2.5. Air Quality

Power Plant

According to the Power Plant´s baseline study, the Project area presents relatively high levels of ambient air pollution, mainly particulate matter (PM). This is probably due to this being an industrial and port area.

Within the department of Sonsonate, where the Project is located, there are no air quality monitoring stations operated by the MARN. The air quality information for the entire study area is limited and focuses only on the municipality of Acajutla. According to the Power Plant ESIA, a baseline air quality monitoring was carried out for the following parameters: nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), total suspended particles (PST), particulate matter less than 10 micrometers (PM_{10}) and particulate matter less than 2.5 micrometers ($PM_{2.5}$). Table 5-2 summarizes the results from the baseline monitoring. The parameters monitored were compared with the air quality criteria established in the local guide entitled NSO 13.11.01: 01 - Air quality and Ambient Atmospheric Emissions (Official Gazette, 2003) and the IFC´s EHS Guidelines (IFC 2007). The location of the monitoring site in Acajutla was selected considering the proximity to sensitive receptors (houses, schools), and presence of other significant sources of emissions (e.g., port, existing power station).

Table 5-2: Ambient Air Monitoring Results - 2016

Duration	NO_2 ($\mu g/m^3$)	NO_2 National Standard* ($\mu g/m^3$)	CO ($\mu g/m^3$)	CO National Standard ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	$PM_{2.5}$ National Standard ($\mu g/m^3$)
1-hour	--	--	540.91	40,000	--	--
8-hours	--	--	457.76	10,000	--	--

24-hours	11.0	150	--	--	17.93	65
Annual	2.11	100	--	--	3.44	15

Notes: *Norma Salvadoreña NSO 13.11.01:01

Fuente: EDP ESIA 2016

Transmission Line

In general terms, the air quality throughout the TL study area is good, given the conditions that prevail in the natural environment (pastures and natural vegetation, as well as agricultural and farming land). The main sources of pollution throughout the TL study area, but which have not yet affected air quality, are the combustion of transport units (public and private) and the non-continuous, or controlled, burning of solid waste from the main urban centers near the study area (Ahuachapán, Concepción de Ataco, Apaneca, San Pedro Puxtla and Santo Domingo). However, for the Acajutla area, air quality is also influenced by local industrial sources, such as the existing power plants and port activities, as well as seasonal agricultural activities (e.g., the burning of cane crops during harvest time, field cultivation and preparation).

5.2.6. Noise and Vibration

El Salvador does not have noise standards and therefore the threshold levels established in IFC's EHS Guidelines (2007) were used to compare noise levels measured under existing conditions. According to the IFC (2007) the noise levels generated by a project should not exceed the levels shown in Table 5-2 or result in a maximum increase of no more than 3 dBA of background noise at the nearest receptor. The IFC guidelines identify two classes or groups of receptors: (i) residential or institutional and educational; and (ii) industrial and commercial.

Table 5-2: IFC´s Threshold Levels for Environmental Noise

Receptor	1-Hour Laeq (dBA)	
	Diurnal (07:00 – 22:00)	Nocturnal (22:00 - 07:00)
Residential, institutional, educational	55	45
Industrial, comercial	70	70

Power Plant

Similar to air quality, the Power Plant baseline study found high levels of noise when comparing the results from the Project area with the IFC EHS Guidelines limits.

The maximum noise levels (62.6 – 67.3 dBA) measured during the day (0700 hrs to 2200 hrs) at all monitoring locations were above the IFC guideline of 55 dBA (daytime). Therefore, the Project´s daytime noise criteria applicable for residential areas in the vicinity of the Project

would be the IFC-EHS guideline of 55 dBA. During night measurements (2200 hrs at 0700 hrs), both the maximum (58.9 – 63.9 dBA) and minimum (43.9 – 55.5 dBA) noise levels registered values above the IFC guideline of 45 dBA (night) for most of the monitoring stations except location L4. Monitoring station L4 is located the furthest away from the existing Duke Energy plant, and the minimum noise levels recorded were below the World Bank guideline of 45 dBA (night).

Transmission Line

According to the TL ESIA noise baseline studies (ERM 2017), the noise levels in this area are indicative of an acoustic environment dominated by low frequency noise with some tonal characteristics. The low-frequency aspect of noise is most noticeable at night, when background noise due to road traffic or urban buzz in general is lower and the dominant noise source is the Acajutla Thermal Power Plant (Duke Energy). In general, noise sources in the study area correspond mainly to rural settlements and to low-moderate traffic typical of natural and agricultural areas. The main sources of noise come from the road to Acajutla and small urban centers near the project's study area (e.g. Ahuachapán, Concepción de Ataco, Apaneca, San Pedro Puxtla and Santo Domingo).

5.2.7. Marine Water Quality

Power Plant

Even though it is located on an industrial area, the water quality in Acajutla is categorized as very good. To determine the water quality of the Project area, subject to discharges from the Acajutla Industrial Complex, three seawater quality monitoring campaigns were carried out during three consecutive years, called: Campaign 2014, Campaign 2015 and Campaign 2016 respectively. The analysis of permissible limits was based on the available information. For the evaluation of the data obtained, the Salvadoran Standard CONACYT NSO 13. 49. 01:09 and the Cuban Standard NC 521: 2007 were taken into consideration.

- pH – Results for this parameter were within the normal range for marine life.
- Salinity – The average salinity recorded for Acajutla´s coastal marine area was 32.9 ±0.27 for 2014, 33.2 for 2015, and 32.08 for 2016. The salinity levels registered for Acajutla are adequate for sustaining marine life.
- Dissolved Oxygen (DO) – Average DO was 7.0 ±0.55 in 2014; 7.55 ±0.05 in 2015; and 7.12 ±0.44 in 2016. DO values lower than 5 mg/l may lead to stress for aquatic life. Therefore, DO levels registered for Acajutla are adequate for sustaining marine life.
- Turbidity – Turbidity was measured using a Secchi dish. The coastal-marine áreas of Acajutla recorded the following turbidity levels: 2.8 mm ±0.54 mm in 2014; 3.15 ±0.17 m in 2015; and 2.84 ±1.61 m in 2016. Turbidity levels registered for Acajutla are adequate for sustaining marine life.
- Temperature – The temperature levels registered for Acajutla, between 20 and 30 °C, are adequate for sustaining marine life.

- Biochemical Oxygen Demand (BOD) – The average BOD concentration for Acajutla was 1,487 mg/lt ± 68.93 in 2014; 1,447±175 in 2015; and 566 in 2016. The results show concentrations above the permissible levels (BOD = 600 mg/lt) according to norm NSO 13.49. 01:09 CONACYT. These BOD values are considered adverse for sustaining marine life.
- Fenols – Values within the permissible limits.
- Sulfur – All samples registered values within the permissible limits. According to the concentration range recorded for the area, corrosion of iron infrastructure in marine water would append a rate of 0.12 µm/year.
- Chlorides – Values within normal range for marine water.
- Biological parameters (total coliforms, fecal coliforms) – Values are higher than the national permissible limits at monitoring stations located closer to the Acajutla Port. Stations located further away register values within the limits.

6. ASSESSMENT OF CUMULATIVE IMPACTS

Table 6-1 summarizes the results of the assessment of cumulative impacts identified for the selected VECs. For the CIA, the potential impacts from the two components of the Project (Power Plant and TL) are discussed separately given their differences in geography and potential impacts. The potential impacts from other projects that are within the same industry or sector are discussed together. Based on the potential cumulative impacts, a priority ranking is established for each VEC (see Section 3.7 for priority definitions).

In summary, no High priority cumulative impacts were identified. Medium priority cumulative impacts, where VECs could potentially be impacted by other projects and/or external drivers and the Project could potentially contribute to the adverse impact ,were identified on the following VECs: Coastal-Marine Biota; Livelihood from Artisanal Fisheries; Noise and Vibration (from low frequency noise). All other VECs are deemed as Low priority cumulative impacts, where the VECs could potentially be impacted by other projects and/or external drivers, but the Project would not be expected to contribute to the adverse impact or its contribution is expected to be negligible.

Table 6-1: Summary of Cumulative Impact Assessment

VEC	Potential Impacts from the Power Plant Component of the Project	Potential Impacts from the Transmission Line Component of the Project	Potential Impacts from Other Projects	Potential Impacts from External Drivers	Cumulative Impact	Priority Ranking
Terrestrial Biota (flora and fauna)	During Construction, activities such as pipeline installation, vegetation removal, soil movement, and use and storage of hazardous waste and materials may result in distribution and habitat changes for terrestrial fauna, death of fauna from collision with vehicles and elimination of terrestrial flora within the Project´s layout including access roads and laydown area. During Operations, activities such as routine maintenance, reception and delivery of LNG, generation of electricity, storage and use of hazardous waste and materials, could cause the following potential impacts: hazardous materials spills on the ground, habitat loss, increased noise and vibrations, air emissions, and increased exposure to light. The disturbances described above could result in vegetation cover loss and distribution changes for the fauna found in the Power Plant area. Mammals and birds are largely mobile, and most of the bird species identified during the baseline are considered resident species that nest in the same area every year, and most species are also generalists in their diets, which makes them less vulnerable to anthropogenic intervention. Therefore, it is not expected that the Power Plant construction and operations phases would result in an overall reduction in their abundance and diversity in the coast of Acajutla. The impact is considered **Minor.** Potential impact on less mobile species, such as the 16 species (three of them classified as Endangered by MARN) of herpetofauna identified in the area, would be considered **Moderate**. There will be loss of flora, and EDP will carry out a reforestation and replantation effort, that would over time result in a net gain in arborous cover. The impact is considered **Positive**.	During Construction, activities such as soil movement and compaction, construction of new access roads, and transportation of machinery, equipment and parts could result in loss of vegetation cover. The impact on vegetation cover loss is considered **Minor**. To compensate for the loss of flora, EDP will carry out a reforestation and replantation effort that would, over time, result in a net gain in arborous cover. The residual impact would be **Insignificant** or **Positive**. As with the Power Plant, the disturbances described above could result in distribution changes for the fauna along the TL. For mobile animals such as birds and mammals, the impact would be considered **Insignificant**, and for less mobile species like *Agalychnis moreletii* (*"rana de ojos negros"*), the impact would be **Moderate**. During Operations, activities such as routine maintenance, transmission of electricity, could cause the following potential impacts: hazardous materials spills on the ground, habitat loss, increased noise and vibrations, bird collisions with transmission lines. To address potential bird collisions, EDP will install avian collision averters throughout the portion of the TL that crosses through the Los Cóbanos Important Bird Area (IBA). The residual impact is estimated as **Insignificant**.	*Chevron Fuel Storage Terminal Expansion Project* and *Schafik Jorge Hándal Fuel Storage and Distribution Plant*: Construction activities could disturb fauna in the area causing distribution and habitat changes from altered terrestrial habitats. The movement of trucks and heavy machinery could result in collisions with fauna. During Operations, potential impacts include artificial lights can attract birds, collisions with project vehicles, and oil contaminated wastewater that could be discharged to the bay and potentially contaminate both water and soil. *Acajutla Port*: During Operations, potential impacts on soil include discharge from land-based activities such as vehicle maintenance and washing, fuel and material storage and transfer. *Acajutla Thermal Power Plant and Termo Puerto Power Plant:* During Operations, the power plants can generate low frequency noise and vibrations that could disturb local fauna (e.g. nesting birds). Their associated transmission lines could cause bird collisions. *Aquaculture Center in Los Cóbanos*: Threats to biodiversity are mainly associated with conversion of natural habitats during construction (e.g. removal of mangroves, alteration of natural hydrology of lagoons, etc.). *Photovoltaic Plants (Bósforo, Remedios and Sonsonate, Trinidad and Márquez):* Solar PV projects use large amounts of land (typically at least five acres per MW). Long-term displacement and fragmentation of habitat may occur as a result of the installation of the solar array itself, construction of access roads, and power transmission line construction. The natural areas where solar projects are to be sited could be adversely impacted in the short-term from sedimentation and erosion caused during construction.	*Climate Change and Natural Hazards*: Rising temperatures associated with longer-term global climate change could potentially affect some special status species' ranges. *Coastal Solid Waste Pollution*: The Sonsonate coastline, including Acajutla, receive loads of solid waste transported to the beach through discharge from rivers that carry it from the cities across the watersheds. During the rainy season, the conditions worsen since many residents deposit their garbage in open dumps that are easily carried by water and end up washing up in the coast-line. The local municipalities do not have effective waste management programs, nor the capacity to process all the solid waste produced by its cities. Therefore, the existing system cannot handle additional waste produced by large industrial developments in the area. Solid waste that accumulate in coastal ecosystems (i.e. beaches) can potentially harm the local terrestrial fauna, such as birds nesting in the area.	The Project, other projects, and external drivers could have potential negative impacts on terrestrial flora and fauna. Effects and disturbances caused by construction activities would be short-term and reversible. The Project embedded controls and management plans, including the reforestation program, would mitigate potential impacts to an acceptable level (mostly **Minor** or **Insignificant**). Additionally, the potential impacts are localized to the Project area within the larger CIA spatial boundary. In sum, the Project could potentially contribute incrementally to the adverse impact, but further VEC conversion and/or degradation is not likely to occur, or the Project´s contribution would be expected to be negligible.	**Low**
Coastal-Marine Biota (flora and fauna)	During Construction, activities such as dredging and pile driving, may result in distribution and habitat changes for marine fish, corals, mollusks, marine	This VEC would not be potentially impacted by the TL.	*Chevron Fuel Storage Terminal Expansion Project* and *Schafik Jorge Hándal Fuel Storage and Distribution Plant*: Construction activities could cause auditory impacts from pile driving,	*Climate Change and Natural Hazards*: Rising temperatures associated with longer-term global climate change could	The Project, other projects, and external drivers could have potential negative impacts on coastal-marine fauna and flora species. A number of the other projects	**Medium**

VEC	Potential Impacts from the Power Plant Component of the Project	Potential Impacts from the Transmission Line Component of the Project	Potential Impacts from Other Projects	Potential Impacts from External Drivers	Cumulative Impact	Priority Ranking
	mammals and turtles, and benthic invertebrates. These activities could increase suspended sediments in the water environment (increasing turbidity), noise and vibration, artificial light, risk of spills of hazardous waste or materials into the water environment. During Operations, activities such as maintenance dredging, reception and delivery of LNG, water intake for plant cooling systems, storage and use of hazardous waste and materials, could cause the following potential impacts: hazardous materials spills on water, habitat loss, increased noise and vibrations, increased exposure to light, increase suspended sediments in the water environment (increasing turbidity). The disturbances described above could result in distribution changes of fish and marine mammal and turtle communities, and by potential impacts on the coral and mollusk (i.e. oysters) communities in the area. Because fish, marine turtles and marine mammals are largely mobile, the marine terminal construction and operations phases would not result in an overall reduction in their abundance and diversity in the coast of Acajutla. Hence the impact is considered **Minor.** Potential impact on less mobile species, such as corals and mollusks, would be considered **Moderate**.		distribution and habitat changes from altered bottom habitats by dredging. During Operations, potential impacts include artificial lights can attract marine birds, collisions with ships, and oil contaminated wastewater that could be discharged to the bay. *Acajutla Port*: During Operations, potential impacts include underground noise and vibration from ship traffic and maintenance dredging activities. Discharge of ship-generated effluents such as sewage, ballast water, vessel-cleaning water. Also, discharge from land-based activities such as vehicle maintenance and washing, fuel and material storage and transfer. *Acajutla Thermal Power Plant and Termo Puerto Power Plant:* During Operation, withdrawal and discharge with elevated temperature and chemical contaminants such as biocides or other additives, if used, may affect aquatic organisms. Aquatic organisms drawn into cooling water intake structures could be impinged on components of the cooling water intake structure or entrained in the cooling water system itself. In the case of either impingement or entrainment, aquatic organisms may be killed or subjected to significant harm. In some cases (e.g., sea turtles), organisms could be entrapped in the intake canals. *Aquaculture Center in Los Cóbanos*: Threats to biodiversity are mainly associated with conversion of natural habitats during construction (e.g. removal of mangroves, alteration of natural hydrology of lagoons, etc.). Pond-based aquaculture systems may affect aquatic systems due to construction and operation activities, primarily by soil erosion and sedimentation during construction, and through the release of effluents during operation (i.e. wastewater discharges). The effluent released from aquaculture systems typically contains a high organic and nutrient load, suspended solids, and may contain chemical residues including feed supplements and antibiotics.	potentially affect some marine fish species distribution' ranges. *Coastal Solid Waste Pollution*: The Sonsonate coastline, including Acajutla, receive loads of solid waste transported to the beach through discharge from rivers that carry it from the cities across the watersheds. During the rainy season, the conditions worsen since many residents deposit their garbage in open dumps that are easily carried by water. The local municipalities do not have effective waste management programs, nor the capacity to process all the waste produced by its cities. Therefore, the existing system cannot handle additional waste produced by large industrial developments in the area. Solid waste in coastal-marine ecosystems can potentially harm the local fauna, such as marine turtles, marine mammals, marine birds nesting in the area, and ultimately the entire food chain.	located in Acajutla have some degree of negative impacts on the marine environment and its fauna. These effects are compounded by the solid waste pollution in the beaches that end up washing into the ocean, further affecting sensitive marine fauna such as marine turtles and marine mammals. Given that the location of the LNG to Power Project is in a highly intervened and industrial area, the Project could potentially contribute incrementally to the adverse impacts that already exist, and some degree of VEC conversion and/or further degradation is likely to occur. Actions should be implemented in the medium term to mitigate potential adverse cumulative impacts on the VEC.	
Land Traffic	During Construction, which is expected to last 33 months, there will be an increase in the volume of land traffic, consisting of cars, light and heavy trucks, and eighteen wheelers transporting equipment and parts. This increase in road traffic can affect the conditions of road infrastructure, disturb users of adjacent properties, lead to traffic delays, and possibly have public safety implications. The volume of heavy truck traffic generated will vary throughout the construction period. High volume periods are expected to occur at	During Construction, which is expected to last 24 months, there will be an increase in the volume of traffic of about 10 trucks per day per sector, consisting of cars, light and heavy trucks, and eighteen wheelers transporting equipment and parts. This increase in road traffic can affect the conditions of road infrastructure, disturb users of adjacent properties, lead to traffic delays, and possibly have public safety implications. The impacts during Construction would be **Moderate**.	*Chevron Fuel Storage Terminal Expansion Project* and *Schafik Jorge Hándal Fuel Storage and Distribution Plant*: Construction activities could cause increased vehicle traffic for a defined period of time. *Acajutla Port*: During Operations, transport of personnel that work at the Port, heavy trucks delivering or picking up merchandise, and maintenance vehicles. *Acajutla Thermal Power Plant and Termo Puerto Power Plant:* During Operation, transport of	*Climate Change and Natural Hazards*: To the extent the frequency or intensity of severe storms and flooding could be influenced by climate change, these could potentially damage some highways and bridges during the Project life cycle (at least 20 years).	The Project and other projects could contribute to the potential negative impacts on this VEC by increasing land traffic. The external driver could exacerbate traffic due to potential damages to road infrastructure. The mitigation measures proposed by the Project would appropriately mitigate the negative impacts and contribution (**Moderate** for the short-term construction and then **Minor** or **Insignificant** for operation). In sum, the Project could potentially contribute incrementally to the adverse impact, but VEC conversion	**Low**

VEC	Potential Impacts from the Power Plant Component of the Project	Potential Impacts from the Transmission Line Component of the Project	Potential Impacts from Other Projects	Potential Impacts from External Drivers	Cumulative Impact	Priority Ranking
	the beginning of the Construction phase. It is expected that most of the components manufactured for the Project will be delivered to the site through the Port. This would reduce the need for long-distance truck travel for the delivery of Project materials. However, heavy equipment and machinery could deteriorate the local infrastructure. Also, construction and installation of the pipeline would require temporary closure of main roads like the Coronel Oscar Osorio Blvd. The impacts during Construction would be **Moderate**. During Operations: Most traffic would be related to routine maintenance and regular operations activities, including daily commute of plant personnel. The impacts during Operations would be **Minor**.	During Operations: Most traffic would be related to routine maintenance, which would represent one truck every one to two months. The impacts during Operations would be **Insignificant**.	personnel that work at the plants and of maintenance vehicles. *Photovoltaic Plants (Bósforo, Remedios and Sonsonate, Trinidad and Márquez)*: An increase in land traffic may occur as a result of the installation of the solar array itself, construction of access roads, and power transmission line. This impact would be temporary during the construction phase. During operations the vehicles that would circulate the area would be mostly maintenance crews.		and/or degradation is not likely to occur, or the Project´s contribution would be expected to be negligible.	
Livelihood from Artisanal Fishing	During Construction and Operations, the two main activities that could result in negative impacts on artisanal fishermen, are dredging and vessel traffic (**Minor**). According to a model that predicts the trajectory that suspended sediment particles will follow once the disturbance has occurred (EDP ESIA 2016), the impact on fishing areas used by the artisanal fishermen will be **Insignificant**.	This VEC would not be potentially impacted by the TL.	*Chevron Fuel Storage Terminal Expansion Project* and *Schafik Jorge Hándal Fuel Storage and Distribution Plant*: Construction activities could cause auditory impacts from pile driving, distribution and habitat changes from altered bottom habitats by dredging. During Operations, potential impacts include artificial lights can attract marine birds, collisions with ships, and oil contaminated wastewater that could be discharged to the bay. These could ultimately affect marine fauna which artisanal fishing depends on. *Acajutla Port*: During Operations, potential impacts include underground noise and vibration from ship traffic and maintenance dredging activities. Discharge of ship-generated effluents such as sewage, ballast water, vessel-cleaning water. Also, discharge from land-based activities such as vehicle maintenance and washing, fuel and material storage and transfer. These could ultimately affect marine fauna which artisanal fishing depends on. *Aquaculture Center in Los Cóbanos*: Threats to fish populations are mainly associated with conversion of natural habitats during construction (e.g. removal of mangroves, alteration of natural hydrology of lagoons, etc.). Pond-based aquaculture systems, may affect aquatic systems due to construction and operation activities, primarily by soil erosion and sedimentation during construction, and through the release of effluents during operation (i.e. wastewater discharges). The effluent released from aquaculture systems typically contains a high organic and nutrient load, suspended solids, and may contain	*Climate Change and Natural Hazards*: Rising temperatures associated with longer-term global climate change could potentially affect the distribution of some fish species. *Coastal Solid Waste Pollution*: The Sonsonate coastline, including Acajutla, receive loads of solid waste transported to the beach through discharge from rivers that carry it from the cities across the watersheds. During the rainy season, the conditions worsen since many residents deposit their garbage in open dumps that are easily carried by water. The local municipalities do not have effective waste management programs, nor the capacity to process all the waste produced by its cities. Therefore, the existing system cannot handle additional waste produced by large industrial developments in the area. Solid waste in coastal-marine ecosystems can potentially harm the local fauna, such as marine turtles, marine mammals, marine birds nesting in the area, and ultimately the entire food chain (including fish).	The Project, Other Projects and external drivers would contribute to the potential negative impacts on this VEC, impacts on fishing livelihoods, by affecting vessel traffic, reducing available fishing areas, and affecting marine fauna and fisheries on which the livelihood dependent on. Artisanal fishing is the second most important economic activity in the CIA area and was identified as a highly valued VEC by stakeholders. Given that the location of the LNG to Power Marine Terminal, Pipeline, and temporary dock cross through localized areas used by artisanal fishermen, the Project could potentially contribute incrementally to the adverse impacts that already exist, and some degree of VEC conversion and/or further degradation is likely to occur. Actions should be implemented in the medium term to mitigate potential adverse cumulative impacts on the VEC.	**Medium**

VEC	Potential Impacts from the Power Plant Component of the Project	Potential Impacts from the Transmission Line Component of the Project	Potential Impacts from Other Projects	Potential Impacts from External Drivers	Cumulative Impact	Priority Ranking
			chemical residues including feed supplements and antibiotics.			
Air Quality	During Construction, air quality could be negatively affected by activities related to earth movement and terrain preparation, movement of heavy machinery and increased land traffic in surrounding areas. These activities could increase the amount of dust and combustion gases from diesel engines (i.e. CO, SO_2, NO_x, $PM_{2.5}$, PM_{10}, VOCs) in the environment. These potential impacts would be localized and short term, and with the application of the proposed mitigation measures, the impact would be **Insignificant**. During Operations, the main source of emissions that could negatively affect air quality, are the stacks from the thermal power plant when producing energy through combustion of LNG. LNG combustion produces insignificant amounts of SO_2 or particulate matter (PM), the main combustion gases from this process would be NO_x and CO. Other sources of emissions during operations are the emergency combustion unit, the three FSRU and the FSU boilers. EDP modeled emissions for the operations phase using AERMOD and the results show all parameters within the El Salvador standards, except for PM_{10} and TPS, which exceeded the standard by approximately 5%. However, both parameters already exceeded the standard during the baseline study. The impact would be **Insignificant**.	During Construction, air quality could be negatively affected by activities related to earth movement and terrain preparation, movement of heavy machinery and increased land traffic in surrounding areas. These activities could increase the amount of dust and combustion gases from diesel engines (i.e. CO, SO_2, NO_x, $PM_{2.5}$, PM_{10}, VOCs) in the environment. These potential impacts would be localized and short term (24 months), and with the application of the proposed mitigation measures, the impact would be **Insignificant**. During Operations, the main source of emissions that could negatively affect air quality would be combustion from diesel engines from maintenance trucks transiting the line every one to two months. Electric transmission itself would not generate emissions. The impact would be **Insignificant**.	*Chevron Fuel Storage Terminal Expansion Project* and *Schafik Jorge Hándal Fuel Storage and Distribution Plant*: During Construction for the expansion project, air quality could be negatively affected by activities related to earth movement, which would generate dust, and by emissions from diesel engines combustion gases. During Operations, emissions of volatile organic compounds (VOCs) may result from evaporative losses during storage, from operational activities such as filling, withdrawal, additive blending, and loading / unloading of transport links, and due to leaks from seals, flanges, and other types of equipment connections. *Acajutla Thermal Power Plant and Termo Puerto Power Plant:* During Operation, they could generate emissions from the combustion of fossil fuels (i.e. SO_2, NO_X, PM, CO, and greenhouse gases). SO_2 and NO_x are of special concern because they have been implicated in long-range and trans-boundary acid deposition (IFC 2017). *Ahuachapán Geothermal Power Plant*: During Operations, geothermal power plant emissions are negligible compared to those of fossil fuel combustion-based power plants. Hydrogen sulfide and mercury are the main potential air pollutants associated with geothermal power generation employing flash or dry steam technologies.	*Climate Change and Natural Hazards*: Rising temperatures associated with longer-term global climate change could potentially affect the dispersion and thermodynamics of pollutants emitted to the air (Radaideh 2017).	The Project, other projects, and external drivers could contribute to the potential negative impacts on this VEC: decreased quality of the air shed. However, most other projects are already in operation and therefore their impacts are already considered in the Project baseline and residual impact assessment. According to models conducted as input for the Power Plant ESIA, the Project´s embedded controls and mitigation measures proposed would appropriately mitigate the negative impacts and contribution (**Minor** or **Insignificant**). In sum, the Project could potentially contribute incrementally to the adverse impact, but further VEC conversion and/or degradation is not likely to occur, or the Project´s contribution would be expected to be negligible.	**Low**
Noise and Vibrations (from low frequency noise)	During Construction, noise could be generated during cleaning, earth movement, pile-driving (on land and sea), general construction activities, and construction-related traffic. These are the typical sources of noise for the main construction activities as a result of material handling and use of machinery and equipment on the site. The impact during Construction would be **Moderate**. During Operations, the noise model indicates that the noise levels contributed by the Project operation in neighboring industrial zones and residential areas will be at or below the applicable Project limits. The impact	During Construction, activities such as movement of earth, access road construction would, and use of heavy machinery would increase noise levels at the work fronts. These impacts would be short-term and temporary in nature. After applying mitigation measures, the impact would be **Minor**. During Operations, an increase in noise level for the surrounding area is not expected, and the impact would be **Insignificant**. **Low frequency noise-induced vibrations** – It has been reported that high-tension (high-voltage) power lines and transformers generate a low frequency noise described as a murmur and low frequency noise-induced	*Acajutla Thermal Power Plant and Termo Puerto Power Plant:* In general, during operation, noise sources in combustion facilities include the turbine generators and auxiliaries; boilers and auxiliaries, such as pulverizers; diesel engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; circuit breakers; and cooling towers. They produce detectable levels of low frequency noise and vibrations that currently affect the residents of Acajutla. *Photovoltaic Plants (Bósforo, Remedios and Sonsonate, Trinidad and Márquez)*: The three plants will start operations in late 2018 or early 2019, once they do, their respective transformers and	*Climate Change and Natural Hazards*: Rising temperatures and increased rains and relative humidity associated with longer-term global climate change could potentially increase the crown effect from high voltage power lines.	The Project, Other Projects and external drivers would contribute to the potential negative impacts on this VEC by increasing noise levels, especially low frequency noise-induced vibrations. Additionally, noise was identified as a highly valued VEC by stakeholders. Given that the location of the new Power Plant is within the same municipality where there are two operating power plants and three new photovoltaic plants, the Project, specifically the Power Plan, could potentially contribute incrementally to the adverse impacts that already exist, and some degree of VEC conversion and/or further degradation or perception of degradation is likely to occur. Actions should be implemented in the medium	**Medium**

VEC	Potential Impacts from the Power Plant Component of the Project	Potential Impacts from the Transmission Line Component of the Project	Potential Impacts from Other Projects	Potential Impacts from External Drivers	Cumulative Impact	Priority Ranking
	during Operations would be **Insignificant**. **Low frequency noise-induced vibrations** – Low frequency noise in the range between 10Hz a 200Hz, has been identified as a nuisance with potential health effects for the residents living near the Project. EDP requested Wartsila to run a model to compare the low frequency noise produced by the existing thermal power plant (Acajutla Power Plant) and the one proposed by EDP. Results show that EDP´s power plant, with all its embedded controls (e.g. exhaust silencer), would generate a level of low frequency noise significantly lower than the Acajutla Plant.	vibrations described as a buzz (IFC 2007). This type of noise is produced by the "crown effect", which can generate noise of up to 20 dBA. The crown effect and noise produced increases with high relative humidity levels. After applying mitigation measures and by embedded controls in the design, the impact would be **Insignificant**.	transmission lines could produce low frequency noise and vibrations. *Ahuachapán Geothermal Power Plant*: Noise sources in geothermal facilities are mainly related to well drilling, steam flashing and venting. Other sources include equipment related to pumping facilities, turbines, and temporary pipe flushing activities. Temporary noise levels may exceed 100 dBA during certain drilling and steam venting activities. During Operations, the plant´s substations and transmission line could also produce low frequency noise and vibrations.		term to mitigate potential adverse cumulative impacts on the VEC. Affects in the TL area are expected to be **Insignificant**.	
Marine Water Quality	During Construction, activities such as offshore pile driving and dredging could alter marine water quality by causing erosion and sedimentation. During Operation, maintenance dredging would also increase sedimentation in the area, increasing turbidity. In addition, the Power Plant operation requires water intake for plant cooling systems, which could generate a thermal plume around the discharge point affecting the surrounding water. During Construction and Operations stages, the potential residual impacts on marine water quality would be **Moderate**.	This VEC would not be potentially impacted by the TL.	*Chevron Fuel Storage Terminal Expansion Project* and *Schafik Jorge Hándal Fuel Storage and Distribution Plant*: Construction activities could cause increased turbidity by dredging. During Operations, potential impacts include oil contaminated wastewater that could be discharged to the bay. *Acajutla Port*: During Operations, potential impacts could result from ship traffic and maintenance dredging activities. Discharge of ship-generated effluents such as sewage, ballast water, vessel-cleaning water. Also, discharge from land-based activities such as vehicle maintenance and washing, fuel and material storage and transfer. *Acajutla Thermal Power Plant and Termo Puerto Power Plant:* During Operation, withdrawal and discharge with elevated temperature and chemical contaminants such as biocides or other additives, if used, may affect marine water quality. *Aquaculture Center in Los Cóbanos*: Pond-based aquaculture systems, may affect aquatic systems due to the release of effluents during operation (i.e. wastewater discharges). The effluent released from aquaculture systems typically contains a high organic and nutrient load, suspended solids, and may contain chemical residues including feed supplements and antibiotics, which could negatively affect marine water quality.	*Climate Change and Natural Hazards*: Rising temperatures associated with longer-term global climate change could potentially affect some marine water temperature. Also, natural hazards such as landslides and inundations, tend to wash up all kinds of debris into the ocean and affecting marine water quality. *Coastal Solid Waste Pollution*: The Sonsonate coastline, including Acajutla, receive loads of solid waste transported to the beach through discharge from rivers that carry it from the cities across the watersheds. During the rainy season, the conditions worsen since many residents deposit their garbage in open dumps that are easily carried by water. The local municipalities do not have effective waste management programs, nor the capacity to process all the waste produced by its cities. Therefore, the existing system cannot handle additional waste produced by large industrial developments in the area. Solid waste in coastal-marine ecosystems can potentially harm the local fauna, such as marine turtles, marine mammals, marine birds nesting in the area, and ultimately the entire food chain.	The Project, other projects, and external drivers could contribute to the potential negative impacts on this VEC by decreasing marine water quality. However, according to models conducted as input for the Power Plant ESIA, the Project´s embedded controls and mitigation measures proposed would appropriately mitigate the negative impacts and contribution (**Minor** or **Negligible**). In sum, the Project could potentially contribute incrementally to the adverse impact, but further VEC conversion and/or degradation is not likely to occur, or the Project´s contribution would be expected to be negligible.	**Low**

7. CUMULATIVE IMPACTS MANAGEMENT FRAMEWORK

7.1. PROJECT LEVEL

Effective application of the mitigation hierarchy (avoid, reduce, remedy) to manage individual contributions of cumulative impacts is recommended as best practice. EDP has incorporated a number of physical or procedural embedded controls in the Project design. These are considered from the very start of the impact assessment process as part of the Project, and are factored into the pre-mitigation impact significance ratings. In addition, a number of mitigation measures detailed in the Power Plant and TL ESIAs have been proposed to address potential impacts from the Project. The ESIAs also include an Environmental and Social Management Plan, which summarizes the mitigation and monitoring measures for all environmental parameters, including the VECs assessed in this CIA.

At the Project level, the above measures are considered sufficient to address the contributions of the Project to cumulative impacts on the identified VECs.

7.2. REGIONAL LEVEL

Ultimately, the management of cumulative impacts is the responsibility of government and regional planners. However, it is considered best international practice that private-sector developers make best efforts to engage relevant stakeholders and promote management of cumulative impacts in their project areas (IFC 2013; Franks 2010).

The CIA identified medium priority cumulative impacts on the following VECs: Coastal-Marine Biota; Livelihood from Artisanal Fisheries; Noise and Vibration (from low frequency noise). Therefore, the development and implementation of a multi-stakeholder collaborative management framework, to the extent possible, is recommended. EDP could foster such collaboration by participating, to the extent feasible and practicable, in working groups and/or industry organizations aimed at addressing management of potential impacts on regional resources to which EDP's Project could incrementally contribute with respect to cumulative impacts.

Here are some initiatives that EDP could take to strengthen a collaborative management framework for the VECs that the Project could contribute cumulatively with medium priority:

Coastal-Marine Biota

- Potential direct effects on fisheries - Conduct fish biomass studies periodically to monitor any effects of the Project on fish populations, particularly species that are important to artisanal fishermen. Promote information exchange and sharing related to coastal-marine biota monitoring/studies between the Project and the other projects to enrich common information and identify potential synergies on information gathering and mitigation measures.

- Solid Waste Management - Engage with local authorities and community leaders to organize beach cleaning efforts, coupled with educational campaigns about proper solid waste management at a local and regional level.

Livelihood from Artisanal Fisheries

- Promote the creation of a Marine Traffic Safety Committee and invite the CEPA, other relevant authorities and projects in Acajutla to participate. The Committee could discuss major risks associated with their marine traffic and potential interaction with artisanal fishermen. The committee could:
    - Coordinate meetings with CEPA and other relevant authorities to establish the order of priority of the traffic of the vessels, in accordance with the provisions national regulations.
    - Sponsor the communication of standards of maritime security through programs such as an "environmental awareness campaign and maritime security for fishermen".

The measures described for coastal-marine biota also contribute to the mitigation of this VEC.

Noise and Vibration (from low frequency noise)

Even if a site is equipped with noise control or meets regulations at its property line, the operator's risk of complaints may remain high due to the presence of low frequency noise (Alves et al. 2018), especially when located in an industrial area with other projects contributing to this type of noise.

- Promote information sharing related to low frequency noise between the Project and the other projects to enrich common information and identify potential synergies on information gathering and mitigation measures.
- Evaluate opportunities to use shared access roads and substations with other projects in the vicinity.
- Promote the creation and maintenance of urban green spaces around the Project and other project areas.

8. REFERENCES

Alves, J. A., Silva, L. T., & Remoaldo, P. C. (2018). Impacts of low frequency noise exposure on well-being: a case-study from Portugal. *Noise & Health*, 20(95), 131-145.

BNamericas. Electronic document, available at: https://www.bnamericas.com/project-profile/en/proyecto-solar-fotovoltaico-bosforo-fase-ii-proyecto-solar-fotovoltaico-bosforo-fase-ii, accessed: November 26, 2018.

Consejo Nacional de Ciencia y Tecnología (CONACYT). 2003. Norma Salvadoreña NSO 13.11.01:01 - Calidad del Aire Ambiental Inmisiones Atmosféricas. San Salvador, El Salvador.

Diario El Mundo. 2018. Electronic article, available at: https://elmundo.sv/preparan-12-nuevos-proyectos-renovables-que-daran-energia-a-700000-hogares/, accessed: November 26, 2018.

ElSalvador.com. 2017. Electronic article, available at: https://www.elsalvador.com/noticias/nacional/363875/alcaldia-y-marn-buscan-erradicar-botaderos-de-basura/, accessed: November 26, 2018.

Energía del Pacífico (EDP). 2016. Estudio de impacto ambiental y social para el Proyecto de la Planta LNG. Energía del Pacífico Acajutla, El Salvador. Dillon Consulting Limited – Eco Ingenieros. December 2016.

Energía del Pacífico (EDP). 2017. Estudio de impacto ambiental Volumen I. Proyecto Línea de Transmisión Ahuachapán a Acajutla, El Salvador. Environmental Resources Management. January 2017.

Franks, D., et al. 2010. Cumulative Impacts: A Good Practice Guide for the Australian Coal Mining Industry.

Global Energy Observatory. URL: http://globalenergyobservatory.org/geoid/43614, accessed: November 26, 2018.

Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. Science 342 (15 November): 850–53. URL: http://earthenginepartners.appspot.com/science-2013-global-forest

International Bank for Reconstruction and Development. 2016. Country Disaster Risk Profiles. World Bank Group, Washington DC. Electronic document, available at: https://www.gfdrr.org/sites/default/files/El%20Salvador1.pdf, accessed: November 20, 2018.

International Finance Corporation (IFC). 2007a. Environmental, Health and Safety Guidelines: Crude Oil and Petroleum Product Terminals.

_____. 2007b. Environmental, Health and Safety Guidelines: Aquaculture. Washington D.C.: IFC. Washington D.C.: IFC.

_____. 2007c. Environmental, Health and Safety Guidelines: Geothermal Generation. Washington D.C.: IFC.

_____. 2012. Performance Standards on Environmental and Social Sustainability. Washington D.C.: IFC.

_____. 2013. Good Practice Handbook - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets. Washington D.C.: IFC.

_____. 2017a. Environmental, Health and Safety Guidelines: Ports, Harbors and Terminals. Washington D.C.: IFC.

_____. 2017b. Environmental, Health and Safety Guidelines: Thermal Power Plants. Washington D.C.: IFC.

International Union for Conservation of Nature (IUCN). 2016. The IUCN Red List of Threatened Species. Version 2016-1. Electronic document, available at: http://www.iucnredlist.org

La Geo Grupo CEL. URL: http://www.lageo.com.sv/?cat=1007, accessed: November 26, 2018.

Ministerio de Agricultura y Ganadería (MAG). 2017. Electronic article, available at: http://www.mag.gob.sv/muelle-artesanal-de-acajutla-sera-remodelado-en-beneficio-de-los-pescadores/, accessed: November 26, 2018.

Ministerio de Medio Ambiente y Recursos Naturales (MARN). 2013. Segunda Comunicación Nacional sobre Cambio Climático. San Salvador, El Salvador.

_____. 2017. Acuerdo No. 74 – Listado oficial sp. Especies Amenazadas o en Peligro de extinción. San Salvador, El Salvador.

Overseas Private Investment Corporation (OPIC). 2012. Environmental Guidance Renewable Energy): Solar Projects. Electronic document, available at: https://www.opic.gov/opic-action/all-project-descriptions, accessed: November 26, 2018.

ThinkHazard. 2017. El Salvador. Electronic document, available at: http://thinkhazard.org/en/report/75-el-salvador, accessed: November 20, 2018.

United States Agency for International Development (USAID). 2017. El Salvador Country Fact Sheet. Electronic document, available at: https://www.usaid.gov/documents/1862/usaid-el-salvador-country-fact-sheet, accessed: November 20, 2018.