GBN Global Business Network Programme

YOUR PARTNER FOR DEVELOPMENT COOPERATION

Partnership Ready Cambodia: Solar PV potential in the commercial and industrial sector

Introduction

The energy market will become ever more important for Cambodia's economy as it continues to develop, with rapidly increasing demand for electricity. The Cambodia Energy Outlook estimates an increase by 7.5 times from 2015 to 2040.

According to Cambodian authorities, electricity demand in the country is expected to grow from its current 1.5 GW to 2.3 GW by 2020, and 2.8 GW megawatts by 2021. So far, power imports from Laos, Vietnam and Thailand are helping the country to meet its growing demand.

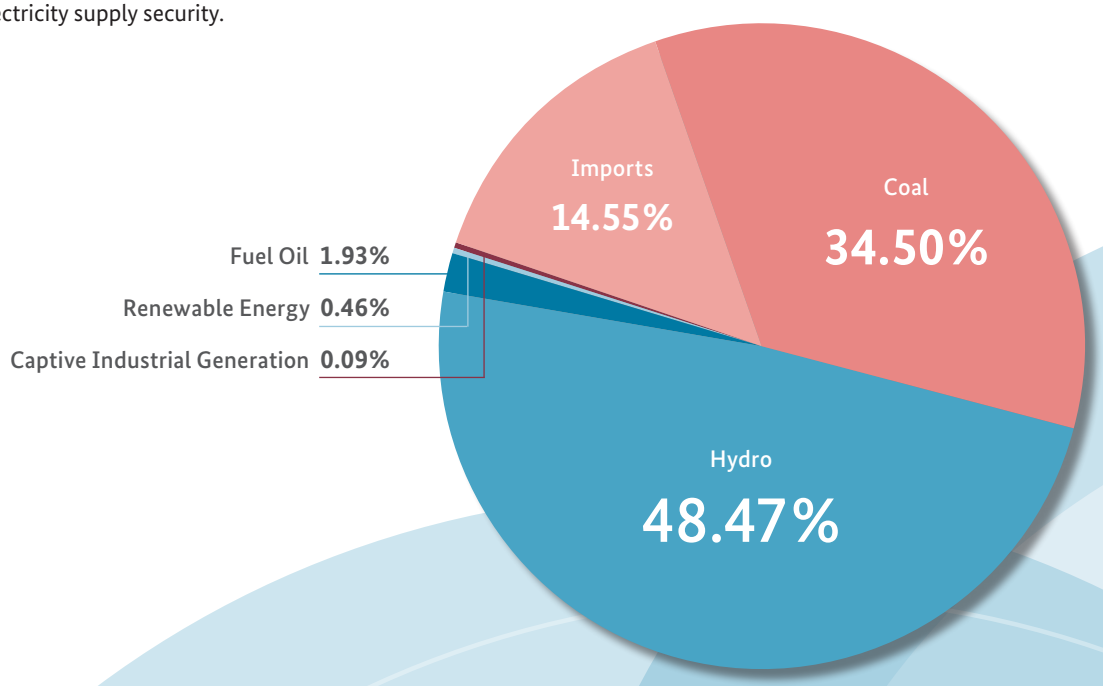
In Cambodia, electricity generation is dominated by hydro power and coal power plants. Power outages are especially common in the dry season, making Cambodian businesses dependant on diesel back-up systems to ensure their electricity supply. Both, high electricity costs and power outages lead to an increasing attractiveness of investments in photovoltaic systems. Solar PV systems for on-site electricity generation can be a solution to lower electricity costs and to increase electricity supply security.

Market overview for renewable energies

The current generation sources of coal-fired and hydro power plants are unlikely to be able to cope with the rising demand for electricity soon, and the market is increasingly looking to alternatives. The potential for renewable energies is important. Additionally, renewable energies benefit from the government's encouragement, even if appropriate policies and financial support are still lacking.

In 2018, renewable energy only made up 65 MW of the total 2,200 MW installed capacity. However, when we include hydro power (which is controversial because of its environmental effects), renewable energy provides a share of nearly 50% of electricity consumed in Cambodia.

Structure of Electricity Consumption in 2018



→ WIND

Wind resources are quite rare in the country. A medium intensity can be found in areas with higher elevation in the southwest near the coast and in the eastern part of Cambodia. When grid-accessibility is given, wind power can be considered as potentially economically feasible in these areas, according to a report of the Asian Development Bank (ADB).

→ BIOFUEL AND BIOGAS

The government's target of producing biodiesel and bioethanol to displace 10 % of diesel consumption by 2030, and 20 % of gas consumption, is realistic. The exploitation of agricultural residues (e.g. from rice and corn production) could reduce the dependence on forest resources in rural areas. Concerning the use of land for biofuels, prudence is recommended in light of the rural population's vulnerability in terms of food security. Since 2007, the International Institute for Energy Conservation (IIEC) has been working with Cambodian partners to develop off-grid rural electrification based on biofuel. Biogas production has a good potential, according to the ADB report. The National Biodigester Programme (NBP) identifies advantageous conditions in Cambodia, such as the climate and the availability of input (water and dung). The microfinance institution PRASAC and the NBP provide loans to households so that they can buy a biodigester. SNV, a Dutch organisation, supports the NBP and works with the Ministry of Agriculture, Forestry and Fisheries (MAFF) to develop the biogas sector. For example, Phnom Penh Sugar has built a power plant that generates biogas (16 MW) and the Mong Rithy Group produces biogas from pig waste. However, it should be noted that farming practices and their small scale represent limitations for biogas production.

→ SOLAR PV

The opportunity for solar PV in Cambodia is high due to fast-growing demand for power, good solar irradiance and availability. Average sunshine duration is 6-9 hours a day, which leads to an approximate annual yield of 1,600 kWh/kWp.

Cambodia's first utility-scale solar PV project reached financial close in May 2017, a 10 MW farm in Bavet City, Svay Rieng Province. Since August 2019, a solar park in Kampong Speu with a total capacity of 60 MW is online. In 2019, a 60 MW solar farm tender resulted in a price of 3,877 USD ¢/kWh which is cheaper than any hydro project in Cambodia. The government has recently approved a 60 MW solar farm in Kampong Chhnang Province, as the first part of a 100 MW National Solar Park, as well as a 60 MW farm in Pursat.

Cambodia's council of ministers announced in July 2019 that it has approved four new large-scale solar power projects with 140 MW of total capacity. The projects, which were submitted by the local group Schneitec Infinite, Chinese panel maker Risen Energy, Ray Power Supply, and Green Sustainable Ventures, will be constructed on a Build-Own-Operate (BOO) basis.

The total amount of solar capacity to be built by 2022 is 410 MW.

→ SOLAR ROOFTOP INSTALLATIONS

Market investigations have shown that the current market price of rooftop solar is around 800 to 1000 USD/kWp (depending on system size), with 20-year power purchase terms of approximately 10 USD ¢/kWh. Existing rooftop solar installations are visible demonstrations of the viability of rooftop systems.

The primary industry in Cambodia is within the garment sector, which accounts for two thirds of the more than 1,500 registered factories in Cambodia in 2017. The remaining one-third of the non-garment factories are a diverse set of manufacturing operations, including food, beverage and tobacco factories (8%); fabricated metal products (7%); chemical petroleum, coal, rubber and plastic products (7%); paper product, printing and publishing (3%).

Garment factories have high power consumption and consistent load profiles. Nevertheless, garment factories typically operate on short 2-, 3- or 5-year lease agreements with site owners, making long term investments difficult to prioritise despite a large proportion having been at the site for one or two decades. Taking the criteria above into consideration, the attractiveness of different industrial sectors can be assessed as follows.

Suitability of industrial sectors for rooftop PV installations

Highly attractive	Medium attractive
• Food and beverage factories • Concrete manufacturers • Hotels	• Motorcycle/car parts producers • Wire harness assembly • Plastic products factories • Carton box and paper processing factories • Electrical products • Garment / Textile

During the national supply-demand mismatches, typically in the dry season, solar PV becomes especially interesting for sectors reliant on diesel back-up systems. According to the World Bank, firms report a 3.6% loss of annual sales due to frequent (if not severe) power outages, leading to a reliance on diesel back-up generation. These firms suffer 1.4 outages per month for an average of 1.3 hours. 40% of firms own or share a generator, contributing an average of 9% to their total electricity use. The proportionally higher cost of energy from generators adds to the cost-saving potential of solar PV generation for these firms.

Hotels especially are considering solar self-generation solutions for this reason as many are running their generators up to 10 hours per day to address the electricity supply shortfall. Other commercial sectors suitable for rooftop solar include commercial-scale agriculture and public services, i.e., airports and hospitals.

Special Economic Zones (SEZs) play a role providing a stable business environment, reasonable infrastructure and public utilities. The majority of investors are from Cambodia, Japan, China, Thailand and Taiwan. The most common economic activity within SEZs are light manufacturing, categorised as 'labour intensive operations in automotive and machinery, electrics and electronics, and other various assembly activities'. Out of 22 registered SEZs, of which many are not yet operational, key SEZs include three at Sihanoukville Port, three at Bavet, and one each in Phnom Penh, Poipet and Koh Kong. The biggest SEZ is located in Sihanoukville. It houses approximately 110 (majority) Chinese businesses. Other SEZs are close to the Thailand or Vietnam border and directly import electricity from the two neighbouring countries, therefore being of less interest to embedded solar. Phnom Penh SEZ can be considered as highly suitable for solar PV rooftop systems due to its high plot utilisation and colocation to demand.

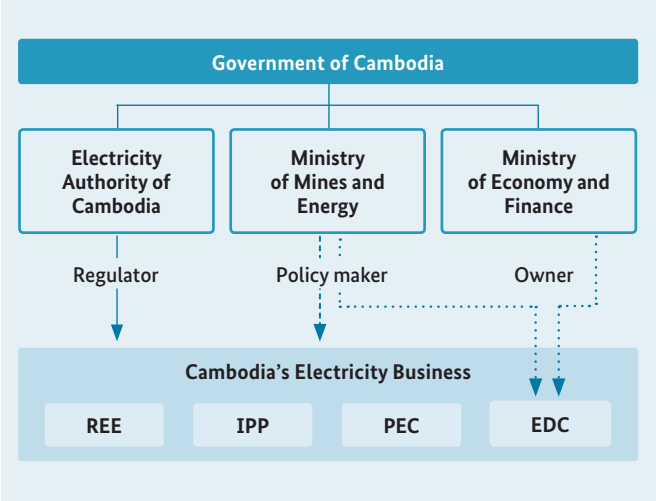
Rules and regulation

→ DIVISION OF RESPONSIBILITIES

The Ministry of Mines and Energy (MME) is in charge of setting and administering government policies, strategies, and planning in the power sector. The Electricity Authority of Cambodia (EAC) is responsible for regulating the electricity industry and has the duties of licensing, tariff setting, solving the disputes between producers/suppliers and consumers, setting up the uniform accounting standards, enforcing regulation, reviewing of planning and financing performance.

Electricité du Cambodge (EDC) is responsible for the generation, transmission and distribution of power in the country. EDC is co-owned by MME and the Ministry of Economy and Finance (MEF). Independent Power Producers (IPPs) are private companies that received a licence from EAC to generate electricity and sell it to EDC. Similarly, Rural Electricity Enterprises (REEs) and Provincial Electricity Companies (PECs) are private-owned electricity providers who get a licence from EAC to provide power outside the main economic centres.

Division of responsibilities in the Cambodian Power Sector



→ LEGAL FRAMEWORK

The regulation of electricity generation for self-consumption was recently clarified by the 'Solar Regulation'. How to manage the addition and operation of embedded solar systems is a critical context to the development of the solar regulation, and to the government's consideration of embedded solar systems in general. Limited on- or off-grid solar capacity has been installed to date, and EAC and EDC state concerns around the proliferation of roof-top solar without adequate controls, grid codes and installation standards. The Solar Regulation was released in order to clarify and update the position on embedded solar generation.

The Solar Regulation allows electricity generation for self-consumption for solar PV off-grid systems and for grid-connected systems if they meet certain criteria. Off-grid systems – those not connected and synchronised with the national grid – are allowed to use solar or other generation for self-consumption, regardless of required capacity. Those connected and synchronised with the national grid need to meet the following criteria:

- They must be categorised as 'Big' or 'Bulk' consumers (supplied by the national grid at 380V – 22kV and > 22kV respectively)
- Maximum inverter capacity is limited to 50% of the electricity contract demand
- Excess energy is not allowed to be fed into the grid, unless a Power Purchase Agreements (PPA) has been signed with EDC or another licence holder
- Technical requirements like anti islanding and harmonic distortion (similar to international standards)

→ ELECTRICITY TARIFFS AND OUTLOOK

Historically, Cambodia has one of the highest electricity tariffs in South-East Asia and the Pacific, due to a historic reliance on oil-fired generation. Cambodia's tariff structure is very simple, a one-part, per kWh charge. Recent tariff reductions mean the rates for commercial and industrial (C&I) companies buying power from the national grid now ranges from 11.7 to 15.9 USD ¢/kWh in 2019, while those in SEZs can be charged different rates. Market engagement has shown that C&I companies currently pay tariff rates ranging from 17 to 22 USD ¢/kWh.

Under the current Solar Regulation, C&I customers connecting solar PV for self-consumption are subject to a two-part tariff, consisting of a usage charge and a capacity charge. The usage charge tariff, or Energy Price Rate, ranging from 9.3 to 12.0 USD ¢/kWh, is lower than one-part tariff charged to users only buying power from EDC. The capacity charge, or 'Power Price Rate', is charged per month on the basis of the contract demand (in kW) that is agreed with EDC for customers connecting at higher voltages. In Cambodia, solar is the only technology subject to a capacity charge, with all other technologies charged a simple, one-part, per kWh tariff.

Customers applying this two-part tariff structure can pay more or less per month compared to the basic tariff, depending on the magnitude and pattern of consumptions. At a high level, this means that if the per kWh charge is low relative to the typical national grid price, savings can be made (given that the quantity of use can offset the additional capacity charge). As the capacity charge depends on the contract demand, typically related to the customers' transformer to the national grid, some customers are disadvantaged by having an oversized contract demand relative to their peak load demand. A reduction in the agreed contract demand should be possible in these cases (even if there are some uncertainties, as it is a recent development). Generally, larger customers with significant and consistent loads, such as concrete manufacturers, can achieve significant savings. This is because they are able to optimise the level of consumption relative to their contract demand (i.e. load factor), using power as consistently as possible 24/7 throughout the year. Other customers with high current tariffs may install a system with a lower relative capacity, and benefit from a significantly reduced per kWh tariff while incurring a relatively small capacity charge. Another significant factor in this equation is offsetting diesel generator and fuel costs, which for many C&I customers is a substantial proportion of their total energy costs. For other smaller, intermittent or more seasonal customers, the current regulation and capacity charge renders the business models unviable for now, and they will need to await later regulatory amendments.

→ CONTRACTUAL MODELS

Three common contractual models are self-investment, leasing and PPA. Self-investment, also known as a capital expenditure (CapEx) model, involves full ownership of a solar system relying on the user's initial capital, and the hiring of an engineering, procurement and construction (EPC) contractor. There are many different possible lease arrangements, but the relevant one for solar PV in Cambodia is the leasing of solar generation assets to the site owner for a contracted period of time. This is also called the operational expenditure (OpEx) model, as the site owner pays on an ongoing basis rather than upfront as with the CapEx model. Lease agreements can lead to the site owning the system or not, and the terms of the lease will depend upon the contract duration.

A PPA is simply the contracted sale of power from one company to another, which would need to be accompanied by a rooftop use and access agreement, as with the leasing model. The easiest contractual models to implement are leasing or self-investment models, as a PPA requires extra regulatory compliance. The lease model can be designed to deliver a very similar contractual arrangement to a PPA, and it is advantageous in that it outsources the upfront capital, system management as well as various production and operation & maintenance (O&M) related risks to a third party. Advantages of the self-investment model are that it guarantees ownership and commonly allows for greater payback and control over production, performance, and O&M. Cashflow is the largest barrier to self-investment, but also the level of technical and managerial comfort required to deal with EPC companies and subcontractors more directly than under the leasing model. These factors typically determine which model will be employed. The most common model implemented to date is the self-investment model, using an EPC contractor, followed by leasing models. In the leasing model with a C&I customer that is itself leasing the land, there is no need for an agreement with the original landowner as long as the land-lease is longer than the energy-lease.

Two-part electricity tariff applied to customers connecting solar PV for self-consumption

Condition	Contracted load charge	Consumption charge
Connection at High Voltage (HV) substation (115/230 kV)	2.90 USD/kW/month	9.3 USD ¢/kWh
Connection at Medium Voltage (MV) (22 kV) substation	3.20 USD/kW/month	9.4 USD ¢/kWh
Connection at MV (22 kV) substation in Phnom Penh	4.40 USD/kW/month	10.5 USD ¢/kWh
Connection from a MV (22 kV) distribution network in Phnom Penh and Ta Khmao City	5 USD/kW/month	12.0 USD ¢/kWh
Connection from a MV (22 kV) sub-transmission or distribution network of the national grid	5 USD/kW/month	12.0 USD ¢/kWh

A number of barriers remain to greater achieving Cambodia's rooftop solar potential. The United Nations Development Programme's de-risking study, in draft form as of April 2019, highlights key barriers from interviews held with domestic and international investors and project developers. The key barriers found were:

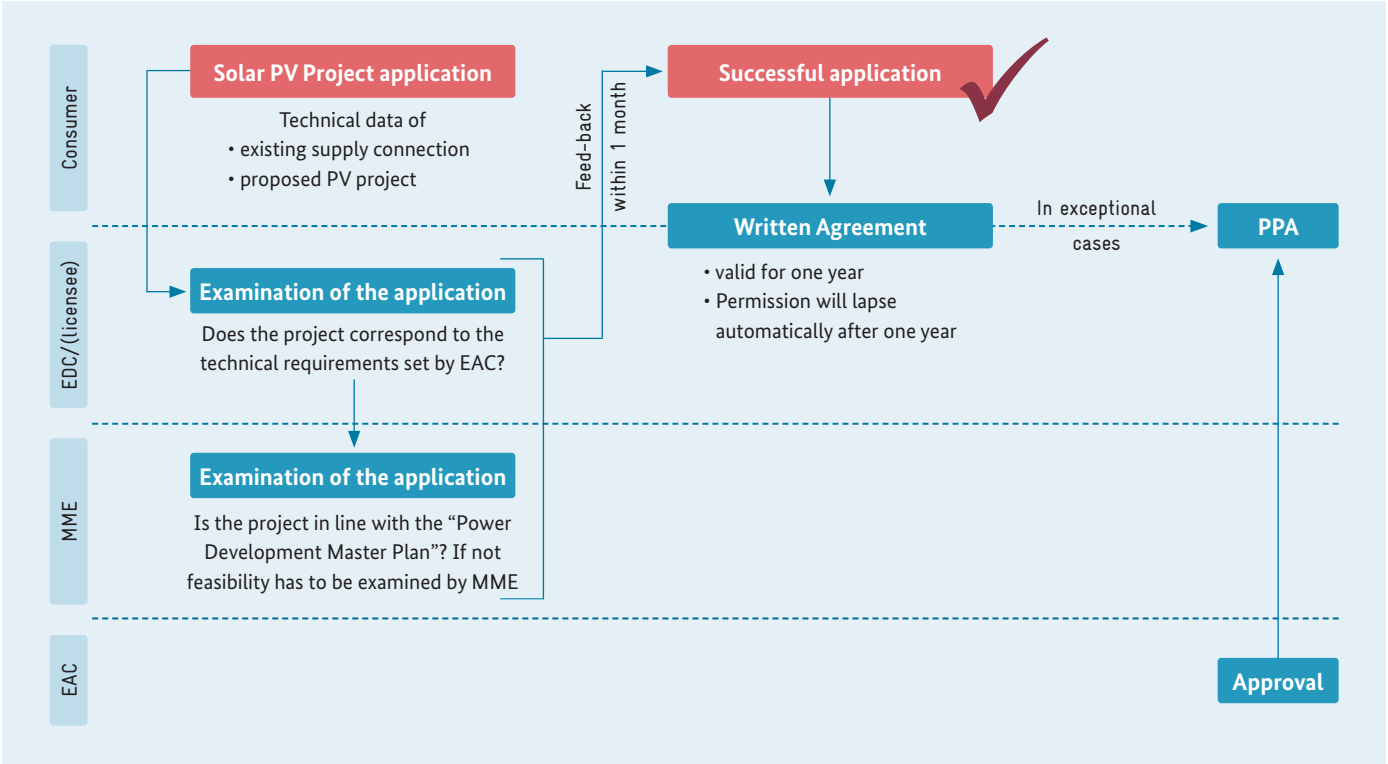
- Power market risk: related to regulatory uncertainty especially on the new tariff structure and grid integration
- End-user credit risk: of C&I electricity end-users
- Financing risk: relating to international and domestic capital scarcity

→ PROJECT APPLICATIONS FOR SOLAR PV

Companies meeting the criteria for grid-synchronised self-generation still need approval from MME and EDC, but this is not typically a barrier to development. Any solar generation installed must be included in MME's Power Development Master Plan before it can be approved, and then must be developed in accordance with this Master Plan. The plan details the generation assets to be installed in Cambodia, as well as development plans for national transmission and distribution assets. If it is not currently included, then a project developer must apply to MME and EDC, who will consider its timing and efficiency and if suitable will provide approval for the project as well as include it in the Master Plan. This permission will take the form of a written agreement that will be valid for one year.

In practice, it is understood that this process is not a typical bottleneck for project development, taking a month or so from submission of sufficient documentation, as long as the project is developed to a sufficient standard and does not have any extra complications i.e. built in protected areas. However, there is no standardised documentation for this process. The ability to sell power back to the grid through a PPA is limited in practice, despite being allowed under the Solar Regulation. If a consumer is supplied with electricity by a power producer other than by EDC, the licence holder and EDC must agree to the installation of the solar PV system as well. This is particularly of relevance for SEZs, which often have their own IPP.

Application process for solar PV rooftop systems based on the 'Solar Regulation'



Business opportunities for Solar PV

C&I companies have the potential for significant savings under the Solar Regulation. Although limited data is available on the consumption, investment profiles and returns on existing solar PV systems, the opportunity for savings under existing regulations is clear. Continued development of solar rooftop systems in Cambodia before and after the Solar Regulation was released, especially in Phnom Penh. This demonstrates the frequent business case for such installations.

To assess the attractiveness of a sector for solar PV rooftop systems, certain criteria have to be taken into account:

- Number of factories in Cambodia
- Consumption level (linked to connection type i.e. Medium Voltage (MV) or High Voltage (HV) for regulatory compliance)
- Operating hours and load variability (likely to be unfeasible under current regulation if a highly intermittent load)
- Typical site and land ownership model (i.e. owned, lease length)
- Diesel generator ownership and usage

Sources and useful links:

- Ministry of Mines and Energy of Cambodia:
  www.eria.org
- Government of Cambodia:
  Scaling-up Renewable Energy for Low Income Countries Program Investment Plan for the Kingdom of Cambodia
  www.climateinvestmentfunds.org
- Electricity Authority of Cambodia (EAC):
  Salient Features of Power Development in Kingdom of Cambodia Until December 2018
  Regulations on the General Conditions for Connecting Solar PV Generating Sources to the Electricity Supply System of National Grid or to the Electrical System of a Consumer Connected to the Electricity Supply System of National Grid
  Regulations on General Conditions of Supply of Electricity in the Kingdom of Cambodia
  www.eac.gov.kh
- Asian Development Bank:
  Renewable Energy Developments and Potential in the Greater Mekong Subregion
  www.adb.org
- World Bank:
  Enterprise Surveys Cambodia 2016
  www.enterprisesurveys.org
  Photovoltaic Power Potential Cambodia
  www.globalsolaratlas.info

YOUR PARTNER FOR DEVELOPMENT COOPERATION

Economic growth creates jobs, improves people's incomes, and promotes innovation. That is why the United Nations 2030 Agenda provides for the active involvement of the private sector in the implementation of the Sustainable Development Goals (SDGs). The Global Business Network (GBN) Programme encourages local and German companies to get involved in sustainable economic development in selected countries in Africa and Asia. Via Business & Cooperation Desks the GBN-Coordinators provide information, advice and guidance for businesses on existing support, financing and cooperation instruments of German development cooperation. The GBN-Coordinators work closely with the German Chamber of Commerce Abroad (AHK) regional offices. The GBN is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

www.bmz.de/gbn

GBN Global Business Network Programme
YOUR PARTNER FOR DEVELOPMENT COOPERATION

NEW MARKETS – NEW OPPORTUNITIES: CAMBODIA

In order to support the sustainable engagement of German companies in emerging and developing countries, Germany Trade & Invest (GTAI), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the German Chambers of Commerce Abroad (AHKs) as well as other partners combined their expertise in the publication series "New Markets – New Opportunities ".

The booklet shows companies the economic potential of future markets as well as the funding and consulting opportunities offered by the German development cooperation. "New Markets – New Opportunities: A Guide for German Companies" is supported by the Federal Ministry for Economic Cooperation and Development (BMZ). All issues are published on the websites of GTAI and GIZ. You can find selected issues, for example on Cambodia also at

www.bmz.de/ez-scouts

GTAI GERMANY TRADE & INVEST

Published by:

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

In Cooperation with:

ADW Arbeitskreis Deutsche Wirtschaft German Business Group Cambodia

EUROCHAM CAMBODIA

AHK Delegation der Deutschen Wirtschaft in Myanmar Delegation of German Industry and Commerce in Myanmar

Published by
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
T +49 6196 79-0
F +49 6196 79-1115
info@giz.de
www.giz.de

Project: Global Business Network (GBN) Programme

Author: Sevea Consulting
T +855 96 9832903

Responsible: Bernhard von der Haar
T +49 6196 79-6145
bernhard.haar@giz.de

Layout: www.w4gestaltung.de

Photo credits: © DHybrid 2019

As at: Eschborn, February 2020

URL-links: Responsibility for the content of external websites linked in this publication always lies with their respective publishers. GIZ expressly dissociates itself from such content.

GIZ is responsible for the content of this publication.

On behalf of: German Federal Ministry for Economic Cooperation and Development (BMZ)

Division: Division 110
Cooperation with the private sector, sustainable economic policy
Berlin

Federal Ministry for Economic Cooperation and Development