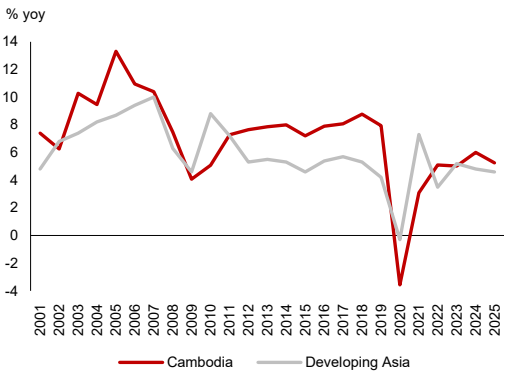
Annex 3. Electricity as a Structural Constraint to Cambodia's GVC Upgrading[61]

Cambodia's economic performance has been relatively robust, yet deepening its industrial integration into global value chains (GVCs) remains difficult. This Selected Issue examines the role of the electricity sector as a structural factor in this transition. Despite notable progress, Cambodia's electricity system continues to face constraints that weigh on the more electricity-intensive, higher-value production stages underpinning deeper GVC participation. Expanding solar energy generation and improving grid quality could ease these constraints and support gradual industrial upgrading.

Background

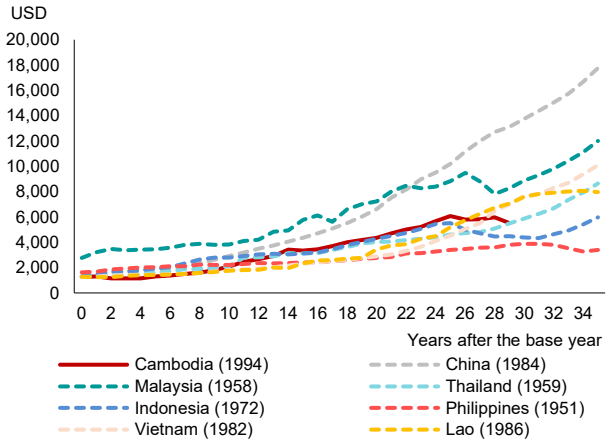
1. Cambodia's economic growth has been relatively robust, but has yet to translate into deeper industrial upgrading. Cambodia's GDP has risen steadily from a low base over recent decades, generally outpacing developing Asia (Figure A3.1). In terms of GDP per capita, however, convergence has been more moderate as compared to regional peers (Figure A3.2). Cambodia's export structure remains concentrated in relatively low value-added and labor-intensive sectors. Garments, footwear, and travel goods (GFT) still dominate merchandise exports, while deeper integration into higher value-added manufacturing segments—such as electronics, machinery, automotive parts, and advanced food processing—remains limited (Vu, 2024). As Cambodia prepares to graduate from least developed country (LDC) status by 2029, the need to strengthen domestic competitiveness and move up the global value chain (GVC) is pressing.

Figure A3.1 Real GDP Growth



Source: United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) via CEIC; NIS
Note: 1) Developing Asia includes 38 developing economies representing more than 95 percent of the population of the Asia-Pacific region (including the Central Asian countries).

Figure A3.2 Selected Economies: GDP per Capita Comparison



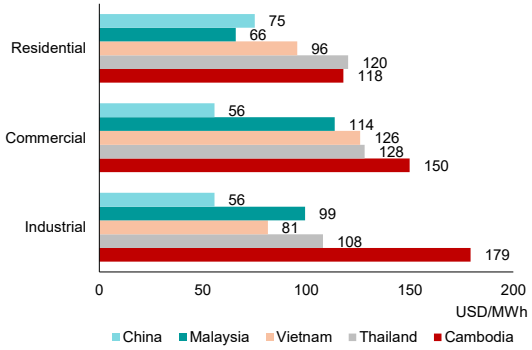
Source: Penn World Tables (PWT); AMRO staff calculations
Note: 1) Parentheses indicate the base year that the sample periods start. Series are normalized to initial income levels by aligning each economy to the year when GDP per capita was closest to Cambodia's 1994 level. 2) GDP per capita is measured in constant 2017 international dollars using Penn World Table 11.0 (rgdpe/pop), adjusted for cross-country price differences and inflation using PPP exchange rates from the International Comparison Program (ICP).

2. Electricity costs and supply reliability together are important structural constraints in Cambodia's industrial upgrading. Cambodia's electricity tariffs remain among the highest in ASEAN, particularly for industrial users (Figure A3.3). This is a disadvantage directly relevant to investment location decisions given that competing destinations such as Vietnam offer industrial tariffs roughly half those in Cambodia. In terms of reliability, despite significant improvements in electrification and generation capacity, survey evidence based on the latest

[61] Prepared by Chunyu Yang, Economist; and Xiaotian (Tina) Liu, Associate Economist.

available data as of 2023 suggests that electricity supply remained a concern for some firms (Table A3.1). Cross-country firm-level evidence from the World Bank Enterprise Surveys, covering 84 developing countries, including Cambodia, over the period 2006–2019, suggests that firms exposed to power outages have revenue-based total factor productivity levels that are approximately 11 percent lower than comparable unaffected firms (Apeti and Ly, 2024).

Figure A3.3 Electricity Price Comparison (2024)



Source: Climatescope by BloombergNEF

Table A3.1 Firm Survey on Production Constraints in Cambodia

Item	%
Firms identifying electricity as a major constraint	**11.6**
Manufacturing	21.3
Garments	22
Other Manufacturing	20.8
Services	8.3
Retail	10.5
Other Services	6.9

Item	%
Firms experiencing electrical outages	**42.8**
Manufacturing	55.7
Garments	82.9
Services	38.5
Item	**Count**
Average number of electrical outages in a typical month	**0.9**
Manufacturing	1.4
Garments	2.3
Services	0.7

Source: World Bank Enterprise Survey 2023

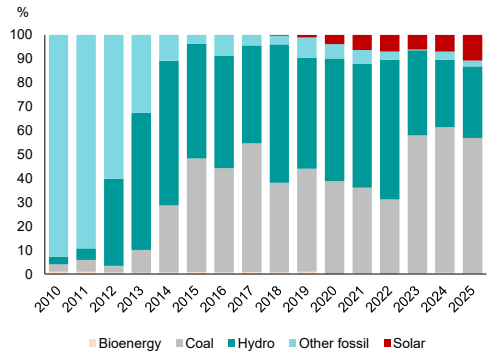
3. This Selected Issue discusses in which way electricity is holding back Cambodia's GVC upgrading. This analysis provides another lens on Cambodia's manufacturing sector by linking electricity intensity, export products, and the smile curve framework. The findings suggest that Cambodia's manufacturing sector is concentrated in less electricity-intensive segments—mainly assembly activity—while more electricity-intensive and higher value-added production stages remain limited.

Cambodia's Electricity Sector: Progress and Remaining Challenges

4. Cambodia's electricity system comprises a combination of domestic generation and imports. Domestic supply is generated mainly from coal-fired plants, hydropower, solar, a small amount of fuel-oil generation, and biomass. Electricity imported from Vietnam, Thailand, and Laos supplements the national grid, especially during periods of peak demand and seasonal shortfalls. Total domestic power-source capacity reached 5,259 megawatts (MW)[62] in 2025, with renewable energy accounting for 63.2 percent of capacity (Electricity Authority of Cambodia, 2026). Electricity delivered to the grid reflects a mixed structure in which coal and hydropower remain major sources (Figure A3.6), while the share of solar has expanded rapidly in recent years (Figure A3.4). However, in terms of average electricity generation, the country is still one of the lowest among regional peers (Figure A3.5).

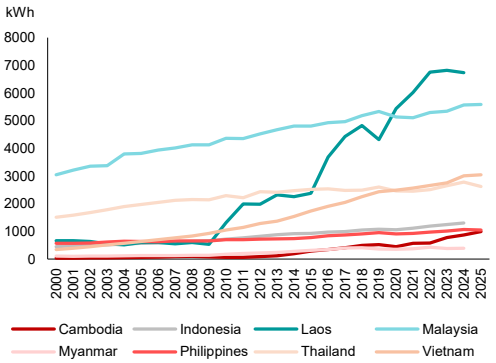
[62] A megawatt measures the power capacity of an electrical system, providing an indication of how much electricity can be produced at any given moment.

Figure A3.4 Structure of Electricity Generation



Source: Ember

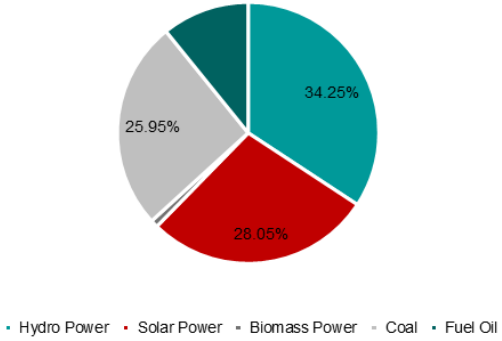
Figure A3.5 Selected Economies: Electricity Generation per Capita



Source: Ember

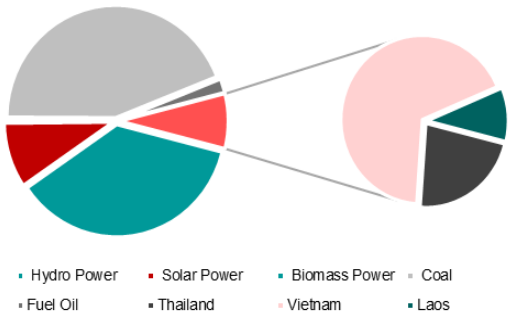
5. Cambodia has made significant progress in expanding electricity access and generation capacity over the past decades. Electrification and installed capacity have expanded rapidly: total power-source capacity reached 5,932 MW in 2025, up from 5,183 MW in 2024, while electricity delivered rose 12 percent from 19,972 gigawatt-hour (GWh) to 22,361 GWh in the same period. Licensed electricity coverage reached 14,557 villages, 99.9 percent of all villages nationwide, among which 14,438 villages were electrified by year-end 2025. At the same time, household electricity access broadened year by year and reached 95.9 percent of total households in 2025.

Figure A3.6 Sources of Electricity Capacity (2025)



Source: Electricity Authority of Cambodia (EAC)

Figure A3.7 Sources of Electricity Delivered (2025)



Source: EAC, AMRO staff calculations.

6. Despite this progress, Cambodia's electricity sector continues to face structural weaknesses.

- **Supply depends heavily on imports and is exposed to external shocks.** While electricity imports from Vietnam, Thailand and Laos accounted for just 7.9 percent of total supply in 2025 (Figure A3.7), down from 8.3 percent in 2024, domestic electricity coverage still calls for attention. This reliance on imports leaves domestic supply exposed to cross-border transmission constraints, partner-country generation conditions, and policy decisions beyond Cambodia's control. Coal-fired generation, meanwhile, remains a significant source of dispatchable power, accounting for 47.7 percent of domestic electricity delivered in 2025. With few domestic resources, this dependence increases Cambodia's exposure to external shocks.
- **Hydropower dominates domestic power generation, and this brings reliability challenges.** Hydropower was the largest renewable source in Cambodia in 2025,

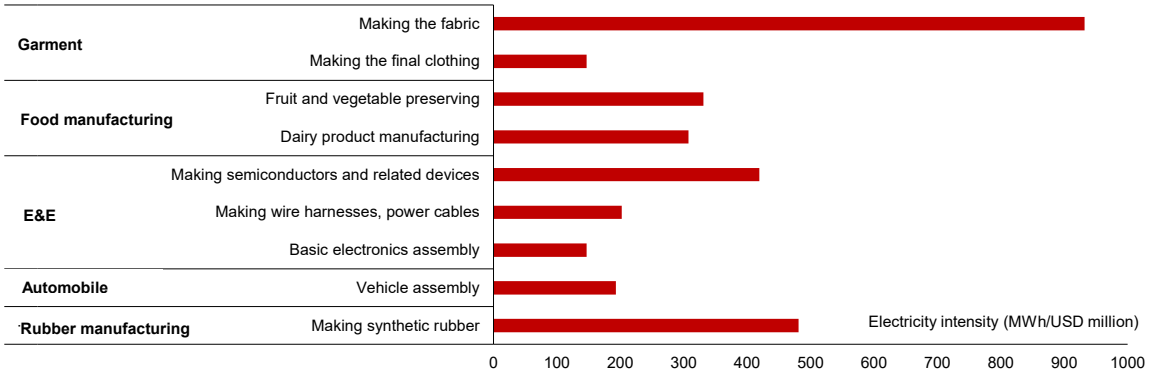
accounting for 39.7 percent of domestically delivered energy. Strong growth in this segment has resulted in a higher clean-energy share in the domestic energy mix, but this also increases exposure to drought, rainfall volatility, and broader environmental issues. Meanwhile, most of the current plants are not built with pumped hydropower energy storage and offer less flexibility in managing supply during wet and dry seasons. Therefore, diversification within the renewable energy portfolio is also important.

- **Weak power infrastructure continues to undermine supply reliability and keep energy costs high.** The heavy reliance on fossil fuel-based generation, a fragmented power supply system, and structural inefficiencies in power generation and transmission infrastructure limit grid capacity and push costs up. The transmission grid remains fragmented and strained, with a weak backbone contributing to overloaded substations, bottlenecks, and a high degree of technical losses that hold back the full utilization of solar resources (ADB, 2025).

Cross-Industry Electricity Intensity and Cambodia's Position in GVCs

7. Electricity requirements vary substantially across different manufacturing sectors and across different production stages within a sector. Based on U.S. Manufacturing Energy Consumption Survey (MECS) data, 63 garment assembly consumes only around 147 megawatt hour (MWh) 64 of electricity per USD 1 million of value added,65 reflecting its labor-intensive nature, while upstream textile production consumes around 932 MWh, more than six times higher (Figure A3.8). Similar patterns are observed in electronics and automotive manufacturing, where downstream assembly activities are relatively less electricity-intensive, while upstream stages such as semiconductor fabrication, paint shops, metal stamping, and complex component manufacturing require substantially greater and more stable power supply (Appendix A3.1; Alby et al., 2014).

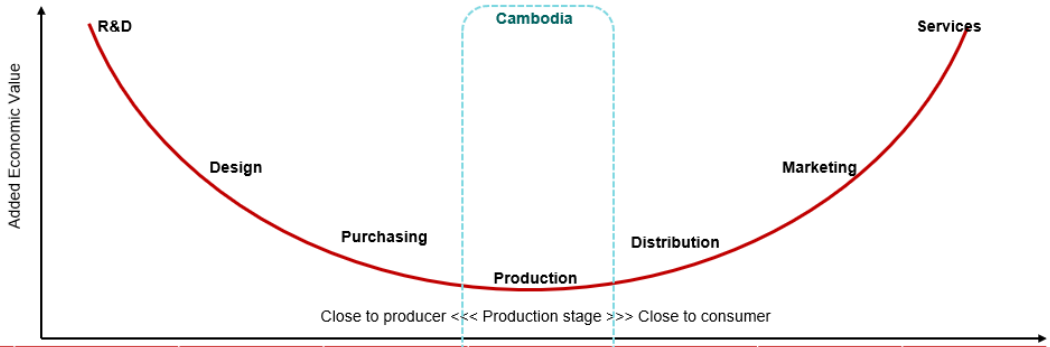
Figure A3.8 Illustration of Electricity Intensity



Source: US MECS 2018; AMRO staff calculations
Note: 1) Electricity intensity is calculated using data from the US Manufacturing Energy Consumption Survey (MECS) by multiplying sectoral energy intensity per dollar of value added by the share of electricity in total energy consumption. Results are expressed as MWh of electricity consumption per USD 1 million of value added. 2) This figure is extracted from Appendix A3.1 and may contain some simplifications for ease of display and illustration. For more detailed descriptions and classifications, please refer to Appendix A3.1.

[63] See https://www.eia.gov/consumption/manufacturing/data/2018/#r3. The MECS is a U.S. national sample survey that collects information on the stock of U.S. manufacturing establishment, its energy-related building characteristics, and energy consumption and expenditures. It is widely used in the literature to benchmark relative energy intensity across manufacturing industries due to its detailed sectoral coverage and comprehensive representation of industrial value chains.
[64] A megawatt hour (MWh) represents how much electricity that system delivers over a period of one hour. For example, if a 1 MW solar array runs continuously at capacity for one full hour, it theoretically produces 1 MWh of electricity.
[65] Original data from the MECS are reported in British thermal units (Btu). Electricity equivalents are converted using 1 MWh = 3,412 thousand Btu.

Figure A3.9 Smile Curve Illustration

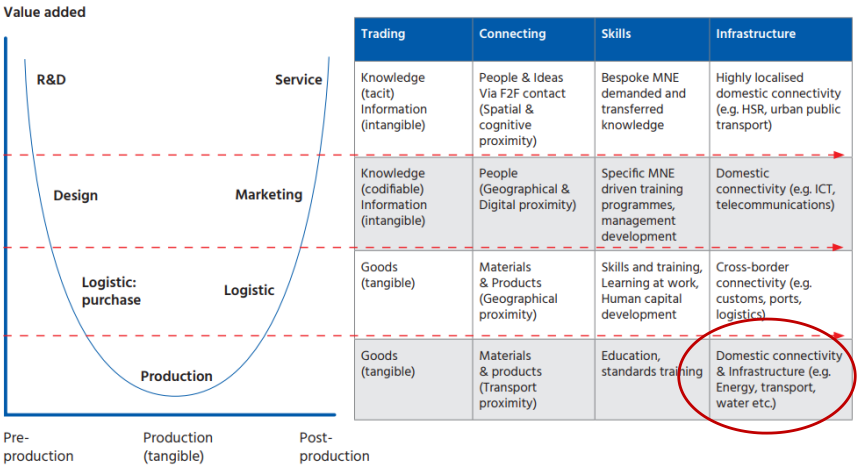


	R&D	Design	Purchasing	Production	Distribution	Marketing	Services
Garment	Material innovation; functional fabrics; sustainable dyeing	Fashion design; pattern making	Fabric sourcing; accessory procurement	Cut-make-trim (CMT); sewing; assembly; packaging	Export logistics; Warehousing; retail distribution	Global branding; fashion campaigns	Retail services; fashion consulting
E&E	Semiconductor R&D; chip design	PCB layout; product prototyping	Electronic component sourcing;	PCB assembly; electronics assembly; testing	Global electronics logistics; warehousing	Product branding; product launches	Software updates; technical supports
Automobile	Engine technology; EV battery R&D; autonomous driving systems	Vehicle styling; interior design	Parts sourcing; supplier network management	Vehicle assembly; stamping; welding; painting	Dealer networks; vehicle logistics; export shipping	Automotive branding; dealership promotion	Maintenance; repair; financing; leasing

Source: AMRO staff's illustration based on Fernandez-Stark and Gereffi (2019).

8. The variation in electricity intensity across production stages reflects, in part, the distribution of value added along manufacturing chains. Under the smile curve framework (Baldwin et al., 2014), value added is highest at the upstream end, covering research and development, components, and materials processing, falls to a trough at the assembly stage in the middle, and recovers at the downstream end toward branding, marketing, and after-sales services (Figure A3.9). In this regard, sustaining growth in value capture requires moving away from the assembly middle toward either end of the chain (Shih, 1996; Baldwin et al., 2014). However, the two ends differ in their electricity requirements. The downstream functions (branding, marketing, and after-sales) and the most upstream knowledge functions (research and development and design) are skill- and service-intensive rather than electricity-intensive. By contrast, the upstream production functions that lie between these knowledge activities and final assembly, namely materials processing and component manufacturing, are markedly more electricity-intensive (Figure A3.8; Appendix A3.1). For an economy at Cambodia's stage, the realistic, investment-led upgrading path runs through these production functions rather than through research, design, or branding. The electricity constraint therefore binds directly on Cambodia's relevant upgrading margin: as the country moves from assembly toward deeper processing and component manufacturing, its electricity demand rises and its exposure to electricity cost and reliability constraints intensifies accordingly. Consistent with this, Crescenzi and Harman (2022) emphasize the importance of improving domestic infrastructure to facilitate upgrading from production to higher value-added stages along the smile curve (Figure A3.10).

Figure A3.10 The Policy Choices along the Smile Curve

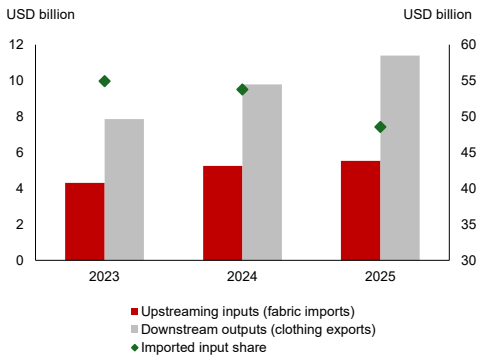


Trading	Connecting	Skills	Infrastructure
Knowledge (tacit) Information (intangible)	People & Ideas Via F2F contact (Spatial & cognitive proximity)	Bespoke MNE demanded and transferred knowledge	Highly localised domestic connectivity (e.g. HSR, urban public transport)
Knowledge (codifiable) Information (intangible)	People (Geographical & Digital proximity)	Specific MNE driven training programmes, management development	Domestic connectivity (e.g. ICT, telecommunications)
Goods (tangible)	Materials & Products (Geographical proximity)	Skills and training, Learning at work, Human capital development	Cross-border connectivity (e.g. customs, ports, logistics)
Goods (tangible)	Materials & products (Transport proximity)	Education, standards training	Domestic connectivity & Infrastructure (e.g. Energy, transport, water etc.)

Source: Crescenzi and Harman (2022).

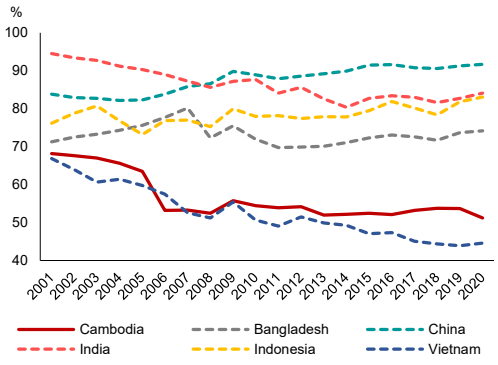
9. Cambodia's export structure remains concentrated in sectors with relatively low electricity intensity, reflecting an industrial base still anchored in labor-intensive assembly. In the garment sector, the upstream fabric production stage not only requires substantially higher electricity inputs (Figure A3.8), but also generates significantly greater domestic value added. However, all fabric used in Cambodia is imported, with fabric imports alone accounting for around 50 percent of the value of every garment exported (Figure A3.11). This partly explains Cambodia's relatively low domestic value-added share of gross exports compared to other major textile-exporting economies in the region (Figure A3.12). In the automobile sector, following the full implementation of the new Law on Investment in 2023, which provides more generous tax incentives (Hernando and Tep, 2024), some major car manufacturers have established or expanded plants in Cambodia. However, production activity remains concentrated in Completely Knocked Down (CKD)[66] operations for the domestic market, which carries relatively low electricity intensity and generates limited domestic value added given that nearly all major components are imported (Figure A3.13). For these two sectors, together with the electrical and electronics (E&E) sector where Cambodia also mainly participates in labor-intensive assembly activities, Cambodia's position along the smile curve remains largely concentrated in the production stage with relatively limited participation in higher value-added segment (Figure A3.9).

Figure A3.11 Fabric Imports and Clothing Exports



Source: GDCE; AMRO staff calculations
Note: The fabric imports shown in the chart exclude imported fabric used in the production of bags, luggage, and footwear rather than in clothing production.

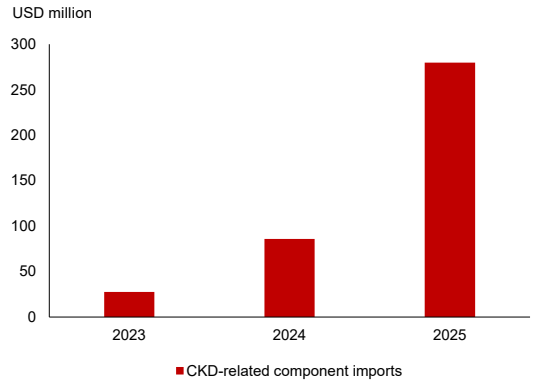
Figure A3.12 Selected Economies: DVA Share of Exports in the Textile Manufacturing Sector



Source: OECD Trade in value-added (TiVA) Database.
Note: DVA = Domestic Value Added.

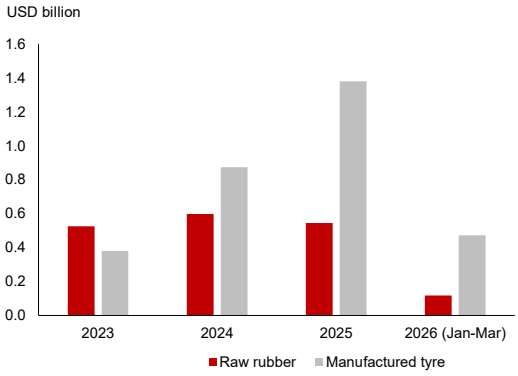
[66] This refers to the process of importing a vehicle in disassembled parts and reassembling it locally, representing the most basic form of participation in the automotive value chain.

Figure A3.13 CKD-related Component Imports



Source: GDCE; AMRO staff calculations
Note: CKD-related component imports are approximated using the following HS6 codes: 840820 (diesel engines), 870710 (vehicle bodies), 870790 (other vehicle bodies), 870829 (body panels), 870830 (brakes), 870840 (gearboxes), 870850 (drive axles), 870870 (road wheels), 870894 (steering columns), 870899 (other parts and accessories), and 940120 (vehicle seats).

Figure A3.14 Exports of Rubber and Tyres



Source: GDCE; AMRO staff calculations
Note: Raw rubber exports comprise three HS6 codes representing unprocessed natural rubber in primary forms: 400121 (smoked sheets, RSS), 400122 (technically specified natural rubber, TSR/TSNR), and 400129 (other natural rubber). Manufactured tire exports comprise 401110 (new pneumatic tires for motor cars) and 401120 (new pneumatic tires for buses and lorries).

10. Having said that, recent rapid expansion of tyre exports illustrates that more reliable electricity supply, where available, can serve as an enabler of industrial upgrading. From 2023 to 2025, tyre exports increased nearly fourfold (Figure A3.14), driven by the rapid establishment of tyre factories across several special economic zones (SEZs). A key enabling factor is that these SEZs benefit from more reliable electricity supply than the general grid. For example, the Sihanoukville SEZ, home to the first major tyre factory, operates its own dedicated 100 MW coal-fired power station,67 providing more reliable and stable electricity than general grid, which is essential for tyre production. Looking ahead, Cambodia's substantial domestic natural rubber base, evidenced by its raw rubber exports (Figure A3.14), positions the country to capture greater domestic value added in tyre manufacturing, if linkages between domestic rubber producers and SEZ-based tyre factories deepen.

Strengthening Electricity Supply to Support Industrial Upgrading

11. Boosting solar energy generation could help ease electricity-related constraints on industrial upgrading. Solar power accounted for 10.2 percent of total electricity delivered in 2025, with 8.9 percent from solar power stations and 1.3 percent from rooftop solar. With strong solar resource potential and a high solar irradiation range (Jayakumar and Sreekumar, 2021), Cambodia can benefit further from solar. With the prices of solar panels and batteries having fallen dramatically over the past few years, solar could become a cheap electricity source. In addition, solar has a shorter construction period than coal-fired and hydro power stations, potentially making solar projects more attractive to investors.

12. Strengthening infrastructure and building energy storage are essential to support higher renewable penetration. Renewable energy development still faces constraints such as limited grid flexibility, insufficient storage, transmission bottlenecks and financing frictions. A more integrated backbone, reduced transmission losses, and better-connected domestic networks will help lower-cost generation reach firms and households more reliably. Further integration into the ASEAN Power Grid framework, including deeper cross-border interconnections and synchronization with neighboring power systems[68], could also help

[67] See https://www.gem.wiki/Sihanoukville_SEZ_power_station
[68] For example, Cambodia and Lao PDR have taken another step towards deepening regional energy cooperation, signing a joint framework aimed at boosting cross-border electricity interconnection and accelerating ASEAN's renewable energy ambitions. See **https://kiripost.com/stories/cambodia-and-laos-partner-to-accelerate-asean-power-grid**.

diversify electricity supply sources, enhance energy security, and improve access to lower-cost electricity.

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Appendix A3.1 Electricity Intensity by Sector

A. Garment

NAICS code	Sector	Typical Activities	Electricity Intensity (MWh/USD mn)
315	Apparel Manufacturing	Making the final clothing/garment, e.g, knitting, cut and sew, accessories	147
316	Leather and Allied Products	Making the footwear, handbags, luggage, and other leather or travel-related final products	161
314	Textile Product Mills	Making other textile-based products that are not clothing	188
313	Textile Mills	Making the textile/fabric itself, e.g., yarn spinning, fabric weaving, dyeing	932

B. Food Processing

NAICS code	Sector	Electricity Intensity (MWh/USD mn)
3115	Dairy Product Manufacturing	308
311	Food Manufacturing (broad)	314
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	331
3116	Animal Slaughtering and Processing	445
3112	Grain and Oilseed Milling	709
311221	Wet Corn Milling	1579

C. E&E

NAICS code	Sector	Typical Activities	Electricity Intensity (MWh/USD mn)
334	Computer and Electronic Product Manufacturing	Making electronic and computer products, including basic electronics assembly such as printed circuit board assembly, solar panels, consumer electronics, and other electronic components	147
335	Electrical Equipment, Appliance, and Component Manufacturing	Making electrical equipment and components, including wire harnesses, power cables, lighting equipment, motors, transformers, and other electrical devices commonly used in automotive and industrial production	202
413	Semiconductor and Related Device Manufacturing	Making semiconductors and related devices, including semiconductor wafers, integrated circuits (chips), sensors, and other advanced electronic components used in computers, smartphones, vehicles, and industrial equipment	419

D. Automobile

NAICS code	Sector	Typical Activities	Electricity Intensity (MWh/USD mn)
111	Automobile Manufacturing	Making automobiles through vehicle assembly operations, including complete or knock-down (CKD) vehicle assembly, where imported components are assembled into finished vehicles.	193
363	Motor Vehicle Parts Manufacturing	Making motor vehicle parts, including brake systems, steering and suspension components, electrical systems, metal stamping, and other intermediate automotive components used in vehicle production	Likely higher
Embedded in 336111	Automotive paint shop operations	Vehicle coating and curing processes within automobile manufacturing plants, including electrocoating, primer, painting, and oven-curing processes that require large and stable electricity and thermal energy inputs	Substaintially higher process-level intensity

E. Rubber Manufacturing

NAICS code	Sector	Typical Activities	Electricity Intensity (MWh/USD mn)
326	Plastics and Rubber Products	Making synthetic rubber and related chemical materials, including synthetic rubber production, polymerization, and upstream chemical processing used as inputs for tyres	481

Source: U.S. MECS 2018, AMRO staff calculations.
Note: Electricity intensity is calculated using data from the U.S. Manufacturing Energy Consumption Survey (MECS) by multiplying sectoral energy intensity per dollar of value added by the share of electricity in total energy consumption. Results are expressed as MWh of electricity consumption per USD 1 million of value added.