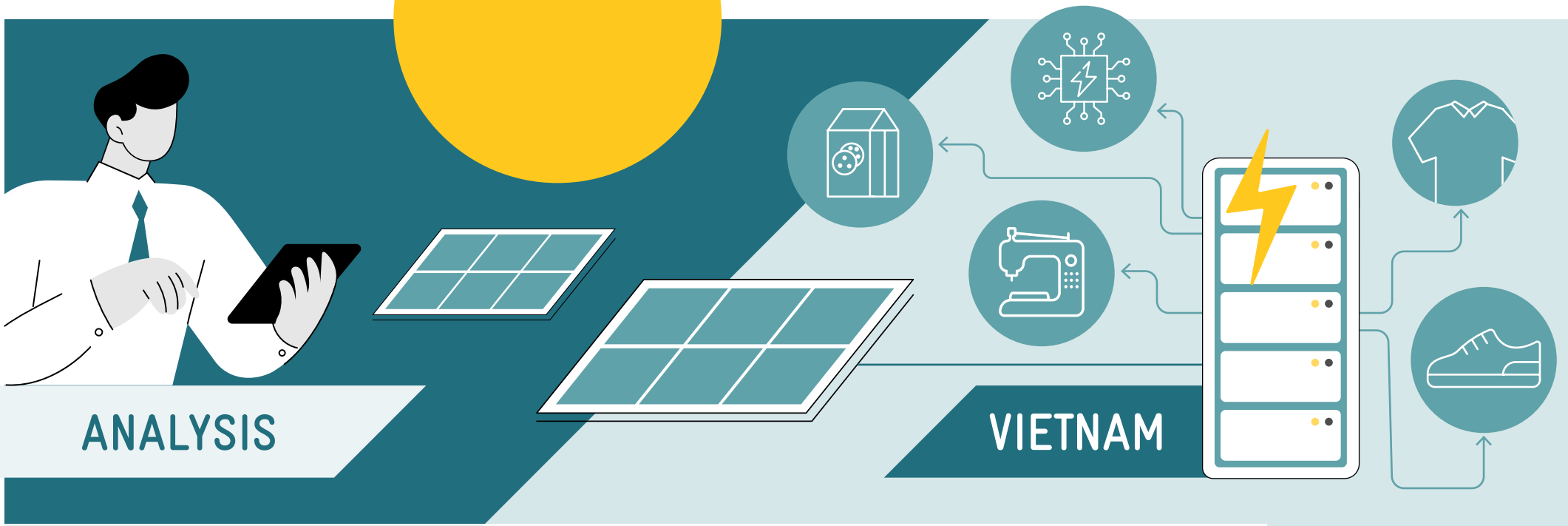

Sector Analysis Vietnam

Battery Energy Storage Systems in the Commercial and Industrial Sector

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

This publication was commissioned by the German Energy Solutions Initiative of the German Federal Ministry for Economic Affairs and Climate Action (BMWK)

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Currency units

VND	Vietnamese dong
EUR	Euro
USD	United States Dollar

Conversion rate as of December 2024

EUR 1 = VND 26,760.867
VND 1 = EUR 0.00004

USD 1 = VND 25,385
VND 1 = USD 0.00004

Source: https://commission.europa.eu/funding-tenders/procedures-guidelines-tenders/information-contractors-and-beneficiaries/exchange-rate-inforeuro_en

Technical units

GJ	Gigajoule
GW	Gigawatt
kg	Kilogram
km	Kilometre
kV	Kilovolt
kVA	Kilovolt-ampere
kWh	Kilowatt hour
l	Litre
m3	Cubic metre
MBtu	Million British thermal units
MVAr	Megavolt-ampere reactive
MW	Megawatt
MWh	Megawatt hour
MWp	Megawatt peak
W	Watt
Wh	Watt hour

Abbreviations/acronyms

ADB	Asian Development Bank
AHK Vietnam	German Industry and Commerce in Vietnam
BESS	Battery energy storage system
BOT	Build-operate-transfer
BST	Bulk supply tariff
C&I	Commercial and industrial
CfD	Contract for difference
CPV	Communist Party of Vietnam
DO	Diesel oil
DPPA	Direct power purchase agreement
EPTC	Electric Power Trading Company
ERAV	Electricity Regulatory Authority of Vietnam
EREA	Electricity and Renewable Energy Authority
EU	European Union
EV	Electric vehicle
EVFTA	EU-Vietnam Free Trade Agreement
EVN	Vietnam Electricity
FDI	Foreign direct investment
FO	Fuel oil
GBA	German Business Association
GDP	Gross domestic product
GENCO	Generation company
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
IPP	Independent power producer
JETP	Just Energy Transition Partnership
Li-ion	Lithium-ion
LNG	Liquefied natural gas
MDMSP	Meter data management service provider
MER	Market exchange rate
MOIT	Ministry of Industry and Trade
NaS	Sodium sulphur
NCS+CL	Nam Con Son-Cuu Long gas field
NLDC	National Load Dispatch Centre
NPT	National Power Transmission Corporation
NSMO	National System and Market Operator
PbA	Lead acid
PC	Power corporation
PDP VIII	Power Development Plan VIII (Vietnam's National Power Development Plan 2021-2023, with a vision to 2050)
PECC2	Power Engineering Consulting Joint Stock Company 2
PM3	Gas field located in the PM3-CAA Block
PPA	Power purchase agreement
PPP	Public-private partnership
PV Power	Petrovietnam Power Corporation
PVN	Vietnam Oil and Gas Group
RE	Renewable energy
SMEs	Small and medium-sized enterprises
SMHP	Strategic multipurpose hydropower plant
SMO	System and market operator
SPPA	Standardized Power Purchase Agreement
TKV	Vietnam National Coal-Mineral Industries Holding Corporation Limited
UPS	Uninterruptible power supply
VDB	Vietnam Development Bank
VRB	Vanadium redox battery
VWEM	Vietnam Wholesale Electricity Market

ENERGY SOLUTIONS – MADE IN GERMANY

The German Energy Solutions Initiative

The German Energy Solutions Initiative of the German Federal Ministry for Economic Affairs and Climate Action (BMWK) aims to globalise German and European technologies and expertise in climate-friendly energy solutions.

Years of promoting smart and sustainable energy solutions in Germany have led to a thriving industry known for world-class technologies. Thousands of specialised small and medium-sized enterprises (SMEs) focus on developing renewable energy systems, energy efficiency solutions, smart grids, and storage technologies. Cutting-edge energy solutions are also built on emerging technologies such as power-to-gas, fuel cells, and green hydrogen. The initiative's strategy is shaped around ongoing collaboration with the German business community.

The initiative creates benefits for Germany and the partner countries by:

- boosting global interest in sustainable energy solutions
- encouraging the use of renewables, energy efficiency technologies, smart grids, and storage technologies, while facilitating knowledge exchange and capacity building
- enhancing economic, technical and business cooperation between Germany and partner countries

THE PROJECT DEVELOPMENT PROGRAMME (PDP)

PDP is a key pillar of the German Energy Solutions Initiative and is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It connects development cooperation with private-sector engagement and supports climate-friendly energy solutions in selected developing and emerging countries, enabling local businesses to adopt solutions in energy efficiency, electricity and heat supply, and hydrogen, while facilitating market access for German solution providers.

Developing and emerging economies offer promising business potential for climate-friendly energy solutions but also pose challenges for international business partners. The PDP team works closely with local industries to develop financially viable projects by providing technical expertise, financial guidance, and networking opportunities.

It identifies project leads, collects and analyses energy consumption data, and assesses projects from both a technical and economic perspective. This includes outlining the business case, calculating payback periods, and evaluating profitability. Companies can then choose to finance projects using their own funds or explore leasing and other financing options. PDP provides cost-free advice to local companies and connects them with German solution providers for project implementation.

Additionally, by offering training, organising reference project visits, and publishing studies on the potential of climate-friendly solutions and on navigating regulatory frameworks, the programme supports market development and fosters private-sector cooperation.

Executive summary

INCREASING DEMAND FOR BESSS IN THE C&I SECTOR IN VIETNAM

In a time of robust economic growth and increasing electricity demand, commercial and industrial (C&I) enterprises in Vietnam are facing numerous challenges. These include unstable power supply, high electricity costs during peak hours and pressure from international partners to transition to clean energy and, in particular, to adhere to global environmental standards, such as RE100. Export-oriented businesses, especially in manufacturing, are under growing pressure to meet stringent requirements.

At the same time, the demand for battery energy storage systems (BESSs) is accelerating, driven by Vietnam's abundant renewable energy (RE) potential, particularly in solar and wind power. However, owing to the intermittent nature of these energy sources, storage solutions are required to ensure continuous electricity supply. BESSs not only enable businesses to store surplus energy during low-demand periods but also alleviate pressure on the grid during peak hours, optimising operating costs.

Currently, the BESS market in Vietnam is nascent, with significant limitations in terms of technical expertise and infrastructure. As at November 2024, Vietnam had only three pilot BESS projects: one at Power Engineering Consulting Joint Stock Company 2 (PECC2), another at VinFast and a third at Kehua Digital Energy in Khanh Hoa.

Zusammenfassung

IN VIETNAMS C&I-SEKTOR WÄCHST DIE NACHFRAGE NACH BATTERIESPEICHERSYSTEMEN (BESS)

Obwohl in Vietnam das Wirtschaftswachstum stabil ist und der Bedarf an Strom stetig größer wird, stehen kommerzielle und industrielle (C&I) Unternehmen vor vielen Herausforderungen. Dazu gehören die instabile Stromversorgung, hohe Stromkosten während der Spitzenlastzeiten und der Druck internationaler Partner, auf Strom aus Trägern regenerativer Energie umzusteigen und globale Umweltstandards wie RE100 einzuhalten. Gerade auf exportorientierte Unternehmen wächst der Druck durch hohe Anforderungen, insbesondere auf Unternehmen in der verarbeitenden Industrie.

Gleichzeitig wächst die Nachfrage nach Batteriespeichersystemen (BESS) rasant. Angetrieben wird sie durch das enorme Potenzial erneuerbarer Energien, die es in Vietnam gibt, vor allem von Solar- und Windenergie. Jedoch braucht es Speicherlösungen, denn die Einspeisung der Energie aus diesen Quellen schwankt. Speicherlösungen können die kontinuierliche Stromversorgung sicherstellen. Hierfür kann der Einsatz von BESS sinnvoll sein. Mit BESS können Unternehmen überschüssige Energie zu Zeiten speichern, in denen die Nachfrage gering ist, sowie das Stromnetz während der Spitzenlastzeiten entlasten und somit die Betriebskosten optimieren.

Der BESS-Markt in Vietnam steht am Anfang. Er weist erhebliche Einschränkungen bei der technischen Expertise und Infrastruktur auf. Im November 2024 gab es lediglich drei Pilotprojekte für Batteriespeicher: eines bei der Power Engineering Consulting Joint Stock Company 2 (PECC2), ein weiteres bei VinFast und ein drittes bei Kehua Digital Energy in Khanh Hoa.

Key industries such as electronics, high technology (high tech), textile, footwear, building materials (for instance cement), automotive, water plants and food processing are increasingly seeking reliable, cost-effective energy solutions that reduce carbon emissions. However, challenges such as high investment costs, an underdeveloped regulatory framework and limited uptake of energy storage technologies pose significant barriers.

Despite these challenges, there are also substantial opportunities for international BESS solution providers, especially those with advanced technology, to establish a foothold in the Vietnamese market. The growing adoption of BESSs is further spurred by Vietnam's RE transition and its commitment to achieving net-zero emissions by 2050. With the increasing presence of multinational corporations adhering to sustainability standards, BESS solutions are becoming a critical factor in ensuring stable power supply, cost savings and long-term energy efficiency for businesses.

BUSINESS OPPORTUNITIES FOR GERMAN AND EUROPEAN SMES IN PROVIDING BESS SOLUTIONS IN VIETNAM

Vietnam represents a promising market for German and European small and medium-sized enterprises (SMEs) specialising in energy storage solutions, thanks to their technical expertise and established reputation in RE technologies. The Vietnamese Government is focusing on RE development and putting in place supportive policies, such as the direct power purchase agreement (DPPA) programme and tax incentives for green technologies, with a view to creating a favourable environment for foreign investors. Additionally, the rapid growth of energy-intensive industries in Vietnam ensures sustained demand for innovative energy solutions.

Schlüsselbranchen wie Elektronik, Hochtechnologie (Hightech), Textil, Schuhindustrie, Baustoffe (z. B. Zement), Automobilindustrie, Wasserwerke und Lebensmittelverarbeitung suchen verstärkt nach zuverlässigen und kosteneffizienten Energielösungen, mit denen sie ihre CO_2-Emissionen reduzieren können. Sie stehen allerdings vor großen Hürden: hohe
Investitionskosten, ein noch unausgereiftes regulatorisches Umfeld und die begrenzte Verbreitung von Energiespeichertechnologien.

Internationalen Anbietern von BESS-Lösungen bieten sich trotz dieser Herausforderungen sehr gute Marktchancen – insbesondere denen mit fortschrittlicher Technologie: Vietnam stellt um auf erneuerbare Energien und verfolgt das nationale Ziel der CO_2-Neutralität bis 2050. Der Einsatz von Batteriespeichern wird in diesem Zusammenhang zunehmend relevant. Mit der stiegenden Präsenz multinationaler Unternehmen, die Nachhaltigkeitsstandards einhalten, werden BESS-Lösungen in Vietnam zu einem entscheidenden Faktor für die Sicherstellung einer stabilen Stromversorgung, Kosteneinsparungen und die langfristige Energieeffizienz von Unternehmen.

GESCHÄFTSMÖGLICHKEITEN FÜR DEUTSCHE UND EUROPÄISCHE KMU IM BEREICH DER BESS

Vietnam ist ein vielversprechender Markt für deutsche und europäische kleine und mittlere Unternehmen (KMU), die auf Energiespeicherlösungen spezialisiert sind. Zurückzuführen ist dies insbesondere auf deren technische Expertise und guten Ruf im Bereich der erneuerbaren Energien. Die Regierung setzt verstärkt auf den Ausbau erneuerbarer Energien. Mit gezielten Maßnahmen schafft sie ein investitionsfreundliches Umfeld für ausländische Unternehmen. Zu diesen Maßnahmen gehören das Programm für direkte Strombezugsverträge (Direct Power

There are several effective strategies that German and European SMEs can use to approach the Vietnamese market, with a focus on collaboration and adaptation to local conditions. Firstly, partnering with local engineering, procurement and construction companies is a crucial strategy that can help German and European SMEs overcome legal and administrative barriers and build trust with local partners and customers. Such partnerships also enable a better understanding of specific market demands and increase the likelihood of successful project implementation.

Additionally, introducing and deploying advanced BESS technologies, particularly through pilot projects with industrial customers, provides an opportunity to demonstrate the clear benefits of such solutions. Pilot projects not only showcase the feasibility of the technology but also encourage wider adoption in the market.

Furthermore, German and European SMEs should make it a priority to offer flexible solutions tailored to the specific needs of Vietnamese businesses. This includes offering support services, training and technology transfer as well as providing products. By leveraging strategic partnerships and their technical expertise and international reputation, German and European SMEs can establish a strong foothold in the Vietnamese market and expand their presence in the energy storage sector.

Purchase Agreement – DPPA) sowie Steueranreize für grüne Technologien. Zudem sorgt das schnelle Wachstum energieintensiver Industrien in Vietnam für eine anhaltend hohe Nachfrage nach innovativen Energielösungen.

Erfolgversprechende Strategien für deutsche und europäische KMU, sich den vietnamesischen Markt zu erschließen, gibt es mehrere, vor allem Kooperationen und die Anpassung an lokale Gegebenheiten. Zentral ist die Zusammenarbeit mit vietnamesischen Ingenieur-, Beschaffungs- und Bauunternehmen (EPCs). Solche Partnerschaften erleichtern deutschen und europäischen KMU den Markteintritt, indem sie rechtliche und administrative Hürden reduzieren und Vertrauen bei lokalen Akteuren aufbauen. Darüber hinaus ermöglichen sie ein besseres Verständnis für die spezifischen Anforderungen des Marktes und erhöhen die Erfolgschancen bei der Umsetzung von Projekten.

Ein vielversprechender Ansatz ist die Einführung und Erprobung fortschrittlicher BESS-Technologien durch Pilotprojekte mit industriellen Kunden. Solche Pilotprojekte ermöglichen es, die Vorteile von Batteriespeichern zu demonstrieren, deren technische Machbarkeit zu untermauern und die Akzeptanz im Markt zu steigern.

Deutsche und europäische KMU sollten zudem flexible Lösungen anbieten, die auf die spezifischen Bedürfnisse vietnamesischer Unternehmen zugeschnitten sind. Dazu gehören neben Produkten begleitende Dienstleistungen, zum Beispiel technischer Support, Schulungen und Technologietransfer.

Durch die Kombination aus strategischen Partnerschaften, technischer Expertise und internationaler Reputation können deutsche und europäische KMU eine starke Marktposition in Vietnam aufbauen und ihr Geschäftspotenzial im Bereich der Energiespeicherung ausbauen.

1

Country profile, business policies and market access

1.1 General information

Geography

Vietnam is a country that lies along the Pacific coast of the Indochinese Peninsula in South-East Asia. It has 4,550 km of land borders with China to the north and with the Lao People's Democratic Republic and Cambodia to the west.

Vietnam's topography is diverse, featuring hills, plains, coastlines and continental shelves. The country has a long coastline that extends 3,260 km along the eastern side of the country and around the southern tip (Vietnam Government Portal, 2024a).

Political system

Vietnam's political system is composed of the Communist Party of Vietnam (CPV), political, socio-political and socio-professional organisations and mass associations. The aim of the CPV is to make Vietnam a strong, independent, prosperous and democratic country with an equitable and civilised society and to achieve socialism and, ultimately, communism (Vietnam Government Portal, 2024b).

Vietnam's political stability, with a single-party system led by the CPV, has been a cornerstone of the country's socio-economic development. This stability is supported by a consensus-based decision-making process, gradual political reforms and a strong emphasis on social stability to address issues such as income inequality. The government proactively manages political and security risks, balancing economic growth with national defence and regional diplomacy.

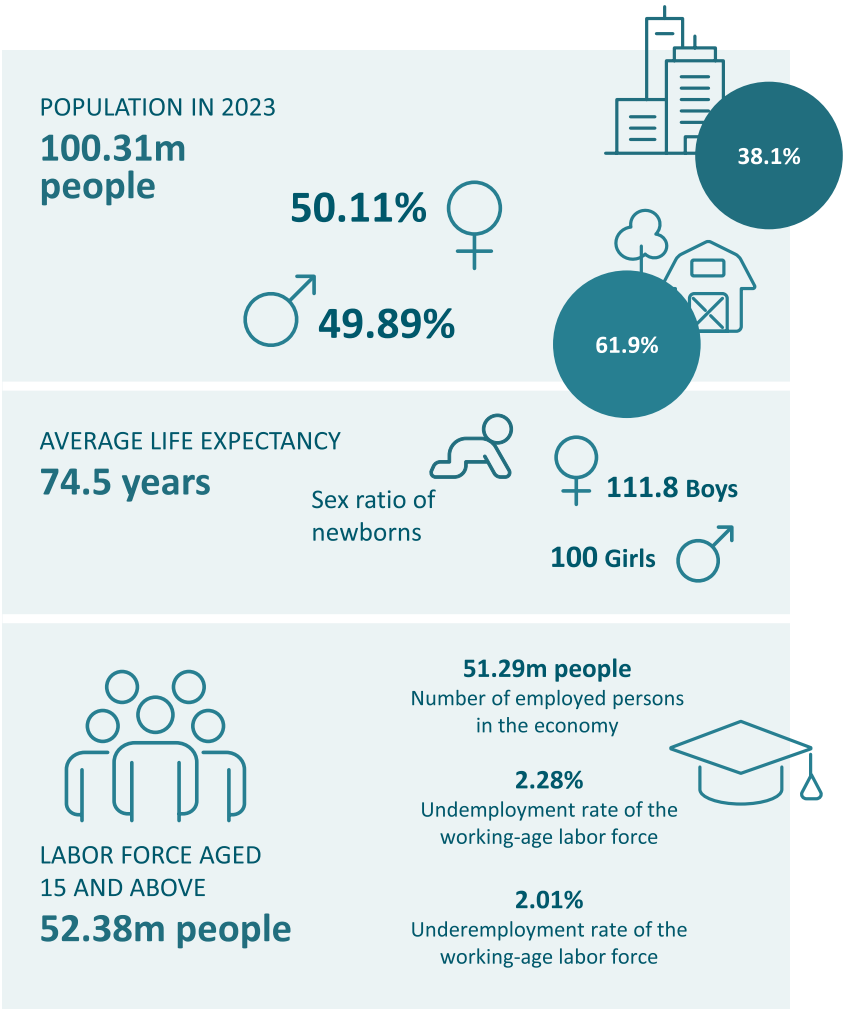
1.2 Social and economic development

Population and social conditions

Vietnam had a population of around 100.31 million in 2023, making it the 15th most populous country in the world (Vietnam General Statistics Office, 2023b). It has a diverse and vibrant social landscape, shaped by its long history, cultural traditions and ongoing social transformations. The country is home to 54 ethnic groups, each with their own unique customs, languages and ways of life.

In recent decades, Vietnam has made significant strides in improving social indicators, including access to education, health care and basic services. The adult literacy rate stands at over 95%, and enrolment rates in primary and secondary education are high. The national health care system has expanded coverage, leading to increases in life expectancy and reductions in infant and maternal mortality rates.

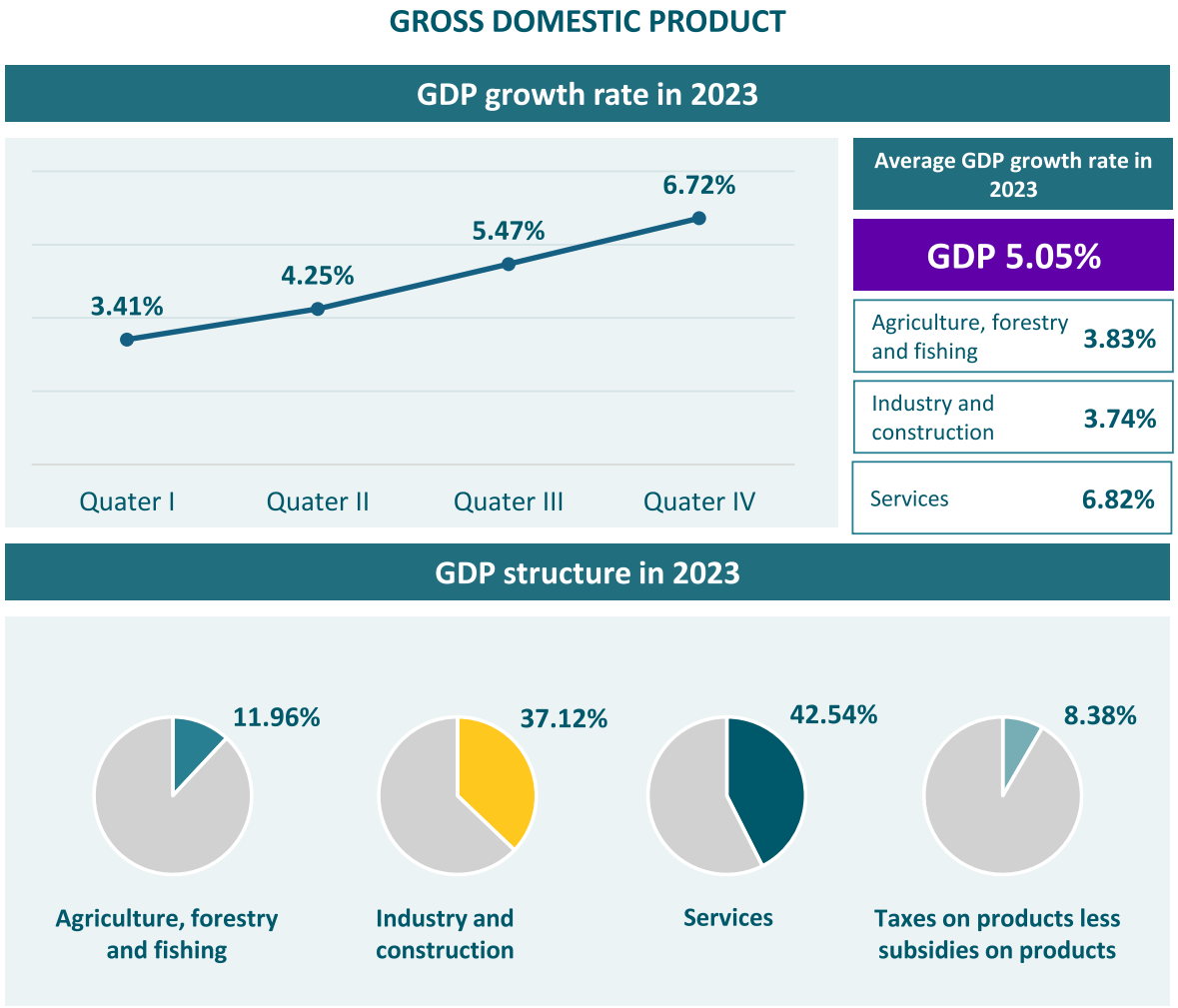
FIGURE 1. Population, labour and employment in Vietnam in 2023



Source: Vietnam General Statistics Office, 2023b

Vietnam has experienced impressive economic growth and development in recent decades, transforming itself from a primarily agrarian economy to an increasingly industrialised and service-oriented one. After the economic reforms known as Doi Moi were introduced in the late 1980s, Vietnam has steadily opened up its markets, encouraged private enterprise and attracted significant foreign direct investment (FDI). This has enabled the country to achieve robust annual gross domestic product (GDP) growth rates, often exceeding 6%–7% over the past 20 years. GDP per capita in 2023 stood at around USD 4,300, up from less than USD 100 in the late 1980s (Vietnam General Statistics Office, 2023b).

FIGURE 2. Economic situation in Vietnam in 2023



Source: Vietnam General Statistic Office, 2023a

1.3 Economic development strategy and key sectors

Economic development strategy

Vietnam's economic development strategy focuses on export-driven growth, diversification and sustainability. The country has prioritised export-oriented industrialisation by developing key manufacturing sectors, such as electronics, textile and footwear, supported by FDI and significant investment in infrastructure and logistics. These efforts have enhanced Vietnam's position in global value chains and boosted its export-led growth model.

In recent years, economic diversification has been a key focus, with expansion from traditional manufacturing into services, high-tech industries and tourism. The government has promoted SMEs and invested heavily in human capital development to create a more dynamic and resilient economy. This shift aims to foster innovation and ensure long-term competitiveness.

Sustainable and inclusive growth is central to Vietnam's strategy, with emphasis on environmental protection, climate change adaptation and poverty reduction. Social welfare programmes aim to address income inequality, while decentralisation and regional integration enhance economic decision-making at the local level. Together, these initiatives aim to balance economic growth with social equity and environmental sustainability.

Key economic sectors

Vietnam's economy is driven by a number of key sectors including manufacturing, agriculture, services and infrastructure.

- **Manufacturing** plays a central role, with industries such as electronics, textile and footwear attracting substantial FDI, particularly from Asian countries, including Japan, the Republic of Korea and Taiwan.
- **Agriculture and aquaculture** remain vital. Vietnam is a leading exporter of commodities such as rice, coffee, rubber and seafood. Efforts to modernise and mechanise farming practices are enhancing productivity and competitiveness.
- The **services sector** is expanding rapidly, driven by tourism, finance, telecommunications and IT. The emergence of a dynamic start-up ecosystem in urban centres further highlights Vietnam's shift towards a knowledge-based economy.
- **Infrastructure and logistics** are also critical to Vietnam's growth, supported by investment in transportation networks, including major ports, airports and industrial parks. Key infrastructure developments, such as special economic zones and logistics hubs, facilitate trade and attract investment, ensuring that Vietnam remains competitive in regional and global markets.

1.4 Investment climate and market entry for foreign companies

Foreign policy

Since the nation's early days, Vietnam's foreign policy has focused on enhancing international solidarity, friendship and cooperation with its partners on the basis of equality and mutual benefit.

In spite of complex developments globally, Vietnam remains unwavering in its open foreign policy, attaching great importance to developing relations with all countries, territories and international organisations and promoting independence, self-reliance, diversification and multilateralisation. This policy has yielded many positive results for national construction and defence and contributes to global peace, cooperation and development (Anh Minh, 2023).

Investment climate

Vietnam's investment climate is characterised by openness to foreign investment, supported by favourable policies and incentives. Since the economic reforms of the late 1980s, the government has actively sought to attract FDI by creating a conducive environment in accordance with the Law on Investment and the Law on Enterprises. Efforts to enhance transparency and simplify administrative procedures have further strengthened the legal and regulatory framework.

Infrastructure and logistics development play a key role in improving the investment climate. There has been significant investment in roads, railways, ports, airports and industrial parks and in establishing special economic zones and logistics hubs. While these advancements support business operations, challenges such as bottlenecks in infrastructure and the need for energy and telecommunications upgrades remain areas for improvement.

Vietnam also benefits from a young and relatively skilled workforce, bolstered by investment in technical and vocational education. However, the availability of highly specialised skills, particularly in high-tech industries, poses a challenge that Vietnam must address to sustain competitiveness in these sectors.

Market entry

Foreign companies entering the Vietnamese market have several options, depending on the level of involvement and strategic objectives. Establishing a **wholly foreign-owned enterprise** allows companies full ownership and maximum control over their operations, making it the preferred choice for those seeking independence and flexibility. Alternatively, a **joint venture** with a local entity offers shared ownership and the possibility of leveraging local market knowledge and networks to enhance market entry.

For companies engaging in preliminary market exploration, a **representative office** provides a low-risk option for conducting market research, advertising and liaison activities. However, representative offices are not allowed to directly carry out commercial operation under the law. **Mergers and acquisitions** offer another route, enabling foreign investors to acquire stakes in established Vietnamese companies to gain access to local operations and an existing customer base.

Other entry strategies include **contractual arrangements**, such as licensing, franchising or distribution agreements with Vietnamese partners. Such agreements provide foreign companies with market access without requiring the establishment of a formal legal entity, making them ideal for businesses seeking a lower level of commitment or a flexible entry point.

1.5 Vietnam's relations with Germany

Diplomatic milestones

After 49 years of diplomatic relations (since 1975), upgraded to a strategic partnership since 2011, the bilateral trade relationship between Germany and Vietnam continues to develop, with the two countries cooperating with and complementing each other. In 1991, the Vietnam–Germany Friendship Association was formed from the previous Friendship Association with the Federal Republic of Germany and the German Democratic Republic. The mutual trust and understanding between Vietnam and Germany have been increasingly strengthened since the two countries established a political consultation mechanism in 2008.

A new phase of Vietnamese–German relations was ushered in with German Chancellor Angela Merkel's official visit to Vietnam in 2011. The two countries committed to a raft of specific projects to enhance mutually beneficial cooperation in various fields, such as strategic political dialogue, economic, trade and investment cooperation, judiciary and law, development cooperation, environmental protection, education, science, technology, culture, media and society (Communist Review, 2011).

Economic and trade cooperation

Economic and trade cooperation has been continuously developed and is a prominent feature of the relationship between the two countries. Vietnam and Germany have signed many economic cooperation agreements, such as the Double Taxation Avoidance Agreement (1997) and the Investment Protection Agreement (1998). Over the past 10 years, total bilateral trade has doubled from USD 5.57 billion in 2011 to over USD 11.24 billion in 2022 (Vietnam News Agency, 2022).

The EU–Vietnam Free Trade Agreement (EVFTA) is an important driving force that enhances economic and trade relations between them. In recent years, Germany has consistently maintained its position as Vietnam's largest trading partner in Europe, accounting for about one fifth of Vietnam's exports to the European Union (EU) market (Le Hai Trieu, Pham The Phuong, 2015). In terms of investment cooperation, as at May 2023, Germany had 444 active FDI projects (total registered capital of over USD 2.36 billion) in Vietnam, ranking 18th out of 143 countries and territories that invest in the country (Government News, 2024). In the first half of 2024, Germany was Vietnam's second largest trading partner in the EU (after the Netherlands), accounting for 17% of total trade between Vietnam and the EU. In a context in which Germany is reducing imports from other markets, the growth in imports from Vietnam is considered a positive sign. (Center for WTO and International Trade of the Vietnam Chamber of Commerce and Industry, 2024).

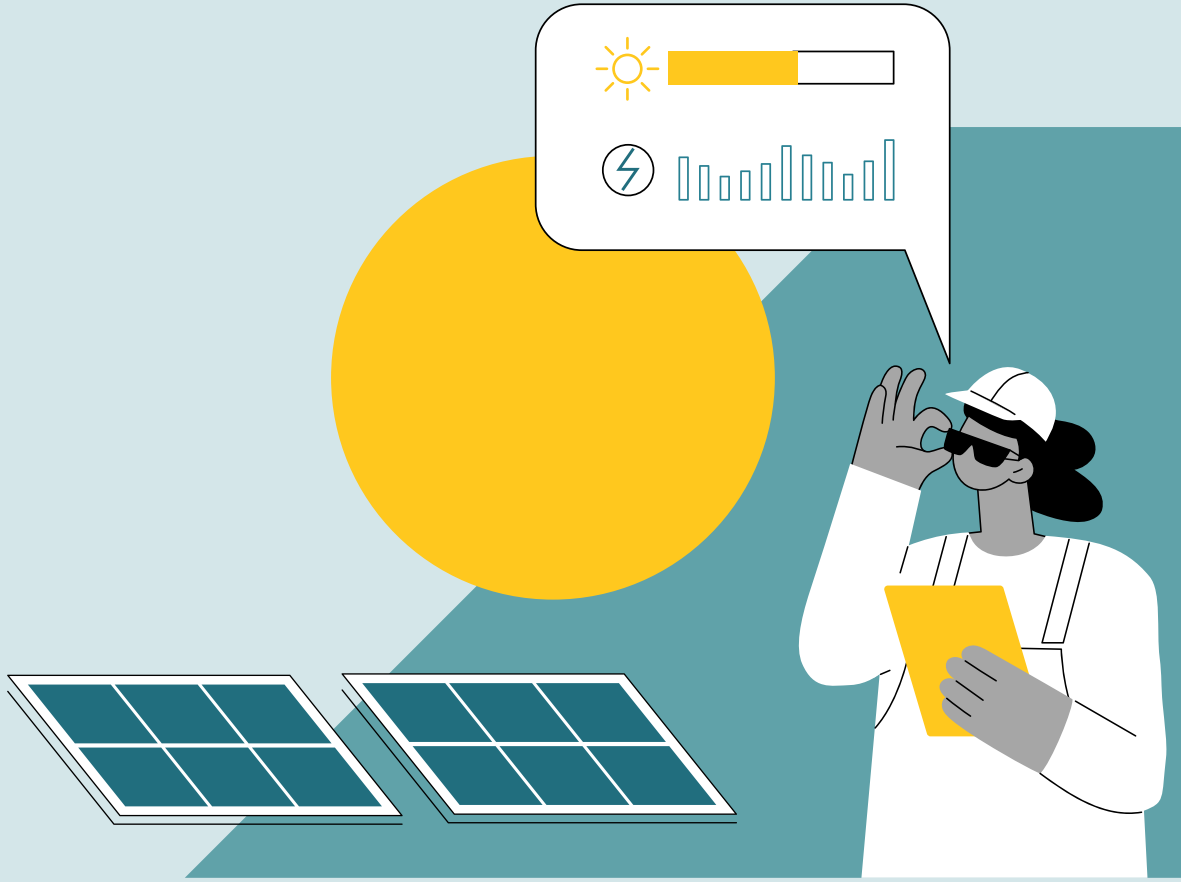
Representative trade bodies for German enterprises

German Industry and Commerce in Vietnam (AHK Vietnam) and the German Business Association (GBA) are key organisations that support German enterprises in Vietnam. AHK Vietnam serves as the official representative of German companies, offering services such as market entry assistance, business matchmaking and regulatory guidance while also advocating for German businesses and fostering bilateral economic cooperation through events and forums (Delegation of German Industry and Commerce in Vietnam, 2024).

GBA complements these efforts by providing networking, advocacy and information for German companies operating in Vietnam. Through seminars, workshops and social gatherings, GBA helps members navigate the Vietnamese market and stay informed about industry trends and regulations. Both organisations play a crucial role in strengthening ties between German businesses and local stakeholders and promoting sustainable economic growth in Vietnam (German Business Association, 2024).

2

Overview of Vietnam's energy sector



2.1 Energy sector development policies and strategy for BESS development

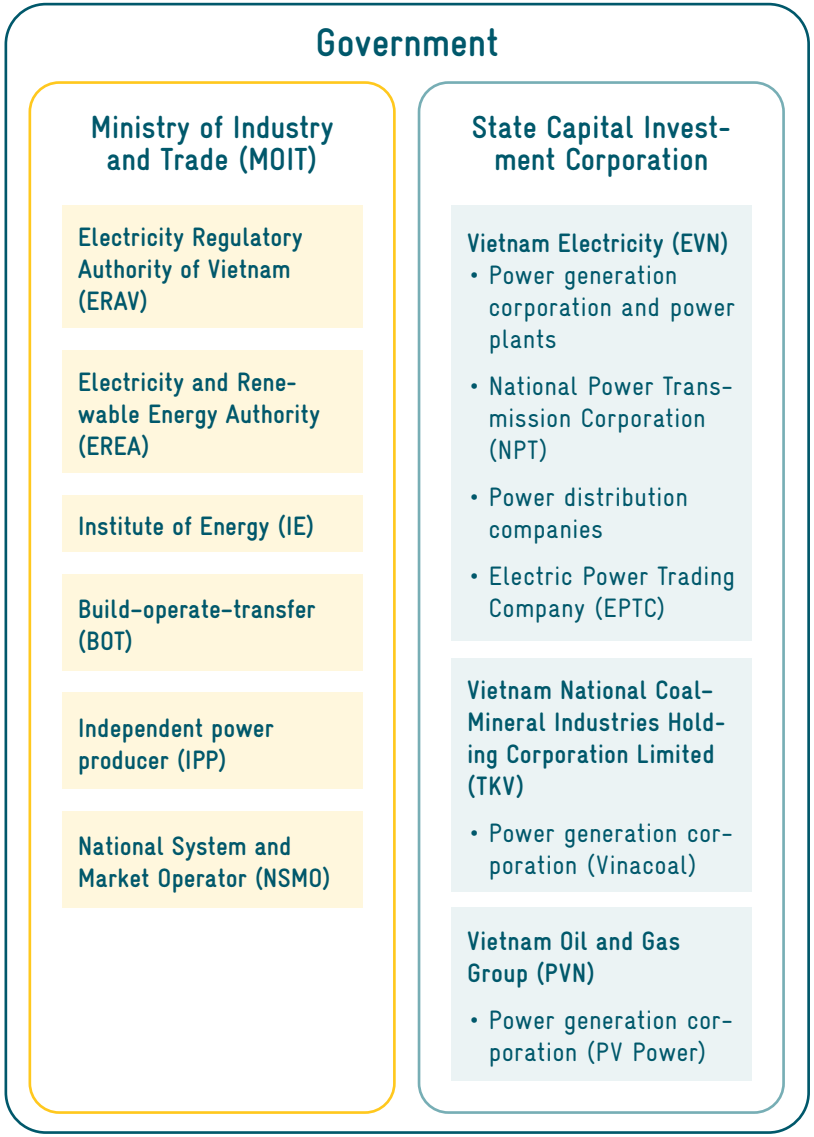
The rapid development of RE in Vietnam, particularly wind and solar power, requires BESS deployment to buffer the intermittency of these sources and ensure grid reliability. Vietnam's National Power Development Plan 2021–2023, with a vision to 2050 (PDP VIII) emphasises that the development of solar energy should be combined with the installation of BESSs when the cost is reasonable and that they should be located close to wind and solar power generation sites and load centres. The plan expects storage batteries to reach a capacity of 300 MW by 2030, accounting for 0.2% of Vietnam's total electricity capacity. However, the policy framework for BESSs in Vietnam is still being refined and will continue to be adjusted to align with the country's economic and environmental development goals.

2.2 Administrative division of responsibilities in the energy sector

Vietnam's electricity industry operates under unified government management guided by the Electricity Law, which covers power generation, transmission, distribution, trading and construction consulting. The sector involves diverse entities, including state-owned groups such as Vietnam Electricity (EVN), Vietnam Oil and Gas Group (PVN) and Vietnam National Coal–Mineral Industries Holding Corporation Limited (TKV), alongside private enterprises and foreign investors participating through build–operate–transfer (BOT) and independent power producer (IPP) models.

The government manages the sector through the Electricity and Renewable Energy Authority (EREA), the Electricity Regulatory Authority of Vietnam (ERAV) and the National System and Market Operator (NSMO) under the Ministry of Industry and Trade (MOIT). These agencies oversee regulation, supervision and coordination to ensure the efficient operation of the electricity sector.

FIGURE 3. Organisational structure of the electricity sector

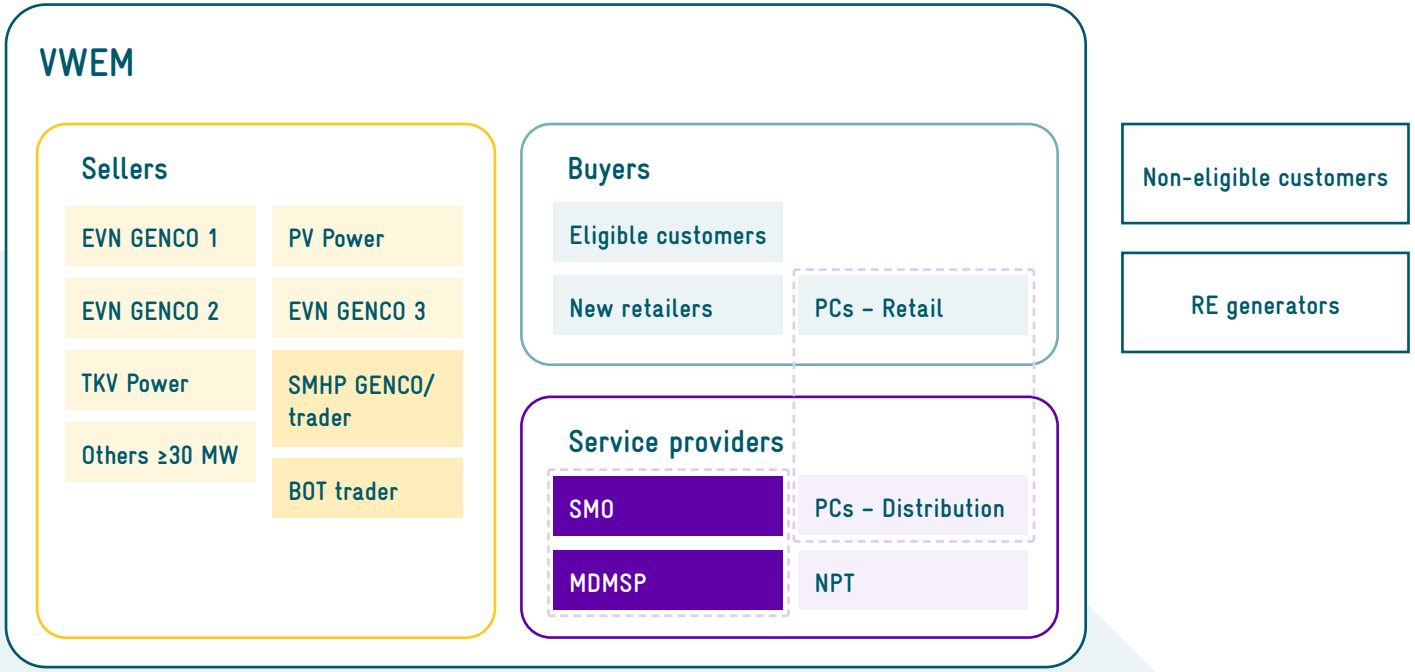


Source: Authors' own compilation, Hapeco (2024)

2.3 Energy market structure and actors

Market participants in the electricity sector

FIGURE 4. Actors and organisational structure of the Vietnam Wholesale Electricity



Source: National Load Dispatch Centre, 2019

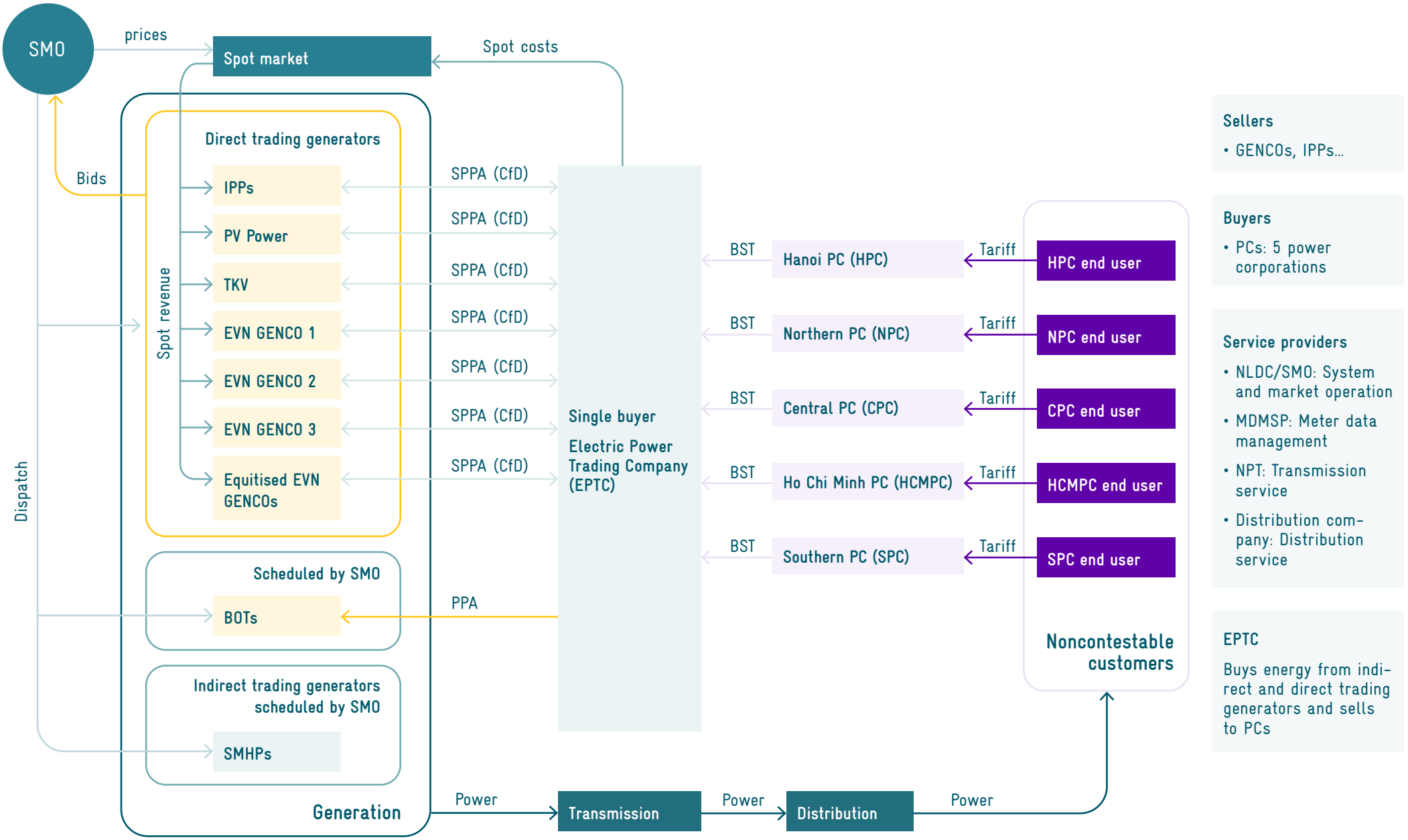
Real-time electricity market

- Market model: A cost-based bidding model (cost-based pool)
- Transaction–dispatch cycle: 30 minutes
- Bidding: Day-ahead bidding applies. Generators prepare a bid for 48 trading cycles for the next day and submit it to the electricity system and market operator. The generators bid within the range of floor and ceiling prices for the total available generation capacity, including a maximum of 10 pairs of bid prices (VND/kWh) and capacity (MW) for each generating unit in each trading cycle.

Contract mechanism

- Contract allocation (vesting contracts): An allocation process is carried out, according to which contracts for difference (CfD) are signed between the generator and EVN and subsequently between the generator and power corporations.
- Bilateral contracts: The seller and buyer negotiate and agree on the price and committed output, signing a bilateral CfD.
- Centralised contract trading mechanism: Participants offer or bid for contract output on the exchange, according to the competitive wholesale electricity market regulations. Centralised contract trading aims to address discrepancies (surplus or shortage) between the signed contract output and the actual load demand or generation capacity of the generators.

FIGURE 5. Vietnam's competitive electricity market – Single buyer model



Source: National Load Dispatch Centre, 2019

2.4 Electricity generation and consumption

Electricity generation

Vietnam's total installed capacity increased to more than 87 GW in 2024. RE capacity has grown significantly from just 0.6 GW in 2018 to 23.3 GW in 2024, accounting for 26.7% of overall system capacity.

Output from RE sources accounts for 14% of total system output.

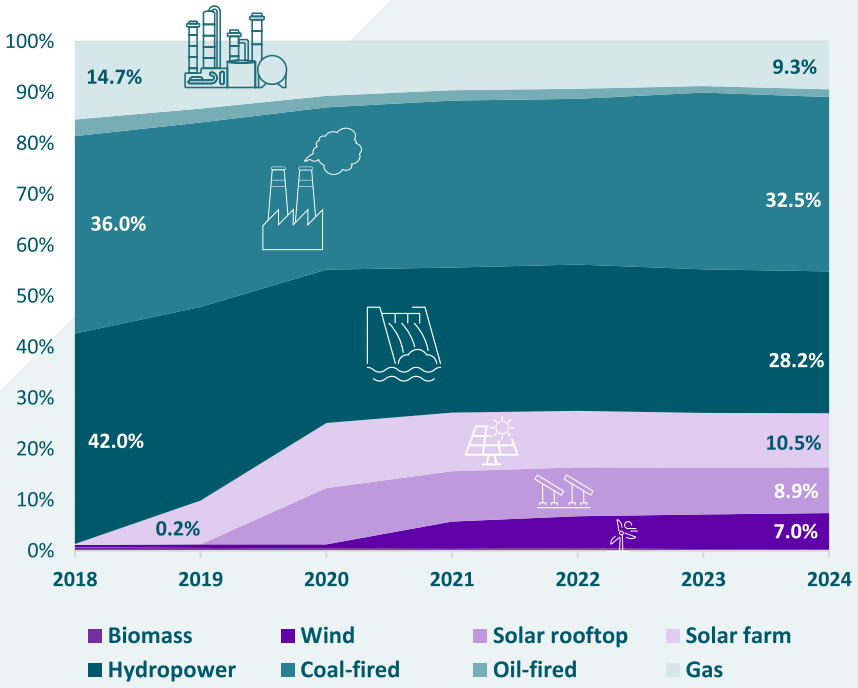
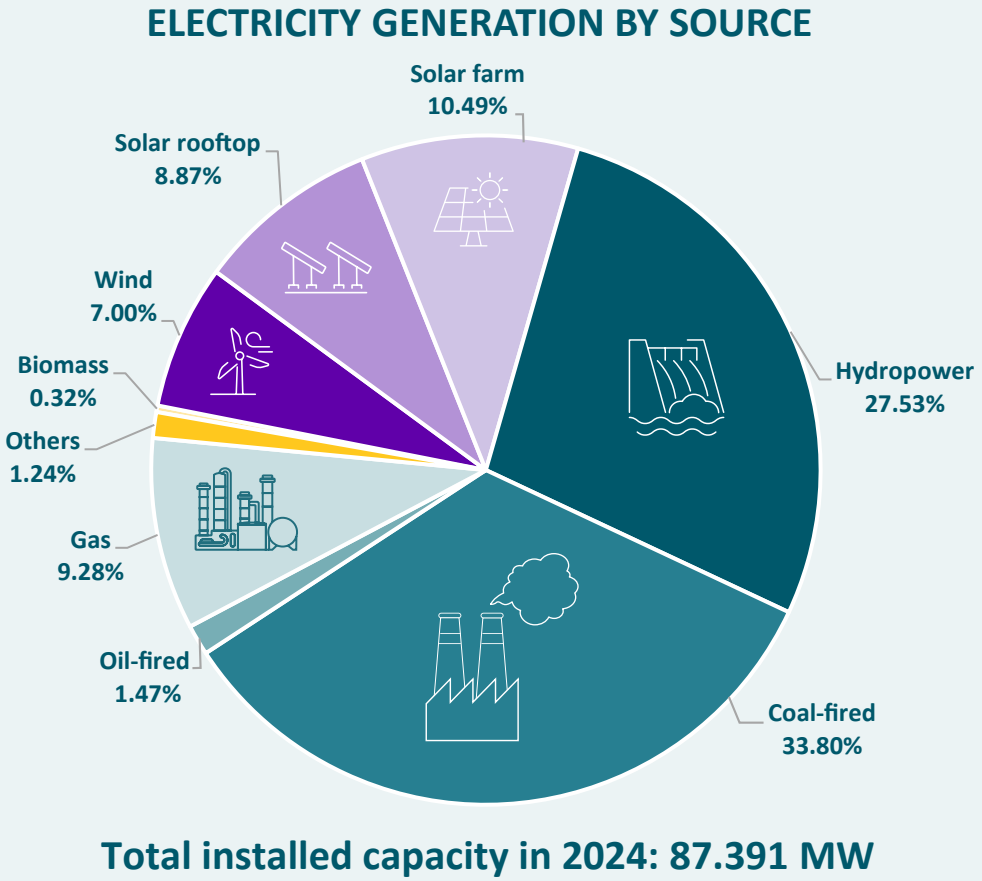
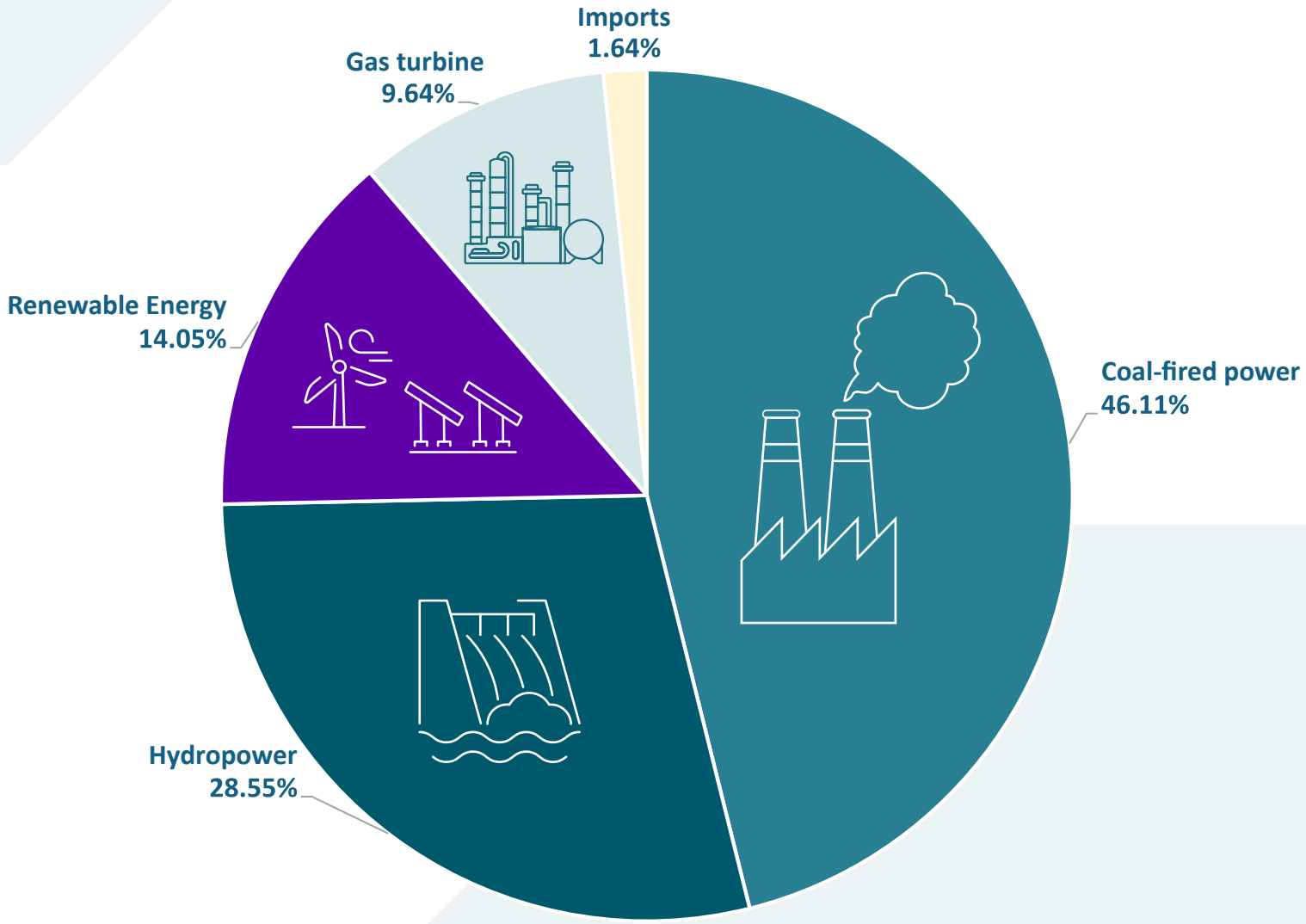


FIGURE 6. Changes in Vietnam's electricity generation mix from 2018 to 2024



Source: Authors' own compilation, Hapeco (2024), based on (National System and Market Operator, 2024)

FIGURE 7. Electricity generation in 2023



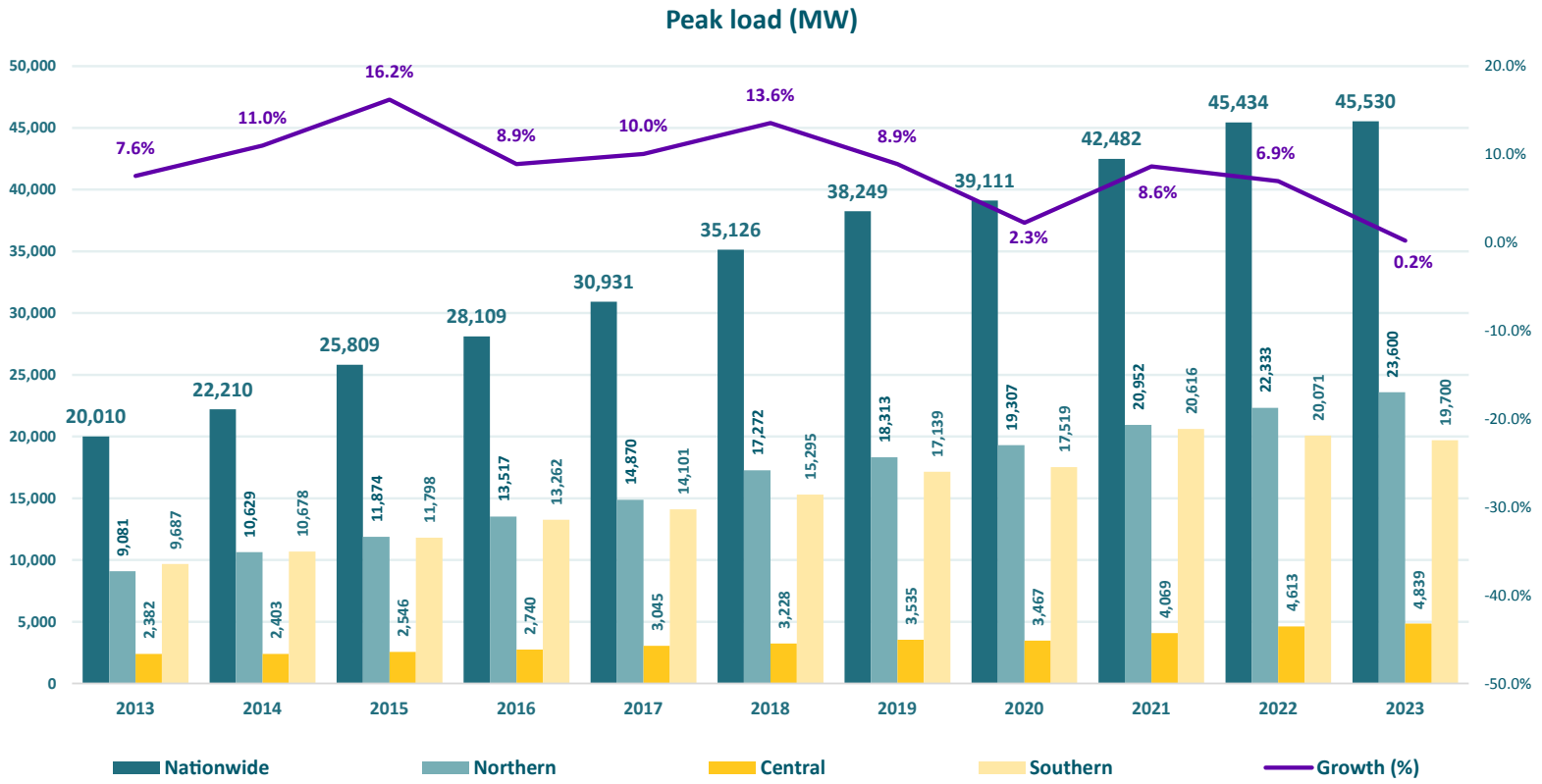
Source: Authors' own compilation, Hapeco (2024), based on (National System and Market Operator, 2024)

Electricity consumption

The average national load growth rate was 8.6% a year in the period from 2013 to 2023. The Northern region accounts for the highest proportion, followed by the Southern region and, lastly, the Central region.

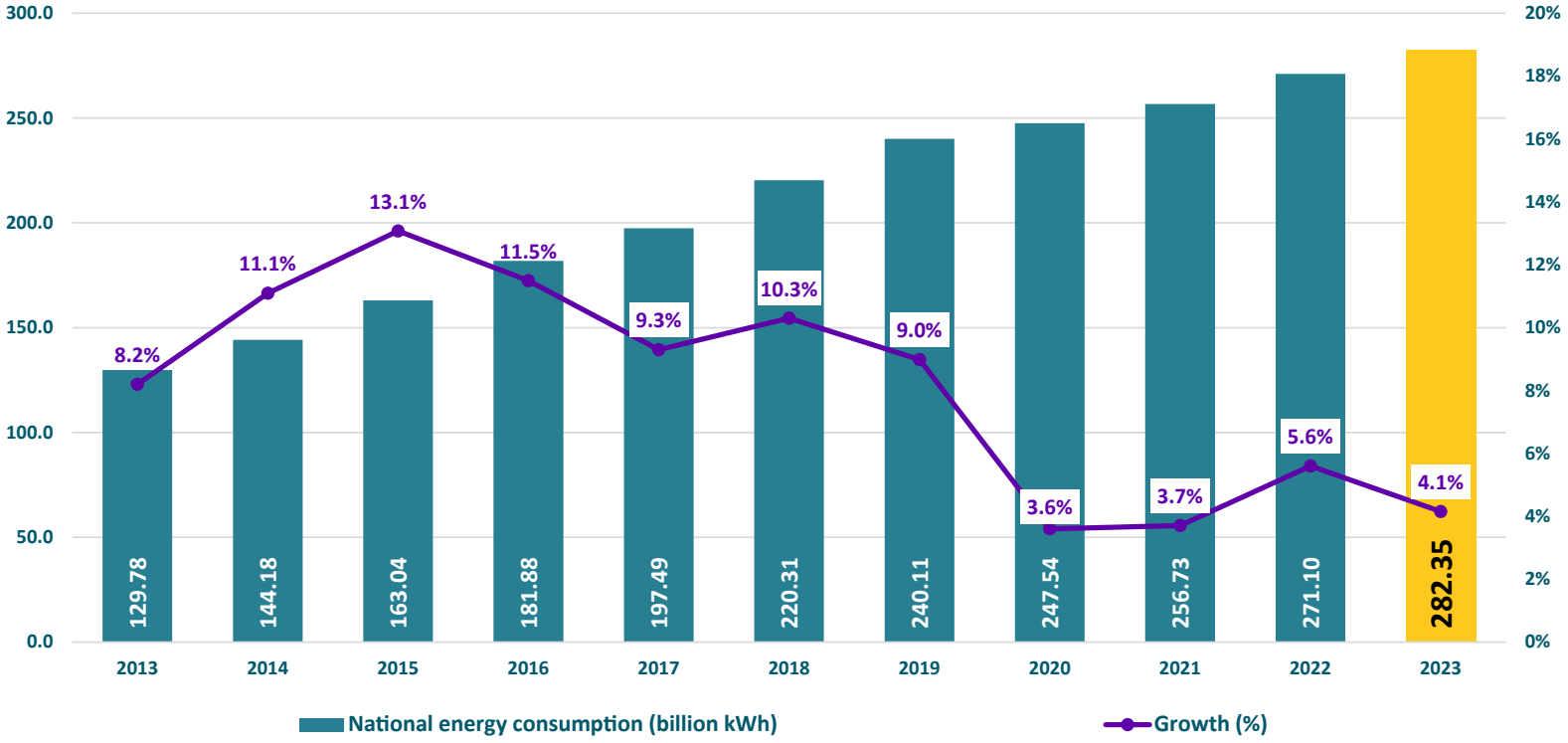
The average growth rate for system output was 8.3% a year in the period from 2013 to 2023.

FIGURE 8. Peak load nationwide and by region in Vietnam from 2013 to 2023



Source: Authors' own compilation, Hapeco (2024), based on (National System and Market Operator, 2024)

FIGURE 9. Growth of national power system output from 2013 to 2023



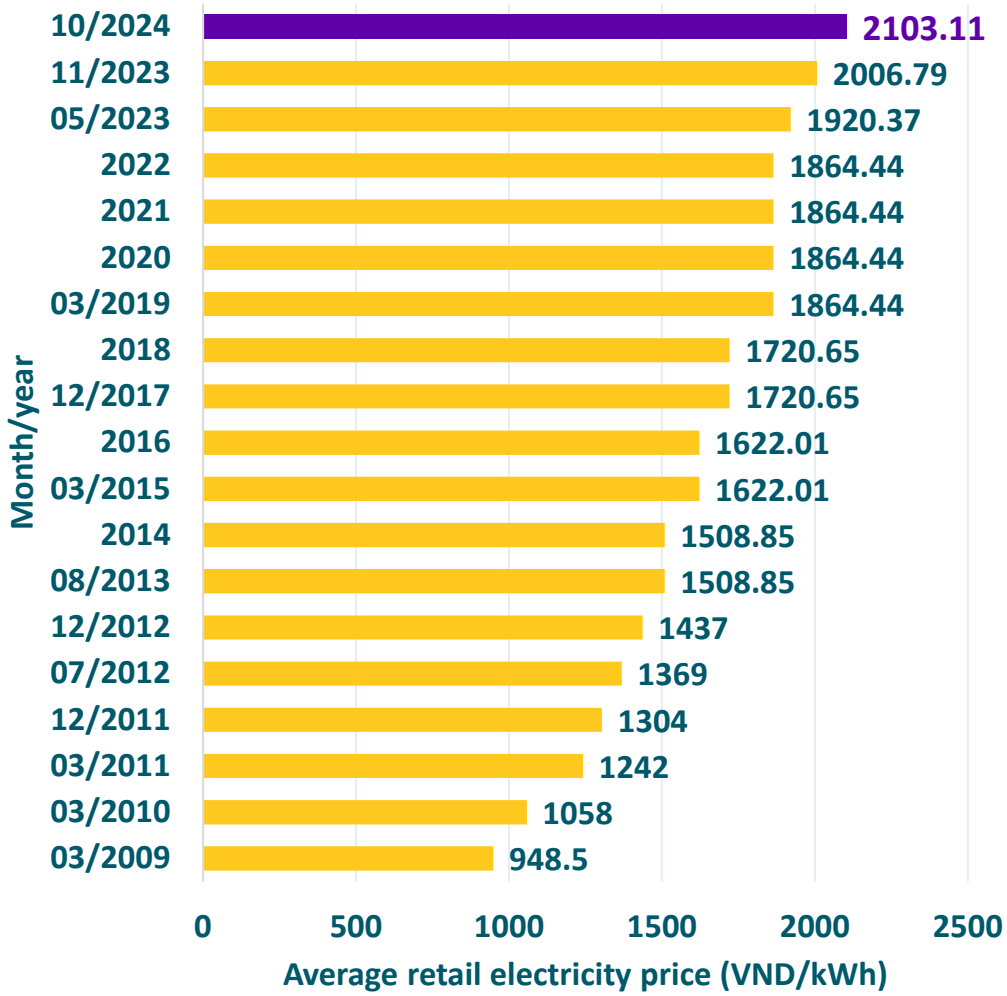
Source: Authors' own compilation, Hapeco (2024), based on (National System and Market Operator, 2024)

2.5 Electricity and fuel tariffs, historical data and forecasts

Electricity

The average retail electricity price is determined periodically by calculating total production and business costs, plus a reasonable average profit margin, per kWh of commercial electricity.

FIGURE 10. Average retail electricity price in Vietnam from 2009 to 2024



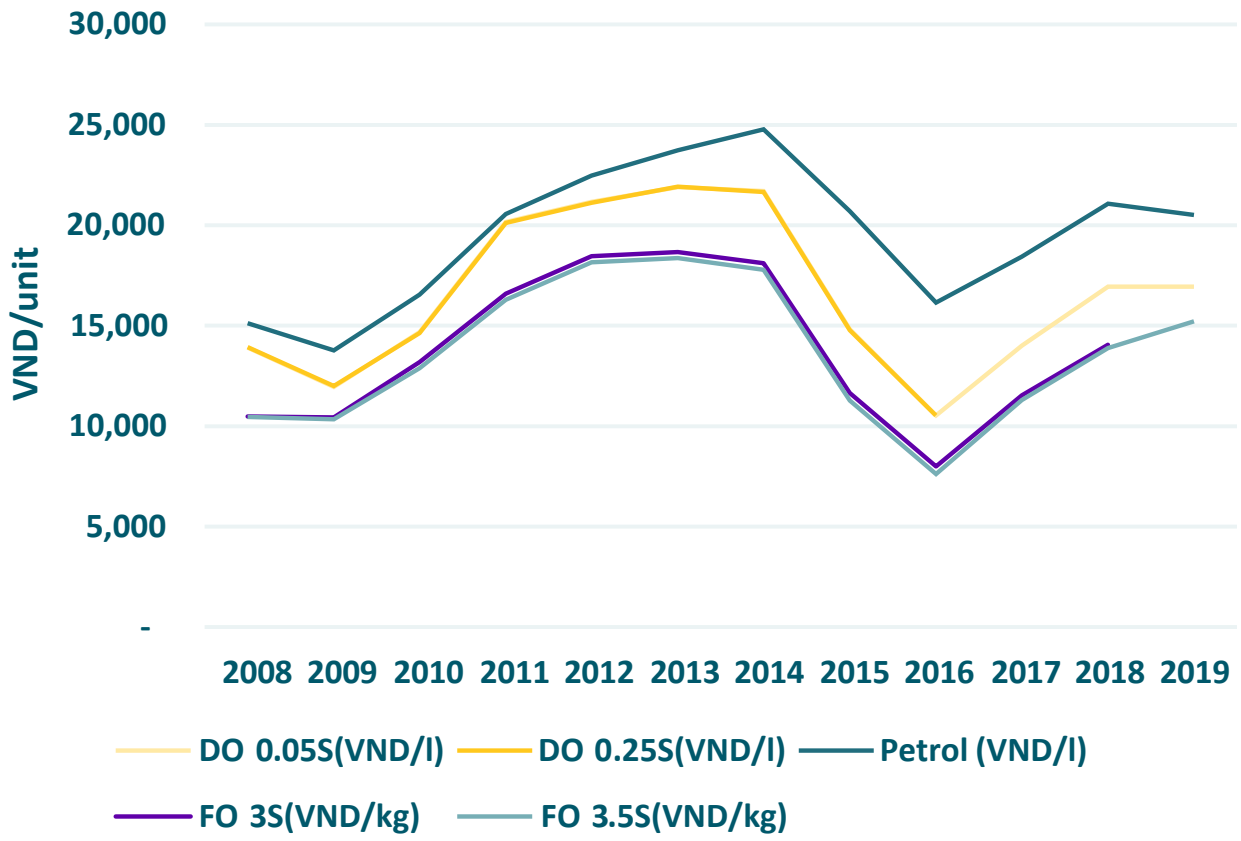
Source: Authors' own compilation, Hapeco (2024)

Petroleum products

The government establishes 'base prices' as price ceilings for petroleum products. The formula for determining these ceilings for consumer prices incorporates various taxes and fees, such as import duties, special consumption taxes on petrol, including E5, a stabilisation fund fee, an environmental protection tax and value added tax (VAT). These taxes and fees allow the government to adjust the selling prices of petroleum products at its discretion (Danish Energy Agency, Embassy of Denmark, MOIT & EREA, 2021).

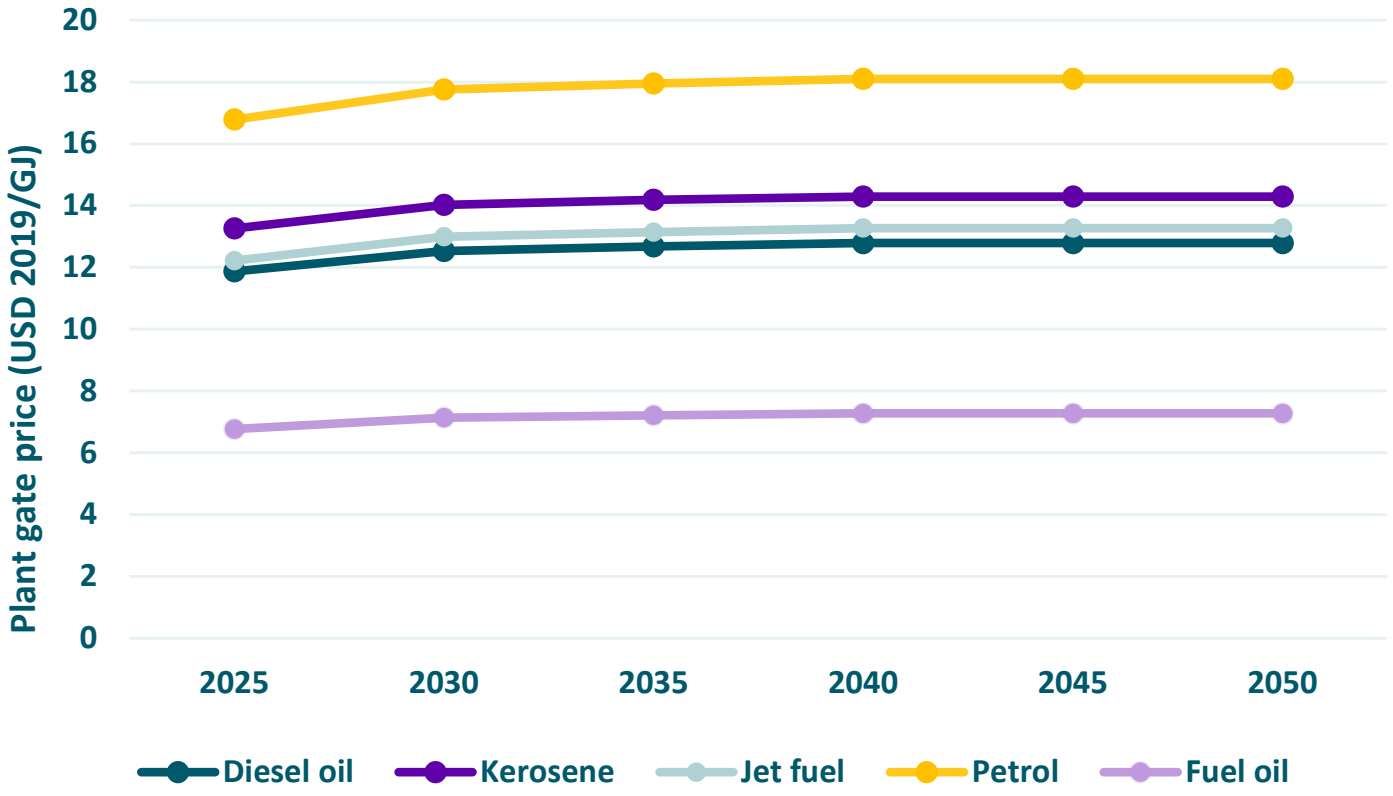
Base prices for domestic oil products are adjusted every 15 days in accordance with global oil prices. As a result, domestic oil prices closely correlate with world crude oil prices. Domestic cost, insurance and freight oil prices are projected based on the anticipated growth rate of global crude oil prices (Danish Energy Agency, Embassy of Denmark, MOIT & EREA, 2021).

FIGURE 11. Average domestic retail prices for petroleum products in Vietnam from 2008 to 2019



Source: Danish Energy Agency, Embassy of Denmark, MOIT & EREA, 2021

FIGURE 12. Projections for domestic oil product prices under the main scenario from 2025 to 2050



Source: Authors' own compilation, Hapeco (2024), based on (Danish Energy Agency, Embassy of Denmark, MOIT & EREA, 2021)

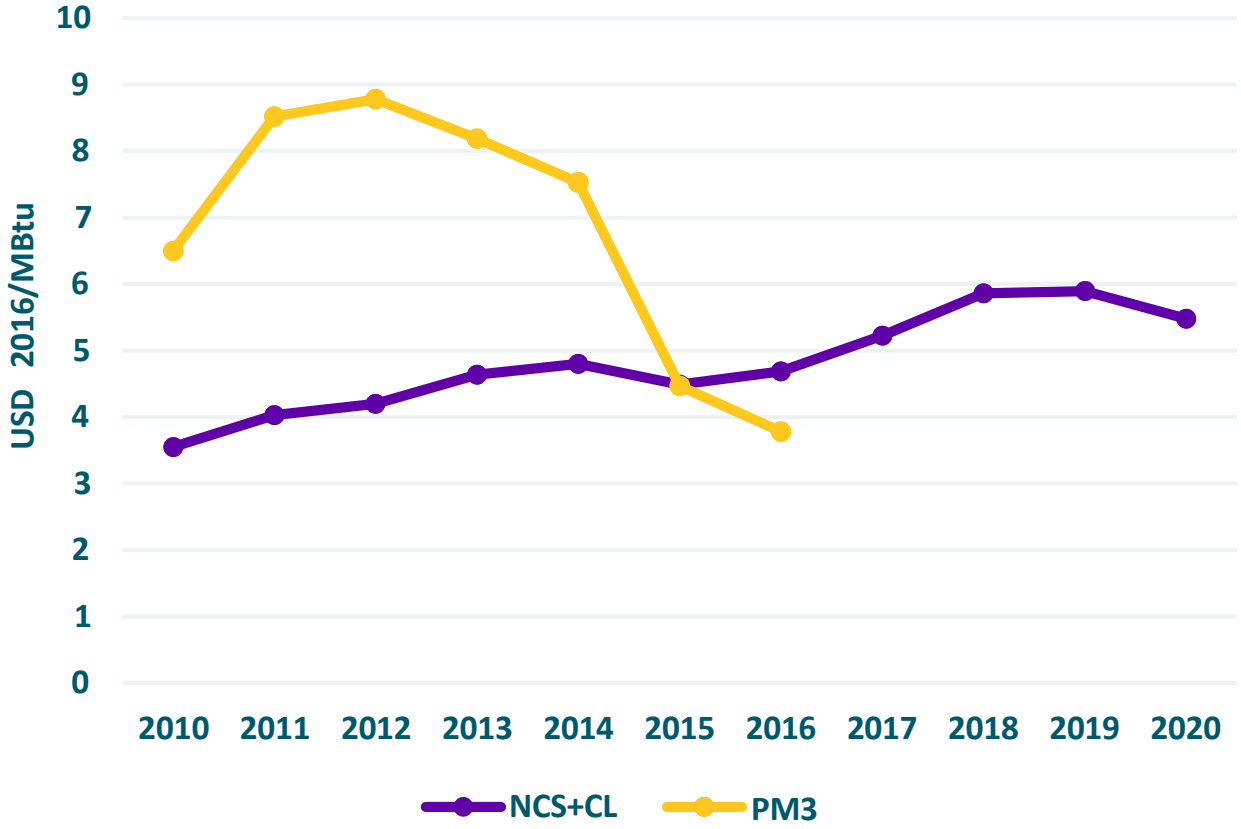
Natural gas

In recent years, the decline of gas fields nearing the end of their productive life and with low prices has been offset by new gas fields coming online that boast large reserves and higher prices. Wellhead prices can be established through bilateral negotiations, government pricing regulations or indexation to fuel oil prices. Pipeline and distribution costs vary significantly depending on the gas field. Two major gas fields in Vietnam are PM^3, located in the PM^3–CAA Block in the Gulf of Thailand in the overlapping petroleum area between Malaysia and Vietnam, and the Nam Con Son–Cuu Long gas field (NCS+CL), located offshore in southern Vietnam.

Future wellhead gas prices are expected to be considerably higher than current prices. Additionally, gas prices may be determined in the future using a 'pass-through' mechanism linked to the electricity buyback rate of gas-fired power plants.

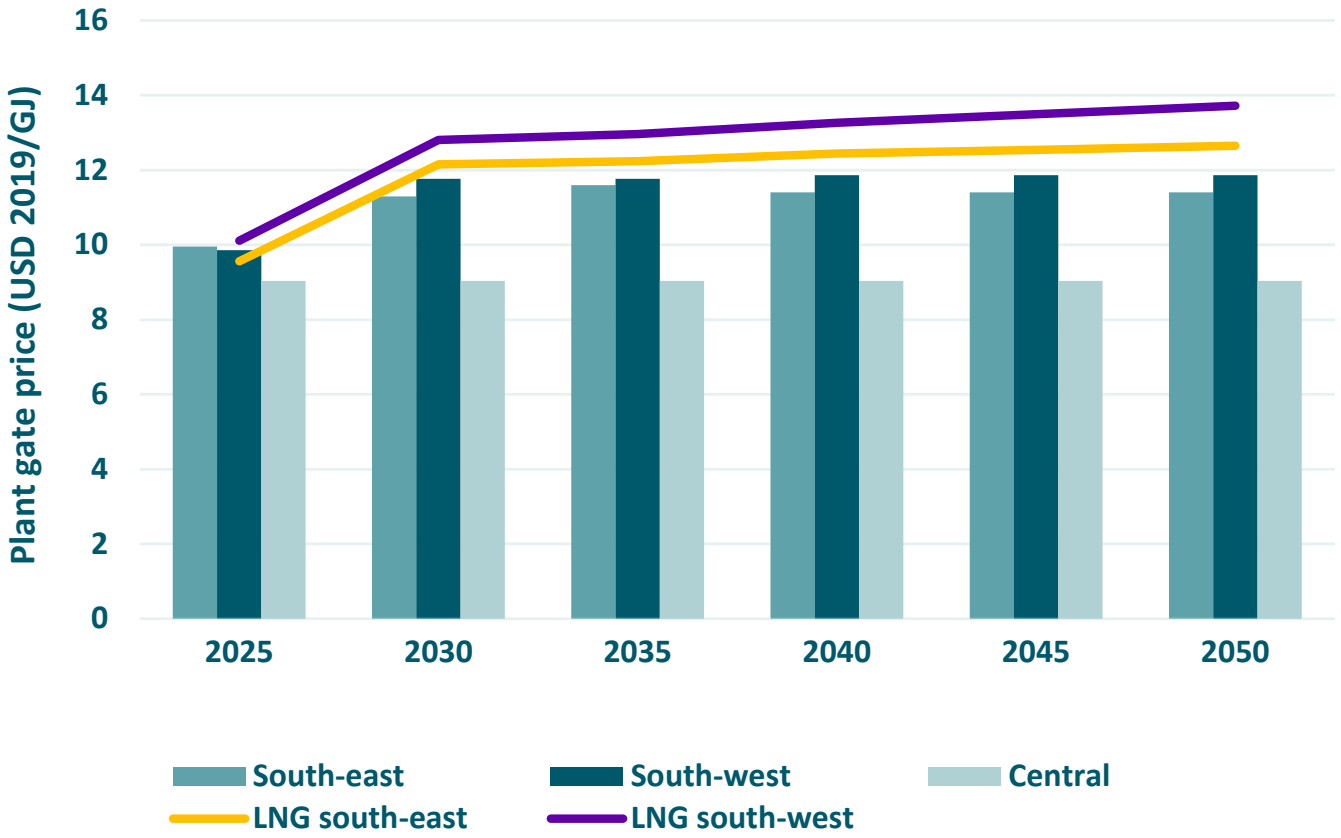
Due to the high prices of natural gas from Block B (natural gas field located in the Gulf of Thailand, off the south-west coast of Vietnam), imported liquefied natural gas (LNG) can compete with domestic natural gas until 2025. After 2025, the price of domestic gas in the south-west of Vietnam will need to be adjusted to remain competitive compared to imported LNG. Starting in 2025, regional gas prices may be determined by LNG prices.

FIGURE 13. Historical gas prices by field from 2010 to 2020



Source: Danish Energy Agency, Embassy of Denmark, MOIT & EREA, 2021

FIGURE 14. Projections for domestic natural gas and imported LNG prices under the main scenario from 2025 to 2050



Source: Authors' own compilation, Hapeco (2024), based on (Danish Energy Agency, Embassy of Denmark, MOIT & EREA, 2021)

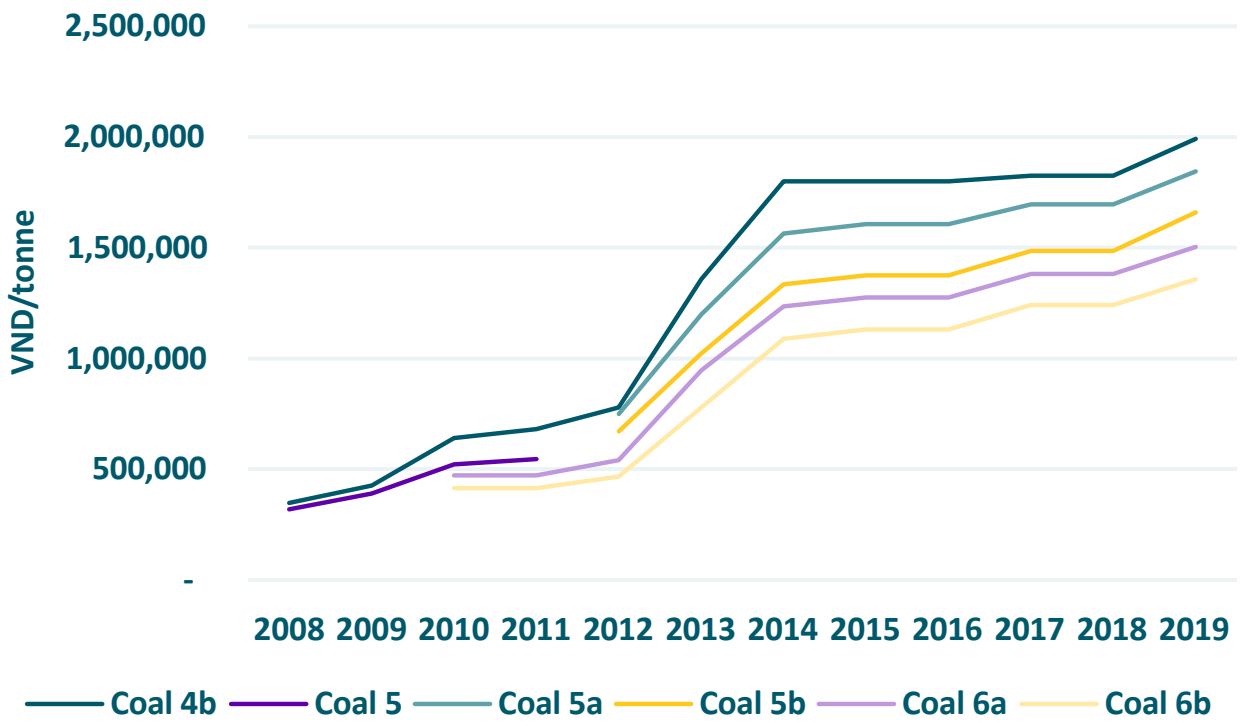
Coal

Vietnamese coal prices are regulated by the government and, historically, domestic coal prices have been kept artificially low. Starting in 2014, subsidies for coal used in power plants were removed. The following are factors in current coal pricing:

- Coal prices are subject to natural resources, environmental protection and export taxes
- The low frequency of coal price adjustment results in a delayed response to global coal price trends and a failure to maintain stable prices for domestic users
- The government regulates export taxes and/or export quotas to limit coal exports, with a view to ensuring sufficient supply to meet domestic demand

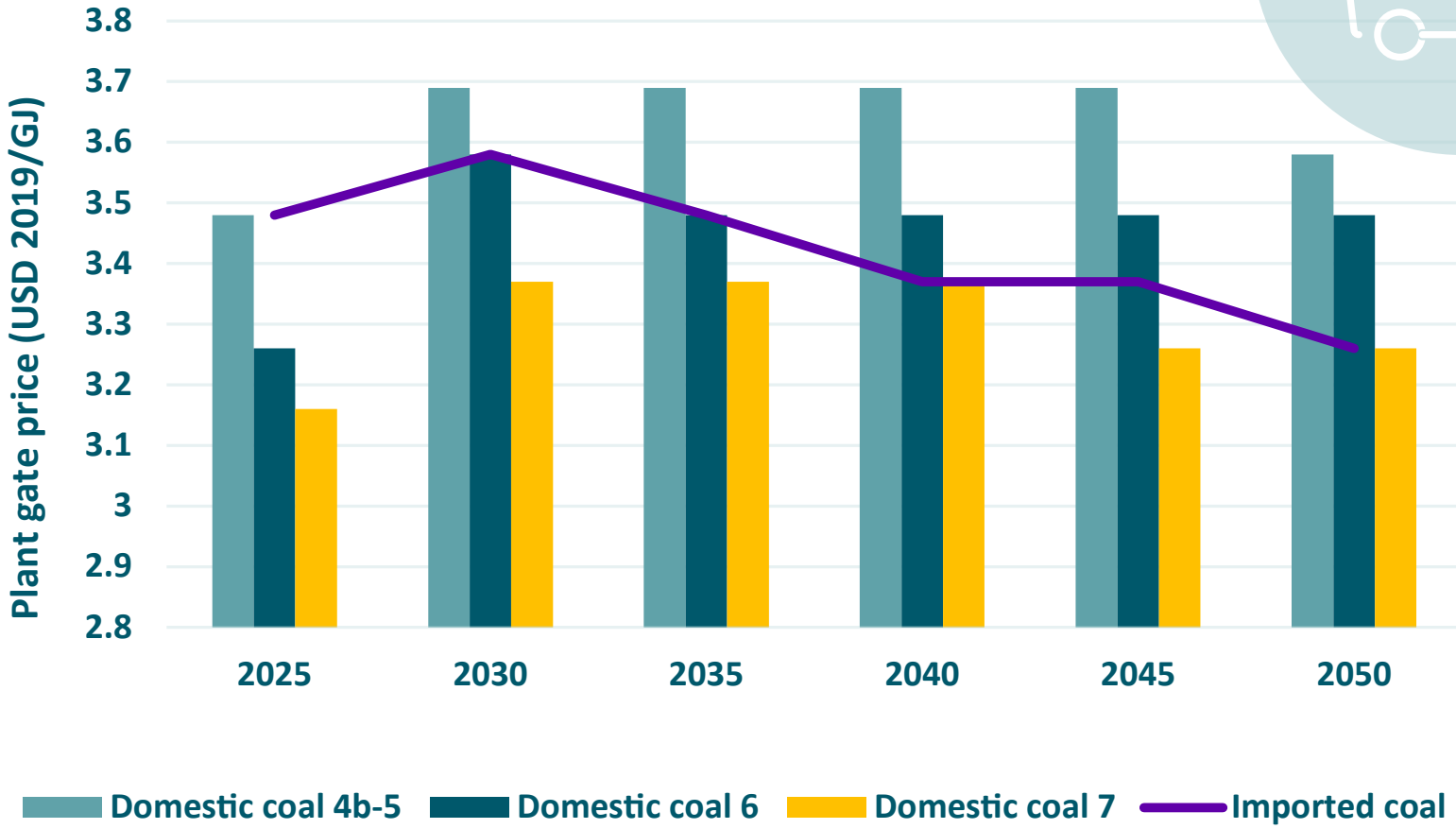
Given the trend of rising domestic production costs, coal production in Vietnam may fall short of planned targets if global coal prices decline due to climate change policies. After 2030, domestic coal prices are expected to surpass those of imported coal.

FIGURE 15. Average domestic coal prices by coal type from 2008 to 2019



Source: Danish Energy Agency, Embassy of Denmark, MOIT & EREA, 2021

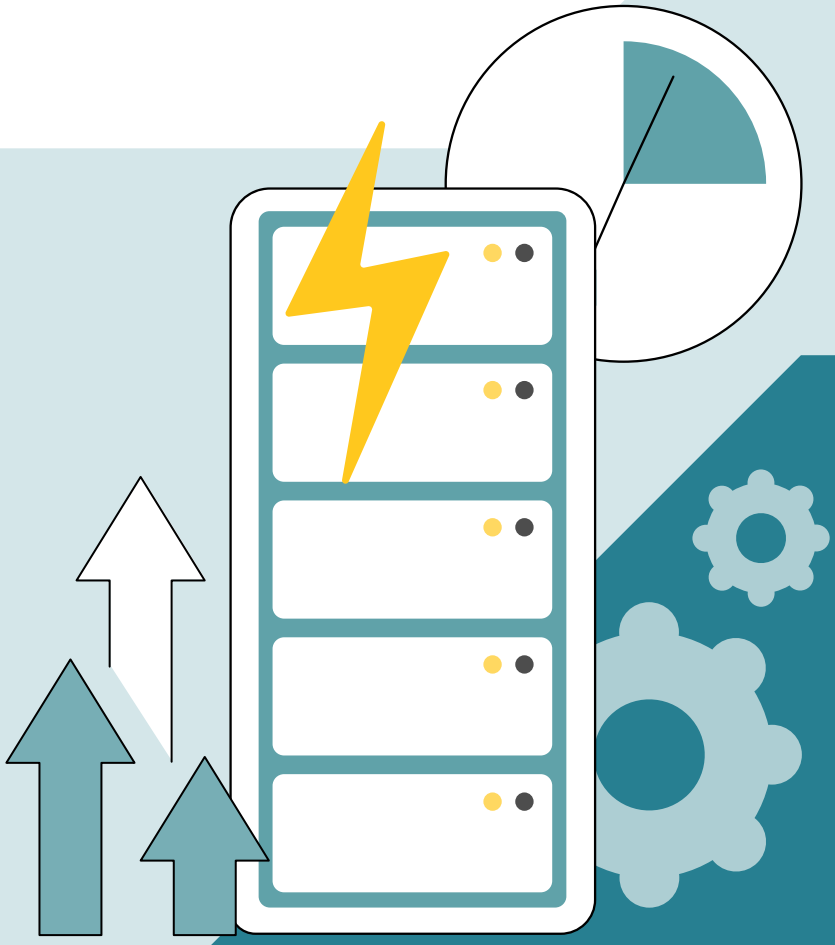
FIGURE 16. Projections for domestic coal prices under the main scenario from 2025 to 2050



Source: Authors' own compilation, Hapeco (2024), based on (Danish Energy Agency, Embassy of Denmark, MOIT & EREA, 2021)

3

Detailed analysis of BESSs in Vietnam



3.1 Government measures to incentivise BESS roll-out

Referring to BESS roll-out, the PDP VIII emphasises that 'the development of solar power should be combined with the installation of BESSs when the cost is reasonable' and that these BESSs should be 'located near wind and solar power generation sites and load centres'. This plan anticipates that storage batteries will reach a capacity of 300 MW by 2030, accounting for just 0.2% of Vietnam's total power capacity. The implementation of BESS projects is currently in the experimental phase, with the feasibility and benefits of BESSs being assessed under various conditions and contexts, including large-scale storage projects combined with renewable power plants. The BESS pilot projects are described below.

Project to implement in Vietnam the political declaration on establishing the Just Energy Transition Partnership (JETP), which is an international initiative designed to support developing countries in transitioning to RE by mobilising financing to reduce emissions and ensure sustainable development:

- Investment in a pilot project for a 50 MW/50 MWh BESS by EVN to develop ancillary services, design the pricing mechanism and establish technical standards
- Pilot project for a 7 MW/7 MWh BESS integrated with a 50 MW solar farm and a project for a 105 MW/105 MWh BESS integrated with a 400 MW solar farm
- Time frame: January 2024 to December 2029.

Document No. 399/EVN KH of 21 January 2022 on EVN investment in BESSs to ensure the power supply in the Northern region:

- Two pilot projects are proposed for BESS sites at Dong Anh 110 kV substation (Ha Noi) and Trinh Xuyen 110 kV substation (Nam Dinh) with 50 MW/100 MWh capacity each
- The operating and management costs of the BESSs are approved as reasonable eligible costs and accounted for in the production/business electricity costs of EVN or its units
- The MOIT is recommended to amend and supplement relevant circulars and processes to fully meet operating requirements for BESSs in the power system

On 22 October 2024, the government issued Decree No. 135/2024/ND CP outlining mechanisms and policies to encourage the development of solar power systems to produce electricity for self-consumption, installed on the rooftops of buildings, including residential houses and government offices, buildings in industrial zones, industrial clusters, export processing zones, high-tech zones and economic zones, production facilities and business establishments, in line with legal requirements for investment and construction. The decree encourages organisations and individuals to install energy storage systems to ensure the safe and stable operation of the power system. In particular, it sets no limits on the installation of BESSs for rooftop solar power plants under the self-consumption model, making no reference to the target of 300 MW by 2030 specified in the PDP VIII. On 3 July 2024, the government issued Decree No. 80/2024/ND CP on the DPPA mechanism, creating opportunities for BESS development. The mechanism enables RE generators to sign DPPAs with large electricity consumers for electricity trading via one of two options: a private connection line or the national power grid. BESSs play a key role in optimising the storage of surplus energy during periods when supply exceeds demand and in providing electricity when demand exceeds supply, thus enhancing the economic efficiency of DPPAs. Furthermore, the implementation of DPPAs encourages investment in RE, which in turn boosts demand for BESSs to address challenges related to the intermittency of RE sources such as wind and solar.

3.2 BESS technologies in Vietnam

The BESS technologies currently available in the market are diverse and have been developed to meet different energy storage and management needs. Some key BESS technologies are described below.

- Lead acid (PbA) battery: PbA batteries stand out as a mature and widely adopted BESS technology option, benefiting from decades of experience, particularly in the automotive industry. These batteries utilise a lead dioxide cathode, a lead anode and sulphuric acid as the electrolyte. They are characterised by fast response times, minimal daily self-discharge rates (<0.3%), relatively high cycle efficiencies (75%–85%) and low capital costs. However, they also have notable drawbacks, including poor performance in low-temperature conditions, often necessitating a thermal management system, limited durability (in terms of both lifespan and cycle life) and environmental concerns due to their lead content. PbA batteries can be used in a large variety of applications, such as:
  - Stationary stand-by and uninterruptible power supply (UPS) systems (telephone and computer centres)
  - Energy management applications (grid-connected energy storage and off-grid household and residential electric power systems)
  - Motive power applications (e.g. in forklifts and hybrid and full electric vehicles)
  - Starter batteries (e.g. starting, lighting, ignition) requiring high power at low temperatures
- Lithium-ion (Li-ion) battery: These batteries are very efficient (75%–90%) and reliable and have good energy density (120–250 Wh/kg) and a slow self-discharge rate (<1%/day). However, they are still expensive for medium- and large-scale applications. The cycle depth of discharge can affect battery life, and the battery pack usually requires an on-board computer to manage its operation, which increases its overall cost.

  The Li-ion battery is considered a good candidate for applications where the response time (milliseconds), small size and/or low weight are important. Owing to their high scalability and flexibility in power and energy, they are used in a large variety of applications:
  - Residential and commercial buildings: time shifting and self-consumption of locally produced photovoltaic energy
  - Distribution grids: voltage, capacity and contingency support in smart grids
  - Transmission grids: ancillary services, namely frequency regulation
  - Renewable generation: smoothing and shaping functions associated with voltage and frequency support to ensure better integration of large renewable power plants into the electricity system
- Vanadium redox battery (VRB): The VRB is one of the most mature flow battery systems. It has a fast response time (faster than 0.001 second), symmetric charge and discharge and high cycle reversibility and can operate for more than 13,000 cycles. They have a relatively high efficiency of up to 75%, with the capacity to provide continuous power for more than 24 hours. They can also be optimised for either real power (MW) or reactive power (MVAr). However, drawbacks include low electrolyte stability and solubility leading to low energy density, the toxicity of some of the materials used and the relatively high operating cost.

  VRBs can be used in a large number of applications, mainly to enhance power quality for stationary applications and UPS devices, improve load levelling and power security and buffer the intermittency of RE-based power generation. The most common applications are:
  - Large-scale non-mobile energy storage applications
  - Peak shaving
  - Energy time shifting

- Sodium sulphur (NaS) battery: It is a high-temperature battery, which uses molten sodium and molten sulphur as the two electrodes and beta-alumina as the solid electrolyte. The working temperature is in the region of 300 °C to ensure the electrodes are in liquid states, which leads to a high reactivity.

  The advantages of this type of battery include rapid charge/discharge reversibility, efficient operation, relatively high energy density (100–120 Wh/kg), near-zero daily self-discharge, high rated capacity (>250 MWh), high pulse power capability, low maintenance, relatively long life and good scale production potential. This type of battery uses inexpensive, non-toxic materials, making it highly recyclable (~99%). However, it needs to maintain a high operating temperature, which discharges it indirectly and leads to high annual operating costs and the need for an extra system to ensure the required temperature. There may also be problems with corrosion that impair its reliability.

  It is considered an economical option for power quality, peak shaving, time shifting and stabilisation of wind farms and solar power plants.

Currently, Li-ion technology is leading the market due to its widespread use and high efficiency. However, emerging technologies, such as the VRB and the NaS battery, are also being researched to reduce costs and enhance their applicability in large-scale storage projects.

TABLE 1. Characteristics of BESS technologies for stationary applications

Parameter/ technology	PbA	Li-ion	VRB	NaS
Power rating (MW)	0.01 – 50	0.01 – >50	0.005 – >50	0.5 – <50
Discharge time	Min – >20 h	Min – 4 h	5 – 8 h	6 – 7 h
Gravimetric energy density (Wh/kg)	30 – 50	120 – 250	10 – 75	100 – 120
Volumetric energy density (Wh/l)	50 – 80	200 – 600	15 – 35	150 – 250
Power density (W/kg)	75 – 300	100 – 5,000	~170	150 – 230
Efficiency (%)	75 – 85	75 – 90	70 – 75	75 – 90
Durability (years)	5 – 15 (~10)	15 – 20	10 – 20	<15
Durability (cycles)	500 – 3,000	2,000 – 10,000	>13,000	2,000 – 5,000
Response time	Milliseconds	Milliseconds	Milliseconds	Milliseconds, if hot

Source: GOPA–International Energy Consultants GmbH, 2020

3.3 Licensing for BESS installation

Licensing for power generation is currently regulated by Circular No. 36/2018/TT BCT (16 October 2018, replacing Circular No. 12/2017/TT BCT). It establishes the following main conditions and requirements that BESSs (like generators) must comply with.

a. Article 3. Electricity licence exemptions

- Where the electricity generated is for domestic consumption and is not sold to organisations or individuals
- Where the electricity generated is sold to organisations or individuals and installed capacity does not exceed 1 MW (or 1 MWp if it is a solar power plant installed at a single location and having one point of connection)
- Where electricity traders in rural, mountainous or island regions purchase electricity with a capacity not exceeding 50 kVA from electricity distributors and supply it directly to consumers in such regions
- Where electricity activities are carried out for national electrical load dispatch and electricity market management

b. The licence is valid for 10 years for power plants that are not on the list, approved by the Prime Minister, of large-scale power plants of special importance in socio-economic terms or for national defence and security

c. Article 7. Application for an electricity generation licence

- The application for an electricity licence must be submitted using Form No. 1 provided in the appendix to the circular
- Certified copy of the business registration certificate
- List of technical and shift managers on Form 3b (attached to the circular), copy of qualifications, electrical safety cards and electricity operation certificates issued by the corresponding dispatch unit for shift managers and power plant lease, operation and management agreements (if any)
- Certified copy of investment certificates
- Copy of environmental certificates and approval
- List of equipment requiring occupational safety inspection, according to applicable regulations
- Copy of fire safety approval and certificate for the installed fire safety system
- Technical specifications and inspection reports
- Inspection certificates for IT infrastructure, telecommunications and the supervisory control and data acquisition (SCADA) system
- In the case of off-grid stand-by generators that only supply customers in the event of grid power failure, the above requirements do not apply; if the electricity produced by the generator is retailed directly to customers, the application must also include a list of the customers and the electrical grid diagram

d. Article 13. Power to issue electricity licences

- The MOIT issues licences to generators on the list approved by the Prime Minister
- ERAV issues licences to generators with a capacity of 3 MW or more and not included on the above-mentioned list
- The Provincial People's Committee issues or authorises the MOIT to issue licences to generators with a capacity of less than 3 MW in its province

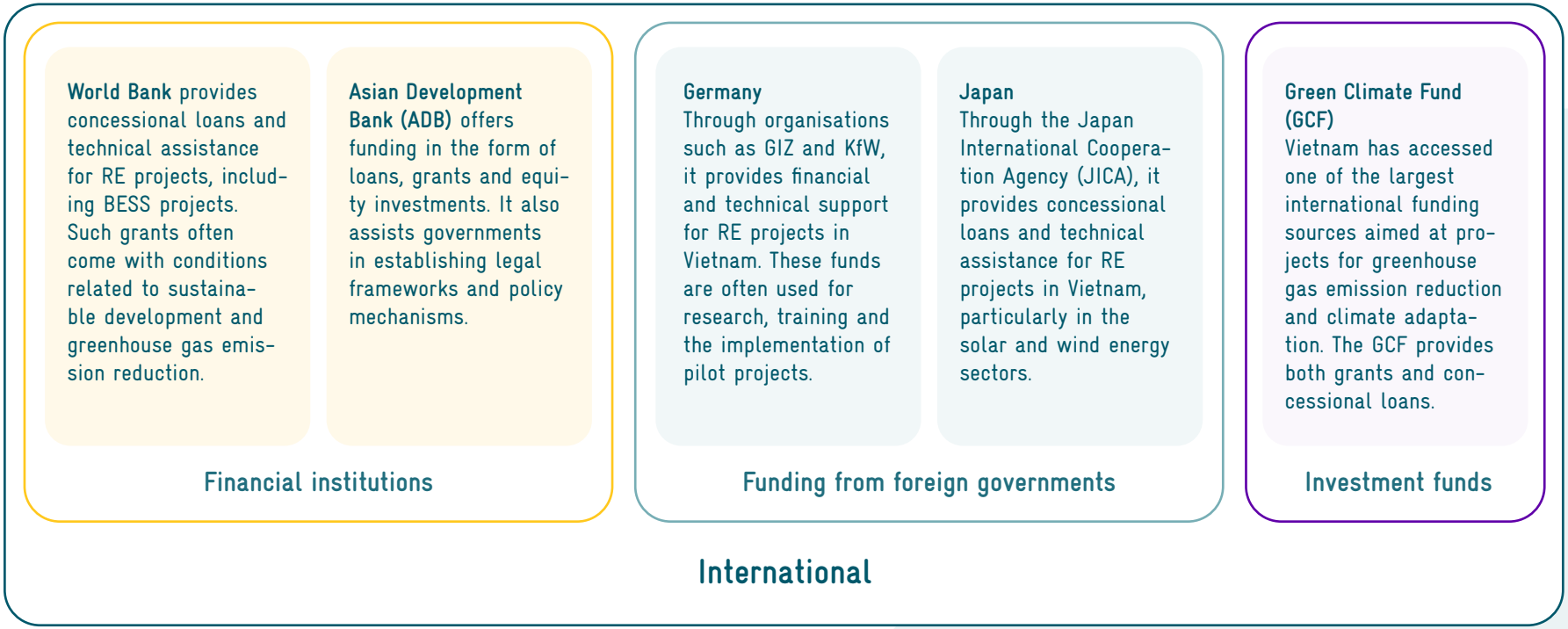
The general requirements and procedures described above for power generation licensing also apply to the licensing of BESS installations, with some further conditions and considerations that will be adopted in the future for specific BESSs (GOPA–International Energy Consultants GmbH, 2021).

Currently, BESSs face many barriers to participating in the electricity market, and there is no mechanism in place for them to provide and receive compensation for ancillary services, such as frequency regulation and voltage control. The government is also considering the creation of an enabling environment for BESSs, establishing clear guidelines for market participation and ensuring fair compensation for the services they provide.

3.4 Financing BESS applications and projects

Diversifying funding sources and support mechanisms is a crucial factor in helping Vietnam continue to strongly promote RE and BESS projects and, at the same time, achieve its energy transition and greenhouse gas emission reduction goals. Some international and domestic funding and capital sources for the development of RE and BESS projects in Vietnam are described below.

FIGURE 17. International funding and capital sources for RE and BESS projects in Vietnam



Source: Authors' own compilation, Hapeco (2024)

FIGURE 18. Domestic funding and capital sources for RE and BESS projects in Vietnam

Banks and financial institutions

Commercial Banks, such as Vietcombank, BIDV and VietinBank, provide concessional loans for RE projects, often backed by government guarantees or support.

Vietnam Development Bank (VDB) offers concessional loans for infrastructure projects, including RE and BESS projects, with favourable interest rates and long-loan terms.

Tender mechanisms and government support

Although the **Feed-in Tariff (FiT)** policy has expired for some types of RE, the Vietnamese Government can still apply other support mechanisms, such as competitive bidding and market electricity prices to ensure profitability for investors.

Direct financial support from the government may be provided in the form of **tax incentives, import tax exemptions** for equipment and partial investment cost support for BESS and RE projects.

Other sources

Large-scale projects, especially those requiring significant initial investment, such as offshore wind and BESS projects, are often implemented under **the PPP model**, where the government and the private sector co-invest and share profits and risks.

Some large companies, particularly international firms committed to sustainable development, are directly funding RE and BESS projects through **DPPAs**.

Domestic

Source: Authors' own compilation, Hapeco (2024)

3.5 Local capacity for project implementation

Vietnam's capacity to implement RE projects in general and BESS projects in particular is improving, enabling the country to meet the increasing demand for clean energy and align with global trends. Although no large-scale BESS projects have been implemented yet, Vietnam has put in place the conditions for BESS roll-out.

Technical expertise

Vietnam has a growing number of engineers and specialists in the RE sector. Training programmes at universities and research organisations are beginning to place emphasis on energy storage technology. However, there is a need for more specialised courses and practical training programmes on BESS technology to enhance the skills of the workforce. Collaboration with international partners with experience in this field will help provide the necessary knowledge and technology.

Existing grid infrastructure

Vietnam's grid infrastructure is increasingly being modernised to meet the growing demand for energy. An improved grid will facilitate the integration of BESSs, allowing for better management of fluctuations in the supply of energy from renewable sources.

Local manufacturing capabilities

The capability to manufacture BESS components and equipment in Vietnam is starting to be developed, with some local companies participating in the production of components. This not only helps reduce import costs but also strengthens self-sufficiency in the energy technology sector. Encouraging domestic enterprises to invest in new technologies will promote the growth of the energy storage industry in Vietnam.

3.6 Challenges and opportunities for international actors

Investment in BESS projects in Vietnam is attracting the attention of international partners due to the country's strong potential for RE development. However, international partners also face significant challenges when implementing BESS projects in Vietnam.

Challenges

- **Lack of clear regulations:** Vietnam is still refining the legal framework for BESSs, including regulations on electricity pricing, bidding mechanisms and support policies. The lack of clarity in the legal framework can increase risks for international investors.
- **Insufficiently attractive support policies:** Decree 135/2024/ND-CP encourages organisations and individuals to install energy storage systems to ensure the safe and stable operation of the power system when investing in rooftop solar power systems for self-consumption. However, detailed guidelines are still required for the implementation of this decree. Additionally, tax incentives, subsidies and financial support for BESS projects remain limited and are not compelling enough to drive strong investment.
- **Large initial capital investment:** BESS projects require significant initial investment, including for batteries, energy management systems and related equipment. This can be a barrier for foreign investors, taking into account that production and operating costs in Vietnam may differ from other markets.
- **Profit risk:** The unstable policy framework means that investors may face the risk of not receiving the expected return on their investment, particularly when electricity prices fluctuate and support policies change.
- **Environmental risks:** BESS projects must comply with strict environmental standards, including in relation to waste management and operational safety. Failure to comply with such standards can lead to environmental and legal risks.

- **Market volatility:** The Vietnamese energy market is still developing and experiences significant fluctuations in electricity prices and consumer demand. This can affect business plans and the ability of investors to recoup their investments.

Opportunities

In spite of the challenges in bringing the first BESS project to fruition, Vietnam is a very promising market with great potential for investors, especially international ones, due to the following strengths:

- **Strong RE growth:** Vietnam is currently the fastest growing RE market in South-East Asia, particularly in the solar and wind sectors. The country's RE market will continue to develop strongly due to the significant potential for offshore wind and rooftop solar energy. This creates substantial demand for BESSs to optimise energy use and ensure grid stability.
- **Government commitment:** The Vietnamese Government has committed to enhancing RE development and transitioning to a sustainable energy system. This presents a major opportunity for international investors to engage in the BESS market.
- **International capital:** International financial institutions, such as the World Bank, the Asian Development Bank (ADB) and green investment funds, are ready to provide financial support for RE and BESS projects in Vietnam. International investors can leverage these funding sources to mitigate financial risks.
- **Development of a competitive electricity market:** Vietnam is experimenting with options for the development of a competitive electricity market in the future, which will create many opportunities for investors in BESS projects. BESSs can help optimise profits from time-of-use electricity pricing.
- **DPPA:** This new model promises to boost the RE market in Vietnam by facilitating electricity trading between consumers and power plants. As a result, the demand for BESS solutions is expected to rise rapidly for both renewable power plants and industrial zones.
- **Demand for ancillary service**s: With the increase in RE, the demand for ancillary services such as frequency regulation and voltage control is rising. BESSs can provide these services, creating additional revenue streams for investors.
- **Transfer of advanced technology:** Vietnam needs advanced technology to develop BESSs, which creates opportunities for international partners to provide and transfer technology. This not only helps improve Vietnam's energy infrastructure but also expands the market for international technology companies.
- **Training and human resource development:** International partners can collaborate with Vietnam in training and developing highly specialised human resources in the BESS field, facilitating effective BESS implementation and operation.

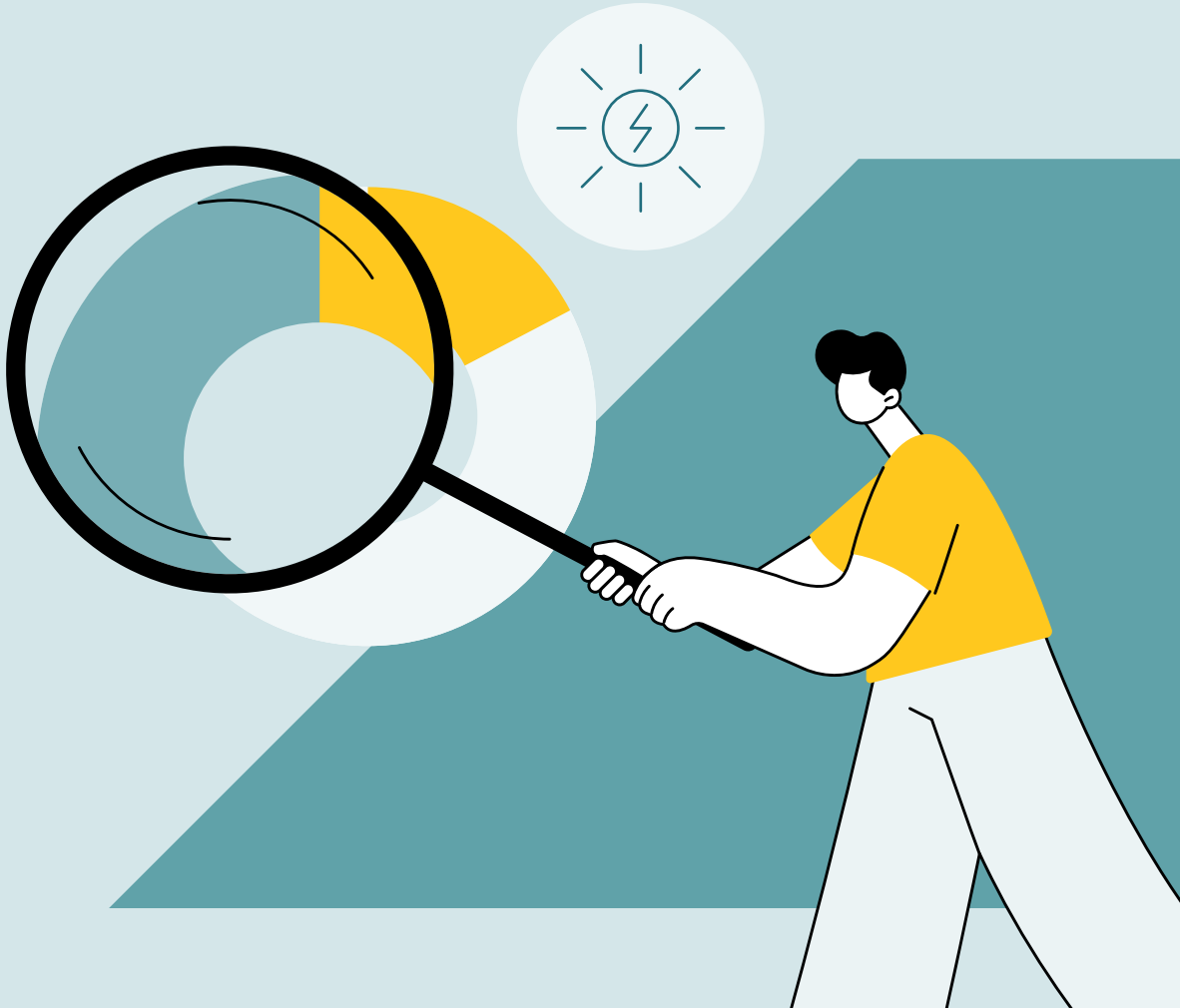
3.7 Recommendations for market entry

By understanding the market, selecting strategic partners, optimising financing, enhancing technical capabilities, complying with environmental standards and maintaining flexibility, investors can mitigate risks and maximise their chances of success in this promising field. Here are some recommendations for investors:

- Thoroughly research the legal framework: Understand and stay updated on the legal regulations and policies related to BESSs in Vietnam, including energy development plans, electricity pricing policies and tax incentives. This will help investors formulate appropriate strategies and comply with legal requirements.
- Collaborate with local partners: Seek out and collaborate with local partners who have experience in the energy sector, such as EVN consulting firms, which already have established infrastructure and networks. A local partner's deep understanding of the market helps mitigate risks and increase the chances of success.
- Seek international funding: Leverage funding and loans from international financial institutions, such as the World Bank, ADB and green investment funds. This can help minimise capital costs and financial risks.
- Develop a flexible business model: Build a flexible business model that can draw on a variety of approaches, such as public–private partnerships (PPPs) and DPPAs, to share risks. Additionally, consider innovative business models, such as storage-as-a-service, to optimise profit.
- Invest in human resource training: Invest in training and developing highly specialised human resources in the BESS field, including engineers, project management specialists and operational teams. This will ensure that BESSs are implemented and operated effectively and meet technical and safety standards.
- Adopt advanced technological solutions: Ensure the use of the most advanced and efficient technologies in BESS deployment, including energy management systems, remote monitoring systems and predictive maintenance technologies. This helps optimise system performance and minimise operating costs.
- Comply with environmental standards: Ensure that BESS projects fully comply with Vietnam's environmental standards and regulations, from design and installation to operation and waste disposal. This not only helps avoid legal risks but also enhances the investor's image as an environmentally responsible entity.
- Build a sustainable development strategy: Develop and implement sustainable development strategies, including using recycled materials, optimising energy efficiency and minimising environmental impacts. This helps investors gain additional support from the community and international financial institutions.
- Monitor and adapt to market changes: Closely monitor trends and developments in the industry and have flexible plans in place to quickly adapt to market fluctuations, taking into account that the energy market in Vietnam is evolving rapidly and may be subject to sudden changes.
- Focus on niche opportunities: Instead of focusing solely on large BESS projects, seek niche opportunities, such as BESSs for rural areas, smaller projects or specific industrial applications, where there may be less competition and higher profit potential.

4

Economic sectors with high potential for BESS applications



4.1 Sector overview

The global BESS market is growing rapidly, driven by technological advancements and cost reductions. BESSs are becoming essential for managing the unpredictability of RE sources, reducing grid congestion, increasing energy storage, minimising energy losses and enabling more efficient energy use.

According to the PDP VIII and Decision No. 1009/QD TTg (JETP declaration), investment in energy storage is expected to result in a capacity of around 300 MW by 2030. This includes EVN's 50 MW/50 MWh pilot BESS project aimed at developing ancillary services, evaluating pricing mechanisms and establishing technical standards. Other pilot projects include the 7 MW/7 MWh BESS integrated with a 50 MW solar plant, the 105 MW/105 MWh BESS integrated with a 400 MW solar plant and other BESS projects with a capacity of 138 MW. The vision for 2050, as outlined in the PDP VIII, is to reach a combined hydropower and battery storage capacity of between 30,650 MW and 45,550 MW.

In addition, Decree No. 135/2024/ND-CP establishes mechanisms and policies to encourage the development of solar power systems for self-consumption installed on the rooftops of buildings. It also encourages organisations and individuals to install energy storage systems to ensure the safe and stable operation of the electrical grid. Notably, it sets no limits on the installation of BESSs for rooftop solar power plants under the self-consumption model, making no reference to the target of 300 MW by 2030 established in the PDP VIII. Decree No. 80/2024/ND CP regarding the DPPA mechanism creates opportunities for BESS development. The mechanism allows RE generators to enter into DPPAs with large electricity consumers via one of two options: a private connection line or the national power grid. BESSs play a crucial role in optimising the storage of surplus energy during periods of oversupply and supplying power during periods of undersupply, thereby enhancing the economic efficiency of DPPAs. Furthermore, the implementation of the DPPA mechanism encourages investment in RE, thereby driving demand for BESSs to address challenges related to the intermittency of RE sources such as wind and solar power.

There follows an overview of BESS functions and benefits for economic sectors.

BESS functions

- Peak shaving: BESSs serve as a tool for managing sudden increases in energy demand, helping to minimise demand charges by reducing energy consumption from the grid during peak hours.
- Load shifting: BESSs allow businesses to utilise stored energy during peak electricity price periods, significantly reducing electricity costs and shifting electricity demand from peak hours to off-peak hours. Using energy from BESSs is beneficial for electricity companies in managing loads, reducing overload during peak times and optimising energy use throughout the day.
- Flexible operation: BESSs enable businesses to adjust their electricity demand from the grid during critical periods without changing their overall energy consumption levels. This flexibility allows users to actively participate in demand response programmes.
- Support for microgrids: BESSs are critical in microgrid operation as they provide the necessary energy storage to enable them to operate independently of the main grid during power outages.
- Integration of renewables: By storing surplus energy from renewable sources, such as solar and wind, and releasing stored energy when production from these sources decreases, BESSs enhance the reliability and stability of green energy sources.
- Voltage and frequency stabilisation: BESSs can provide immediate energy to stabilise the voltage and frequency of the power system during fluctuations, protecting manufacturing equipment from outages.

- Voltage sag mitigation: In large industrial zones, high electricity consumption can lead to voltage sags. BESSs help maintain stable voltage levels and improve power quality.
- Load levelling: This is important for electricity companies as it helps reduce fluctuations in electricity demand, optimises the use of power generation sources, lowers operating costs and enhances the overall efficiency of the power system.
- Spinning reserve: BESSs act as a reliable backup power source that can immediately supply electricity in the event of outages or loss of primary power supply, which is extremely important for electricity companies as it ensures continuity of electricity supply, especially in emergencies.

Benefits of BESSs

- Storage of energy for later use: BESSs function efficiently as an energy storage system due to their flexible capability to store and release energy. Additionally, they can serve as a backup power source, providing immediate energy during power outages to ensure continuity of electricity supply.
- Optimisation of energy costs and reduction of electricity expenses: BESSs do this by storing and releasing electricity according to price fluctuations. The system can store energy during periods of low electricity prices, such as night-time, when demand is lower. It then releases this energy during peak hours, when electricity prices are higher, helping to reduce operating costs and maximise profit for industrial and commercial zones.
- Stable energy supply: Industrial zones often face grid supply fluctuations, especially in areas with underdeveloped grid infrastructure. BESSs help maintain a continuous and stable energy supply, minimising the risk of production interruptions due to power outages. With their fast and efficient response capabilities, they optimise energy use, reduce grid load and enhance electricity supply reliability.
- RE integration: When combined with renewable power plants, BESSs can store surplus energy generated from renewables, such as solar power during the day or wind power when output exceeds consumption. The system then supplies this stored energy during peak demand periods when renewable sources are unavailable, such as at night or on windless days. This allows industrial zones to reduce reliance on the traditional power grid, lower greenhouse gas emissions and optimise energy costs.
- Improved energy efficiency and environmental protection. BESSs optimise energy use, reduce waste and contribute to the sustainable development goals of the C&I sector. They also help businesses meet environmental and energy standards, enhancing their reputation and corporate image.
- Significant benefits for power companies. BESSs optimise RE integration, reduce operating costs and improve power quality. With their rapid energy delivery capability, they provide instant backup power in emergency situations and support more efficient load management.

The outstanding advantages of BESSs make them a key tool in Vietnam's sustainable energy development strategies.

Priority industries for BESS installation have been selected based on various factors, including their importance to the national economy, growth rate, relevance for future BESS applications and an initial assessment of energy consumption levels. The flexibility of BESSs means that they can be used on different scales and are suitable for different purposes. This analysis has identified the C&I sector as the priority target for BESS deployment. It has also established that BESSs have significant potential benefits for EVN power companies and renewable power plants. An overview of the economic sectors with potential BESS applications in Vietnam is provided below.

4.1.1 C&I manufacturing sector in Vietnam

The C&I sector in Vietnam is a pillar of the national economy, with both international trade and industrial production activities playing a significant role. The development of this sector is reflected in indicators related to imports and exports, industrial production and key processing and manufacturing areas.

Commerce

Vietnam's import and export figures for 2023 highlight the importance of international trade. As at November 2023, the total value stood at USD 619.17 billion, with exports at USD 322.5 billion (down 5.9% on 2022) and imports at USD 296.67 billion (down 10.7%). Key export sectors, such as manufacturing industries, accounted for 88.3% (USD 313.73 billion) of exports, with electronics, computers, phones and textiles leading the way. Imports consisted mainly of producer goods, such as machinery, equipment and raw materials, making up 93.8% (USD 307.32 billion) of total imports, which is a reflection of domestic industrial production needs. Major trade partners include the United States (the largest export market at USD 96.8 billion) and China (the largest import market at USD 111.6 billion). Vietnam had a trade surplus of USD 83 billion with the United States but a trade deficit of USD 49.9 billion with China.

Industry

Vietnam's industrial sector is mainly made up of manufacturing, processing and supporting industries. Industrial growth averaged 7.8% annually between 2016 and 2023, with particularly strong growth in high-tech sectors, such as electronics and automotive production. FDI businesses play a crucial role, especially in the electronics manufacturing industry, accounting for over 70% of the export value of processed industrial goods. With regard to local industries, provinces such as Bac Ninh, Hai Phong and Binh Duong are key drivers, with strong development in industrial zones and processing clusters.

TABLE 2. Overview of the C&I sector

C&I sector	Key information	Key figures
Electronics and high tech	The electronics sector, especially semiconductors, and high-tech industries, such as electric vehicles (EVs) and solar energy, are rapidly expanding, driving industrial transformation in Vietnam.	FDI in the electronics sector rose by 38.6% to over USD 4.29 billion in 2024.
Textile	The textile industry continues to grow thanks to labour cost advantages, trade agreements and sustainable supply chains, with a focus on value-added products.	Vietnam ranks third globally in textile exports, with export revenue reaching around USD 40 billion in 2023.
Footwear	Footwear manufacturing holds a strong position, with a global supply chain and increasing demand.	Footwear exports in 2023 exceeded USD 20 billion, and Vietnam is one of the largest footwear exporters worldwide.
Automotive	Vietnam is gradually becoming a regional automotive manufacturing hub, especially for EVs. VinFast leads the market in EV exports.	VinFast exported its first batch of EVs to the United States in 2022, with production exceeding 30,000 EVs per year. The government is providing strong support to meet the target of 1 million EVs by 2030.
Food and beverage processing	This sector is thriving thanks to abundant agricultural output, serving both domestic and international markets.	Food and beverage exports surpassed USD 4 billion in 2023, with significant demand from Asia and Europe.
Water	This sector provides clean water and wastewater treatment and applies advanced filtration technology to meet needs arising from rapid urbanisation and industrialisation in Vietnam.	In 2023, total clean water production capacity exceeded 10 million m3 per day in major cities, and 15%–20% of total wastewater was treated.
Commercial buildings	Commercial buildings in Vietnam, including offices, shopping centres, and hotels, have high energy consumption. They typically use significant amounts of energy for heating, ventilation and air conditioning systems, lighting and office equipment.	The average annual energy growth rate of this sector is approximately 8.7% from 2014 to 2030. Commercial buildings primarily consume energy for air conditioning, which accounts for more than 70% of their total energy consumption.
Construction materials (cement)	The cement industry plays a vital role, driven by growing infrastructure demand and urbanisation and with strong support in the form of significant investment and an expanding domestic market.	In 2023, cement production reached 100 million tonnes, with exports increasing by 10%.

Source: (InnoLab Asia, 2024), (McKinsey & Company, 2023), (Savills Vietnam, 2024)

4.1.2 Power companies and renewable power plants in Vietnam

The power and RE sector in Vietnam is undergoing a significant transformation and plays a key role in achieving the country's sustainable development goals. In 2023, national electricity capacity was approximately 77 GW, with RE accounting for 26 GW (34% of total capacity), including 16.5 GW from solar power and 5 GW from wind power. According to the PDP VIII, approved in May 2023, wind power capacity is expected to reach 6 GW by 2030 and increase further to 70 GW by 2050, while solar power is projected to reach 31.4 GW by 2030. In addition, offshore wind energy and new sources such as hydrogen will be strongly promoted for export and to foster a green economy. However, the intermittency and instability of RE sources pose significant challenges for grid stability.

EVN leads in power management and distribution but also faces challenges posed by local electricity shortages. With international commitments such as JETP, the power sector aims to reduce greenhouse gas emissions by between 204 and 254 million tonnes by 2030, promote green growth and ensure energy security.

4.2 Value chain, actors involved and production, processing and service sectors

In the context of sustainable energy development in Vietnam, industries with potential for implementing BESSs are becoming increasingly important. However, the market is still developing and faces several significant challenges. There is great potential for major industries, including the manufacturing sector, commerce and the power and RE sectors to deploy BESSs to optimise energy efficiency, reduce costs and improve the stability of electricity supply.

4.2.1 Production, processing and service sectors

TABLE 3. Overview of production, processing and service sectors

Manufacturing and processing industry	1. Electronics and high tech • Research and development: Companies such as Vingroup develop electronic products and components in Vietnam • Manufacturing and assembly: Manufacturing and assembly facilities, such as those of Samsung and LG, are primarily located in Vietnam's industrial zones • Quality control and product storage: Products undergo quality checks and are stored for distribution domestically and for export 2. Textile and footwear • Supply chain: From raw material procurement (fibre, fabric, leather) to manufacturing in textile mills located in provinces such as Bac Ninh and Thai Binh • Garment and footwear manufacturing: Factories produce products based on export orders • Packaging and shipping: Once finished, products are packaged and exported 3. Construction materials (cement) • Raw material extraction: Companies extract limestone and other materials • Cement manufacturing: Factories use rotary kiln technology to turn raw materials into cement • Packaging and distribution: Cement is packaged and distributed to construction sites nationwide
Automotive industry	• Design and production: Companies such as VinFast (Vingroup) produce EVs and electric motorcycles at their factories in Hai Phong • Assembly: Imported and locally produced parts are assembled and quality checked at the factories • Distribution and consumption: Products are distributed through domestic dealerships and for export • After-sales service: Technical support, maintenance and parts replacement are provided by service centres

Source: Authors' own compilation, Hapeco (2024)

Commercial buildings	• Construction and design: High-rise buildings, shopping centres and large projects • Rental services: Rental of office and retail space and commercial leasing for businesses • Maintenance and operation: Building management companies maintain electrical systems, air conditioning and elevators • Asset management: Services related to leasing, utility management, security and cleaning
Water companies	• Raw water sourcing: Water is sourced from rivers, lakes and aquifers • Pre-treatment: Debris, sand and large particles are filtered out mechanically • Chemical treatment: Coagulation, sedimentation and odour control processes are carried out • Disinfection: Chlorine or ultraviolet (UV) technology is used to disinfect water • Distribution: Clean water is stored and transported to residential areas
Power companies	• Generation: Electricity is generated from sources such as coal, natural gas and hydro • Transmission: Electricity is transmitted via high-voltage power lines to substations • Distribution: Electricity is reduced to lower voltages and distributed to residential and commercial areas • Services: Power support services are provided
Renewable power plants	• Renewable power generation: Electricity is generated from solar, wind and biomass sources • Operational process: The system converts natural energy sources into electricity using turbines, solar panels and biomass boilers
Oil and gas exploration and production industry	• Exploration and extraction: Companies such as PVN extract oil and natural gas from offshore fields, such as the Bach Ho field • Transportation: Oil and gas are transported via pipelines and oil tankers • Processing: Crude oil is refined at facilities such as Petrolimex and Binh Son • Distribution: Processed products are distributed to petrol stations and industrial clients • Logistics services: Maintenance and repair of exploration and processing equipment

4.2.2 BESSs in industry value chains

Value chains in industries with the potential to deploy BESSs include several stages, from research and production to distribution and consumption. BESSs can be integrated at various points in the value chain to enhance the stability of electricity supply.

TABLE 4. Role of BESSs in industry value chains

Industry	Role of BESSs in value chain
Electronics and high tech	• Store surplus energy from plants to support the continuous operation of high-power production lines • Ensure backup power in the event of power outages and system failures
Textile and footwear	• Provide backup power, minimising the impact of power outages in large manufacturing plants • Combine with RE (such as solar power) in industrial zones
Construction materials (cement)	• Support energy storage from renewable power systems used in clinker and cement production
Automotive (VinFast)	• Store energy in EV battery testing systems • Stabilise the power grid in EV manufacturing plants and charging station systems
Food and beverage processing	• Store RE from the rooftop solar power systems of processing plants • Ensure backup power for cold storage areas and the operation of automated processing lines
Water	• Store energy for large water pump systems and water treatment systems during off-peak hours • Combine with RE at clean water production and wastewater treatment facilities
Commercial buildings	• Store surplus energy (e.g. from solar power or from the grid during off-peak hours) • Supply power to buildings when electricity demand is high (peak hours) • Optimise energy costs by using stored energy during periods when electricity prices are high • Enhance electrical system efficiency, maintaining the stability of the building's electrical grid
Power companies (EVN)	• Store energy during off-peak hours and provide energy to the grid during peak hours • Provide load balancing • Stabilise the electrical system
Renewable power plants	• Store energy from sources such as solar and wind during high production periods and provide power during peak hours or when the supply from renewable sources falls short
Oil and gas	• Store energy from natural gas and oil processing plants for use during high power demand stages • Combine with excess gas recycling systems to optimise energy use

Source: Authors' own compilation, Hapeco (2024)

4.2.3 Actors involved in BESS implementation

Actors involved in BESS implementation are listed below.

- Raw material suppliers: Companies involved in the extraction and processing of raw materials, such as lithium, cobalt and nickel, play an essential role in battery production. Suppliers of chemicals and auxiliary materials also play a supporting role.
- Manufacturers: Companies that manufacture batteries, modules and BESSs.
- Integrators and solution providers: Companies specialising in designing and deploying BESSs for specific applications.
- End users: Industrial businesses, commercial buildings, RE companies and utilities are the main BESS users. Industrial parks and large enterprises, as major electricity consumers, stand to benefit directly from BESS implementation as it will reduce electricity costs and improve energy efficiency.
- Government and regulatory bodies: Governments and regulatory agencies play a decisive role in establishing supportive policies, encouraging investment in BESS projects and ensuring that legal regulations are in place to promote widespread implementation.
- Financial institutions: Investment in BESS technology and infrastructure development requires significant capital from financial institutions and investment funds.
- BESS and energy efficiency technology providers: Companies that provide BESS technology solutions are key players in supplying advanced equipment, technical services and innovative solutions to optimise energy use.
- RE producers: Solar power plants, wind farms and small hydroelectric plants play an important role in generating RE and integrating BESSs to optimise energy supply.
- Power companies: Power companies are responsible for distributing electricity. They can use BESSs to stabilise the power grid and manage electrical loads more effectively, especially in areas where RE use is high.

4.3 Energy demand and consumption profile

Industrial and commercial zones are the largest electricity consumers in Vietnam's economy. Sectors such as textile, manufacturing, electronics production and food processing require large amounts of electricity, especially during peak hours. The electricity consumption of these industries typically peaks during working hours, with the highest consumption occurring in the morning and afternoon. BESS deployment in industrial zones not only helps reduce the pressure on the national grid but also helps businesses save on energy costs by storing electricity for use during peak hours.

The power supply from renewable power plants is inherently unstable and dependent on weather conditions. The electricity produced by these plants often fluctuates, with the highest production occurring during the day in the case of solar power and during periods of strong winds in the case of wind power. BESS deployment helps stabilise electricity supply from these sources, ensuring continuous and stable power to the grid, even when weather conditions are unfavourable. The electricity consumption profiles of power companies largely depend on customer demand, with peak consumption occurring during peak hours or in the dry, hot season. BESS deployment allows power companies to better manage load fluctuations, reduce pressure on the system during peak hours, ensure power supply to loads (especially in northern Vietnam) and optimise the use of RE sources. This is particularly important in areas with a high RE ratio, where power supply fluctuations can affect the stability of the system.

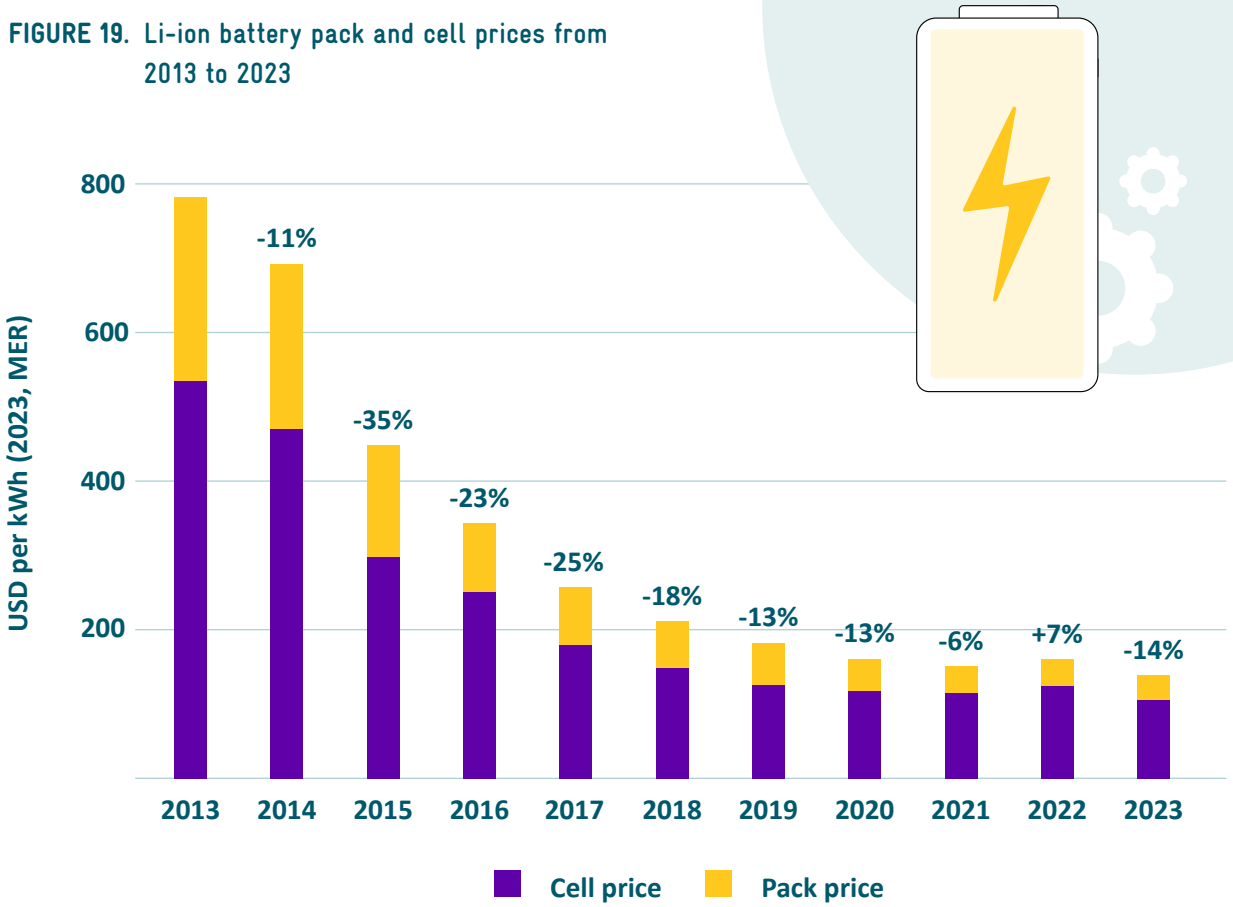
TABLE 5. Energy demand and consumption profile by industry

Industry	Key information	Key figures	Energy demand
Water industry	Clean water production and wastewater treatment to meet needs arising from urbanisation and industrial growth	The water industry in Vietnam is growing strongly to meet the increasing water consumption needs of the population and industrial zones	High electricity consumption (pumping, water filtration, wastewater treatment)
Processing industry	Includes cement, steel, and food and beverages	One of the largest energy-consuming sectors in the Vietnamese economy	Requires electricity and fossil fuels
	It is a major energy-consuming sector	2021: Growth rate was 30.73%, nearly double that of 2020 (17%) 2022: Growth rate was 16.54% 9 months into 2023: Growth rate was 11.77%	Green hydrogen use is expected to reduce emissions from 2040 onwards
Commercial buildings	Offices, hotels and shopping centres	Energy use in high-rise buildings in Vietnam accounts for about 35% to 40% of the country's total energy consumption	BESS deployment can reduce peak load and increase energy efficiency
	High energy needs for air conditioning and lighting	Air conditioning systems account for 40% to 60% of total energy consumption, lighting systems for 15% to 20%, office equipment for 10% to 15% and other auxiliary equipment for the remainder	
Automotive industry	Manufacturing and assembly of cars and EVs	Very high energy consumption at large factories	Very high electricity demand
	Significant investment from VinFast and domestic companies	Accounts for 3% of the country's GDP	Demand for storage and fast charging for EV development
Power companies	Including general government-owned corporations and power companies nationwide	Total system load output in 2023 was 251.25 billion kWh Peak capacity in 2023 was 46,348 MW	Electricity demand increases annually by 8% to 10%, reflecting very high energy demand as a result of economic growth and improved living standards
	Integrated from thermal power, hydropower, RE and imports		
Renewable power plants	Production of energy from wind, solar and hydro sources	RE (solar and wind) accounted for 26.9% of national capacity in 2023	Prioritisation of RE storage through BESSs to support peak loads and optimise output
Oil and gas industry	Exploration and processing of crude oil and natural gas	High electricity consumption at Binh Son, Petrovietnam Gas (PV Gas), etc.	Extraction of diesel and natural gas for production
	Meets national energy demand		Primarily uses oil and gas products as energy sources

Source: Research and Analysis Center – VietinBank, 2019, Vietnam Electricity, 2023, Savills Vietnam, 2023, Song Ha, 2023

Although energy consumption in these industries is high, the adoption of BESS solutions remains limited. The main reason is the high investment cost (according to the International Energy Agency, the price of a BESS was approximately USD 150 per kWh in 2023) as many businesses do not yet clearly understand the economic benefits. Additionally, the support policies and legal framework for BESSs are still underdeveloped, making implementation challenging. Not enough attention has been paid to the technical infrastructure required and to raising awareness of the role of BESSs in optimising energy use, with the result that Vietnam is lagging behind in modern energy technology.

FIGURE 19. Li-ion battery pack and cell prices from 2013 to 2023



Source: Review Energy, 2024

4.4 BESS initiatives and programmes

Government support policies

- Government incentives are a prerequisite for promoting BESSs. Companies investing in energy storage systems should benefit from tax incentives, reduced import costs for equipment and access to preferential loan packages. The government could also implement subsidy programmes or provide direct financial support for RE projects integrated with BESSs. In addition, improving the legal framework to allow energy storage to participate in the competitive electricity market will expand business opportunities.

Developing training programmes and capacity building

- Training for experts and technicians: Specialised training programmes should be organised for experts and technicians on BESS and RE technologies and widely implemented at universities, research institutes and technical training centres across the country. Such training courses will improve the quality of the workforce and help meet market demand.

- Technology transfer and international cooperation: Collaborative programmes with international organisations, universities and major technology corporations around the world should be proposed for the transfer of advanced BESS and RE technologies. Such cooperation will not only help Vietnam access modern technologies but also facilitate the research and development of energy solutions tailored to local conditions.

International cooperation and technology transfer

- Vietnam needs to strengthen cooperation with countries that have advanced BESS technologies, such as Japan, the Republic of Korea, Germany and the United States. This includes the transfer of Li-ion battery production technology, the design of hybrid systems combining hydrogen and BESSs and the sharing of large-scale implementation experiences. Joint investment programmes or research collaborations between Vietnamese and international companies could accelerate the development of this sector.

Testing and scaling up the model

- Pilot BESS projects need to be implemented in areas with high energy demand, such as large industrial zones or resource-rich areas in central and southern provinces with RE potential. These pilots can assess the economic and technical feasibility of BESS deployment, and then successful models can be scaled up to other regions. Additionally, cement, steel and water treatment plants could also adopt pilot BESS integration projects to optimise energy consumption.

Promoting research and development

- Establishment of specialised research centres: Specialised research centres for BESS and RE technologies could be set up at universities and research institutes. Such centres could focus on developing efficient energy storage technologies and sustainable energy solutions.

- Support for businesses in research and development: The government could provide financial support for businesses involved in researching and developing BESS and RE technologies, encouraging innovation and improvements in this field.

- Community-based RE programmes: Efforts could be made to encourage the development of community-based RE projects, where residents can participate in the production and use of clean energy. They could include the installation of rooftop solar systems, small-scale BESSs and EV charging stations. Promoting such initiatives would not only help reduce energy costs for residents but also raise community awareness of the benefits of RE.

Building smart grids

- BESSs could be integrated into the smart grid development programme in Vietnam, where internet-of-things devices and digital energy management technologies support more efficient energy monitoring and regulation. A smart grid

combined with BESSs will help reduce peak load and improve the ability to respond when electricity demand surges.

Applications in key industries

- In the automotive industry, BESSs support the development of fast charging stations for EVs, helping to accelerate EV growth. In the processing industry, integrating BESSs helps maintain continuous operations and reduce electricity costs during peak hours. Oil rigs and water treatment plants can also adopt BESS solutions to minimise dependence on fossil energy.

4.5 Recommendations for lead identification

The list of key industries proposed for the installation of BESSs is based on assessments, case study reports, interviews with industry experts and document research. Detailed recommendations for identifying potential customers are provided below.

TABLE 6. Recommendations for identifying potential customers from different industries

Industry*	Recommendations for BESS installation needs	Reasons
Electronics and high tech	Install BESSs at production facilities and data centres.	Help stabilise power sources during critical production and processing stages, especially for data centres, which require high reliability and efficiency.
	Provide stable energy for pilot and experimental production processes.	Ensure consistent energy supply for data centres, reducing risks and improving operational efficiency.
Manufacturing	Integrate energy storage to reduce energy costs during peak demand periods	Reduce electricity costs in production by storing energy during off-peak hours for use during peak hours
		Ensure continuous operation of the production line
Textile and footwear	Install BESSs for textile and footwear factories with high electricity consumption during peak hours	Reduce load on the grid during peak hours
		Help optimise energy costs during long production shifts
Construction materials (cement)	Provide BESSs for cement plants and other industries with high and continuous energy consumption	Support stable power for continuous production processes
		Reduce electricity costs in long-term production processes
Commercial buildings	Install BESSs in large commercial buildings and complexes with high energy needs and variable loads	Store electricity from solar energy or the grid during the day for use at night or in the event of power outages and reduce energy costs during peak hours

*The table reflects a general sectoral overview based on the consultants work. It doesn't automatically imply that the mentioned sectors comply with the target sectors of PDP's commissioning party, the BMWK. Further intervention and project development activities within the framework of the German Energy Solutions initiative needs to be assessed in compliances with its objectives and eligibility requirements.

Source: Authors' own compilation, Hapeco (2024)

Industry*	Recommendations for BESS installation needs	Reasons
Transportation	Install BESSs in intelligent transportation systems, especially for EV charging stations	Strengthen energy security for EV charging networks and optimise grid load balancing during peak times
Water	Install BESSs in water treatment plants, particularly in facilities that rely on high energy consumption for pumping and operational continuity	Reduce energy costs and ensure continuous operation in water treatment and distribution systems
Renewable power plants	Install BESSs at solar and wind power plants	Help stabilise RE supply, reducing power shortages during peak hours, support smart power systems, integrate RE into the grid, store energy for use when needed and reduce energy costs during peak hours
Power companies	Install BESSs at substations and power distribution centres	Enhance power management and distribution in high-demand areas, stabilise the grid during peak hours, reduce grid operating costs and provide backup energy during power outages
Mining (oil and gas)	Install BESS in oil and gas extraction areas to ensure reliable power supply for high energy-consuming machinery and equipment	Ensure stable power supply for operations in remote areas, reducing the impacts of unstable energy sources
		Increase operational efficiency in remote mining areas where grid power is unstable

5

Conclusions

Vietnam is a country with a young and dynamic population, which provides an abundant labour force and opens up many opportunities for innovation and creativity in economic, social and technological fields. Additionally, the Vietnamese Government's policies supporting economic development, such as administrative reforms, business facilitation and schemes to attract domestic and foreign investment, strongly promote the development of the national economy. These measures not only help the economy grow rapidly but also enhance Vietnam's competitiveness both regionally and globally.

Vietnam consistently maintains an open attitude towards international cooperation, especially in its long-standing friendship with Germany. It aims to access international markets and learn from the experiences and technologies of developed countries, thereby improving the quality of domestic products and services. Thanks to these factors, Vietnam is gradually becoming an attractive destination for international investors and partners, opening up prospects for sustainable and prosperous development in the future.

The demand for electricity in Vietnam has been rapidly increasing over the past decade, particularly due to the strong development of industrial sectors, and this has created a significant challenge in ensuring stable and sustainable power supply. In this context, policies to encourage BESS development are being formulated, adopted and strongly promoted by the government and relevant authorities to leverage Vietnam's enormous RE potential. These policies not only facilitate investment in energy storage technology but also pave the way for international companies to invest in the market. Furthermore, the prices of traditional electricity generation fuels, such as coal, oil and natural gas, are expected to rise in the coming years due to political, market and environmental factors. This further highlights the role of BESSs as an effective solution to reduce dependence on fossil energy sources and enhance renewable energy storage capacity.

A detailed BESS analysis shows that Vietnam is accelerating the development of RE combined with BESSs to optimise energy use and ensure the stability of the power grid. The government has issued policies to encourage BESS deployment, as outlined in the PDP VIII, with the goal of developing a storage capacity of 300 MW by 2030. Specifically, Decree No. 135/2024/ND-CP encourages organisations and individuals to install energy storage systems to ensure the safe and stable operation of the power system, setting no limits on the installation of BESSs for rooftop solar power plants under the self-consumption model. In addition, Decree No. 80/2024/ND CP on the DPPA mechanism not only encourages investment in RE but also boosts the demand for BESSs to address disruptions in the power supply from renewable sources, such as wind and solar energy. These policies create significant opportunities for the development of RE and energy storage systems in Vietnam.

The BESS technologies currently available on the market include the most common types, such as PbA batteries, Li-ion batteries, VRBs and NaS batteries. Li-ion batteries are in the lead due to their high efficiency and wide applicability although the cost is still relatively high. Other technologies, such as VRBs and NaS batteries, are being researched to improve efficiency and reduce costs. Circular No. 36/2018/TT-BCT establishes the licensing process for BESS installations in Vietnam, setting out requirements in terms of technical documentation, environmental permits and operational standards. However, to further promote BESS development, a clearer legal framework is needed, particularly for pricing mechanisms for ancillary services, such as frequency regulation. In terms of financing, BESS projects can leverage international funding from organisations such as the World Bank, ADB and domestic green funds. Diversifying funding sources will help promote RE and BESS projects in Vietnam. Although the country is still in the process of improving technical capacity and grid infrastructure, current conditions show promising potential for BESS development. However, investors still face challenges, including an incomplete legal framework, high investment costs and market volatility. In spite of this, there are significant opportunities thanks to government commitments, strong RE growth and the increasing demand for BESSs to support the power grid and provide ancillary services. Therefore, investors should carefully study the legal framework, cooperate with local partners, seek international funding, comply with environmental standards and build flexible business models. Focusing on potential niche market segments, such as BESSs for rural areas or specific industrial applications, will also yield substantial benefits.

The industry analysis focuses on evaluating the potential of BESSs in the C&I sector, including electronics, high tech, textile, leather, footwear, construction materials (cement), automotive industry, water treatment plants, food processing, power companies and renewable power plants. It examines the different market entry requirements and, most importantly, the effectiveness of BESS installations in these sectors.

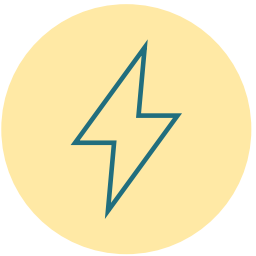
The assessment findings indicate that the majority of the industries surveyed are in the process of considering and researching BESS solutions. The primary barrier is the investment cost, with many businesses still not clear on their economic effectiveness. Additionally, the BESS support policies and legal framework remain incomplete, complicating implementation, and insufficient attention has been paid to the technical infrastructure required or to raising awareness of the role of BESSs in energy optimisation. Therefore, energy service providers and BESS equipment suppliers from Germany could significantly impact the local BESS market at this early stage of development.

Interviews with local experts conducted as part of this analysis show strong demand for BESSs. The practical assessment carried out confirmed high potential for the installation of BESSs to store energy in order to reduce peak electricity costs, enhance supply stability, improve operational efficiency, provide energy backup during outages, lower grid operating costs and integrate RE sources. This is particularly relevant for the C&I sector and for power companies and renewable power plants.

Limited technical expertise on BESSs also restricts the ability to identify, design and implement BESS projects. Moreover, investors often lack a clear understanding of the benefits that BESSs can bring to different sectors. Therefore, more expertise and knowledge is needed, especially among industry experts, to identify BESS opportunities and propose viable solutions. This presents an opportunity for SMEs from Germany to introduce innovative business models and facilitate the implementation of BESS projects. The limited capacity of local energy service companies also represents a significant opportunity for German SMEs to provide BESS services and solutions in Vietnam.

European companies, including German ones, are among the leading manufacturers of energy products and services and are highly regarded in Vietnam, which means that local companies are increasingly interested in becoming distributors for German companies or establishing partnerships to provide services or supply equipment. Partnerships with local companies can therefore be an effective way to penetrate the market.

German companies should conduct due diligence on potential local partners to ensure they have the necessary capabilities and are qualified to transact business. They should also ensure that the cooperation agreements they propose comply with Vietnamese law, fully set out the rights and obligations of each party and stipulate dispute resolution procedures.



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