Transforming Vietnam into a Regional Energy Powerhouse

Eight steps to achieve 30 plus 30 by 30:
A path to achieving an additional $30 billion of GDP per year and 30% reduction in greenhouse gas emissions by 2030

Dave Sivaprasad, Asheesh Sastry, Tuyet Vu, Lars Holm, Alex Dewar, Quan Doan
Christopher Malone, Alex Dolya, Philip Hirshhorn

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EXECUTIVE SUMMARY

Vietnam's energy sector has seen tremendous growth in the last decade. Generation capacity has grown at approximately 10% per year and the country has achieved 99.2% access to electricity – one of the highest rates in the region. Looking ahead, Vietnam has also pledged its commitment to the Paris Climate Agreement, setting a target to reduce greenhouse gas (GHG) emissions by 8% by 2030, a number the country believes could increase to 25% if Vietnam receives additional foreign investment and support.

Within this context, we see significant potential for Vietnam to develop into a regional powerhouse in energy, simultaneously achieving substantial growth in energy supply to meet its domestic energy demand, and cutting back GHG emissions beyond its current intended contribution. To achieve this goal, we recommend an eight-point transformation agenda for the Vietnam energy sector.

1. Drive cost-competitiveness and GHG reduction in Vietnam's oil and gas sector
2. Drive energy efficiency across the energy value chain
3. Develop a vibrant renewable energy (RE) sector and foster a regional renewable energy (RE) champion
4. Manage and de-risk under- or over-investment in grid infrastructure
5. Develop and accelerate the petrochemicals agenda
6. Unlock the full potential of domestic gas
7. Provide policy, regulatory, pricing, and investment certainty
8. Accelerate technology adoption and Industry 4.0 to enable these priorities

In the context of energy transition both globally and in Vietnam, we see opportunities for energy players across sectors to both contribute to and create new sources of competitive advantage in their businesses. Capitalizing on these opportunities requires players to rethink their strategic positioning and transform their operations.

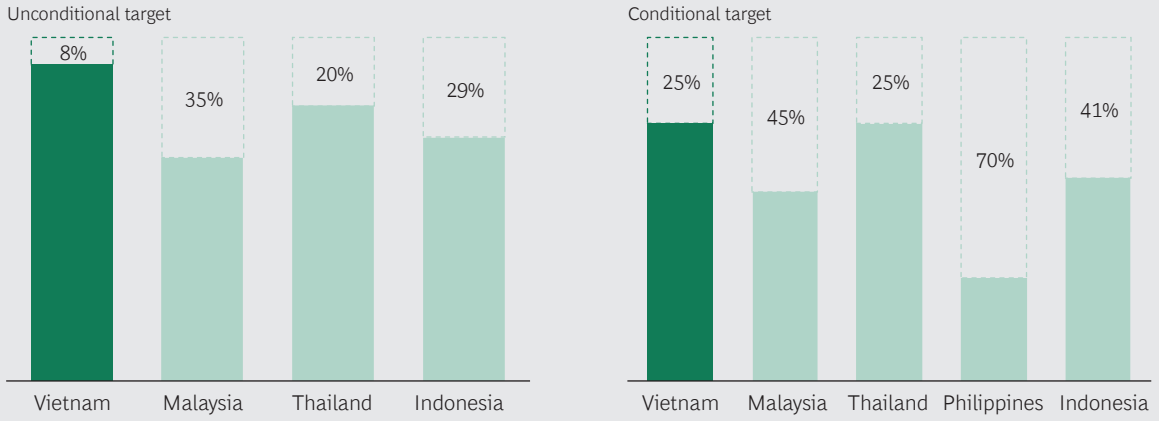
We believe these priorities will have significant impact for Vietnam and estimate they have the potential to ***unlock $30 billion in GDP annually***, while ***decreasing GHG emissions up to 30%*** and creating ***new jobs and opportunities, and improving overall economic competitiveness***.

The Case for Vietnam Energy Sector Transformation

The energy sector is key to supporting long-term economic growth in Vietnam. Energy demand is expected to almost double from approximately 70,000 ktoe in 2020 to approximately 140,000 ktoe in 2035, equivalent to 4.49% CAGR[1] compared with the average 2.1% CAGR of ASEAN countries[2]. At the same time, climate change is a major factor in the future of the energy sector. Vietnam has stated its ambition to decarbonize, and is looking to accelerate this agenda. It aims to reduce greenhouse gas (GHG) emissions by at least 8% by 2030, and possibly 25% if it receives appropriate international support and investment[3]. Compared with its peers in ASEAN, this is a conservative target with potential for uplift if Vietnam manages its transition properly across energy sub-sectors and the value chain . (See Exhibit 1.)

EXHIBIT 1 | Vietnam has potential to go beyond its GHG conservative target while meeting its energy demand, if it manages energy transition properly

GHG Emissions target of comparable developing ASEAN markets by 2030, Vietnam has the most conservative unconditional and conditional target



Source: Intended Nationally Determined Contribution of Viet Nam, Malaysia, Thailand, Philippines, Indonesia, BCG analysis
Philippines does not publish an unconditional target

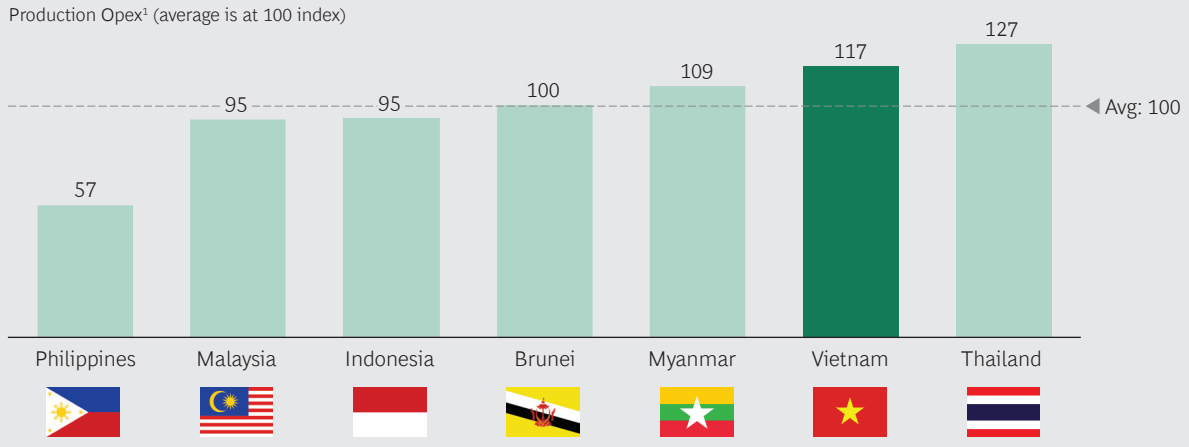
Meeting rapid energy demand growth in the context of energy transition will require a sector level transformation that pursues both demand-side and supply-side levers. In addition, this transformation needs to take into account implications for GDP growth, jobs, state budget contribution, and Vietnam's competitiveness in the global energy market.

We offer an eight-point transformation agenda for Vietnam energy that we believe will help the country achieve a sustainable goal.

1. Drive cost competitiveness and GHG reduction in Vietnam's oil and gas sector

By 2020, Vietnam's major source of energy is expected to be thermal, as it is today; of which around 30% is expected to come from oil and gas[5]. Operational productivity measured by comparing unit production cost with other countries shows Vietnam's upstream oil and gas cost is higher than average for producers in ASEAN[6] countries. (See Exhibit 2.) In the context of global energy transition, there is a belief that not every molecule of hydrocarbon will be produce. Upstream oil and gas players in Vietnam need to drive productivity in their operations and strive to be on the left-hand side of the global supply curve of oil and gas to continue to be competitive. Meanwhile, with the national commitment to tackle climate change, oil and gas players face the dual challenges of improving competitiveness and reducing GHG intensity of the sector.

Exhibit 2 | High production cost in Vietnam vs. other countries



Note: Weighted average production opex against production volume for period 2008-2018
[1] Production opex represents the operational expenses directly related to the production activity which includes materials, tools, maintenance, equipment lease costs and operation related salaries. Depreciation and other non-cash items are not included
Source: Rystad Energy, BCG analysis

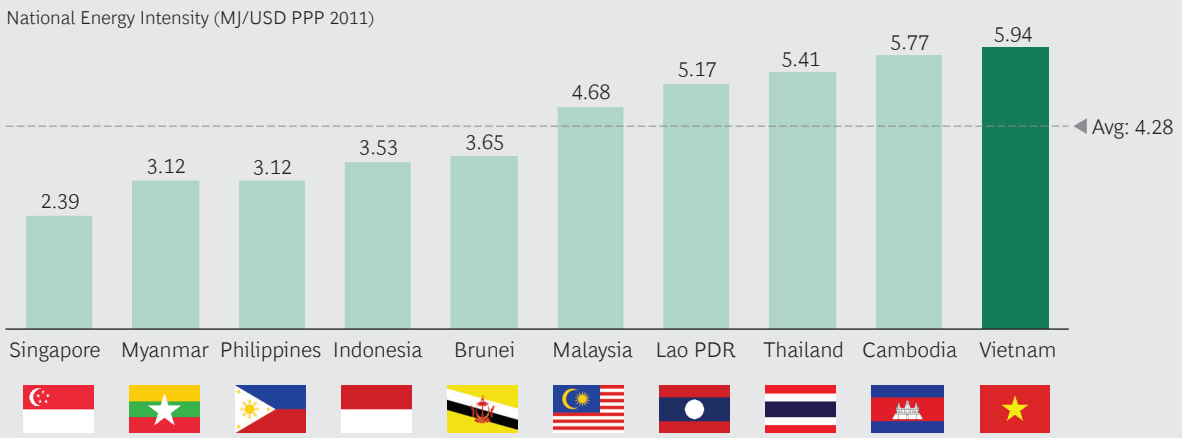
We believe this will require Vietnam upstream oil and gas players to transform their portfolios, operating models, organizational effectiveness, efficiency, and culture and incorporate digital, big data, and Industry 4.0 technologies at scale. From BCG experience, we have seen upstream cost reductions of between $2 to $6 per barrel of oil equivalent[7]. Lower cost and lower carbon intensity will be sources of competitive advantage in the future. As an example, Saudi Aramco, the world's largest oil and Gas Company, publically describes its competitive positioning as the lowest cost and lowest carbon intensity player[8].

2. Driving energy efficiency across the energy value chain

Vietnam has the lowest energy efficiency level in the region, and holds great upside potential for energy efficiency[9]. Given the growing coal capacity in its national power development plan, any energy efficiency improvement effectively cuts the urgency for coal-fired energy generation and clears room for cleaner energy, making it one of the most effective ways to achieve climate change mitigation in Vietnam.

Energy efficiency encompasses most industries and the broader economy. We will focus primarily on the energy value chain, with specific reference to the oil and gas sector to illustrate the potential. Within Vietnam, energy efficiency initiatives at scale will be particularly important to drive both unit cost reduction and GHG emission reduction. (See Exhibit 3.)

Exhibit 3 | Vietnam has lowest energy efficiency vs. other ASEAN peers



Source: Tracking SDG7, International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data.

As an example, global oil and gas players have been pursuing many energy efficiency ideas across their portfolios. Ideas such as offshore platform electrification and integration with renewables have been implemented in some platforms in the Norwegian part of the North Sea. Other areas of focus include eliminating or reducing flaring in operations.

It is essential to recognize that there are many potential initiatives across the value chain, and across the wider economy. The key for the Vietnam energy industry is to drive these ideas at scale. This requires both oil and gas and power players in Vietnam to consider the strategic positioning of energy efficiency at scale, think through the appropriate approach to manage the investment program, and rethink organizational models to make things happen.

3. Develop a vibrant renewable energy sector and foster a regional RE champion

We believe a vibrant renewables sector is a key priority for Vietnam. Renewable sources such as wind and solar account for merely 2.4% of the total energy supply in 2020[10]. Vietnam has significant renewable resources (wind and solar). Reported estimates are wide-ranging: total economic potential for solar has been estimated to range from 204 to 734 GW[11], while for wind the range is between 27 and 144 GW[12]. For wind in particular, Vietnam has shallow coastal waters in the Mekong Delta with strong winds, representing good potential for offshore wind development[13]. Even assuming the lower end of these estimates suggests the potential for more than 200 GW renewable resources in the country. This is equivalent to around four times current installed capacity potential which Vietnam could exploit. An indication of this potential is the volume of international investment flowing into the renewables sector in Vietnam in solar[14] and wind[15], and the growing number of financing channels[16].

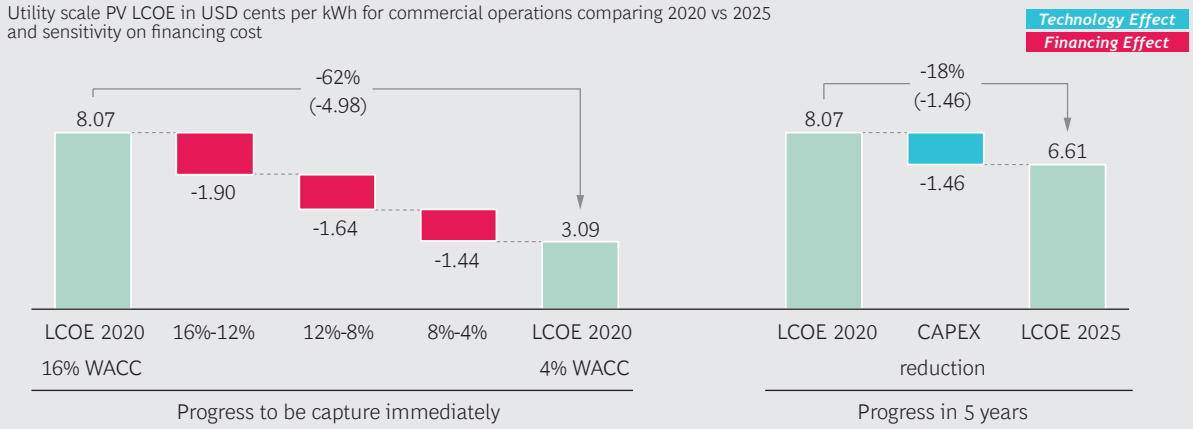
The technology for renewable energy is constantly improving, but in order to realize Vietnam's full potential in renewables, Vietnam must create conditions for lower financing costs for renewable projects.

Today, costs in Vietnam are higher than in other parts of the world. In Vietnam, levelized cost of electricity (LCOE) of ground mounted solar is anticipated to be 8.07 US cent/kWh in 2020. In comparison, globally, solar prices have achieved ranges of 5 to 6 US cents/kWh and in some areas, up to 2 to 3 US cents/kWh. There can be many reasons for these differences. From our experience, a combination of financing costs and local supply chain costs tend to be the largest drivers.

Vietnam cannot rely on technology improvements alone to drive down these costs. Let us illustrate with an example. Consider the impact of financing costs on LCOE for a utility scale solar investment. LCOE is a combination of CAPEX and OPEX discounted by weighted average cost of capital (WACC). For a utility scale solar investment, ~50% of the CAPEX is related to the cost of PV modules sourced from the global market and the remaining 50% is related to locally sourced works. In terms of OPEX, imported spares account for roughly 30% and local works account for 70%. The impact of financing for such as investment is illustrated in the analysis below (see Exhibit 4). Reducing financing costs can have more than three times the impact on LCOE than the reduction in LCOE expected from technology improvements over the next five to seven years. The return for the investor (the leveraged IRR) in our example with 4% WACC is 8%. This is possible through leveraging 80% debt funding in a de-risked environment

It is well known that higher financing costs are a representation of uncertainty. There are numerous levers Vietnam can utilize to increase certainty, reduce financing costs and ultimately reduce LCOE. These include guarantees on portions of financing, certainty in PPA terms, and tax credits to name a few. As an illustration, having a long running offtake agreement for say 15 years, with a bankable party, at a fixed price (or limited market exposure) and shielded against inflation would significantly bring down financing costs and LCOE. The appropriate series of levers implemented well, will enable growth in the sector.

EXHIBIT 4 | Providing a secure framework is ~3.5 times as powerful as technological progress

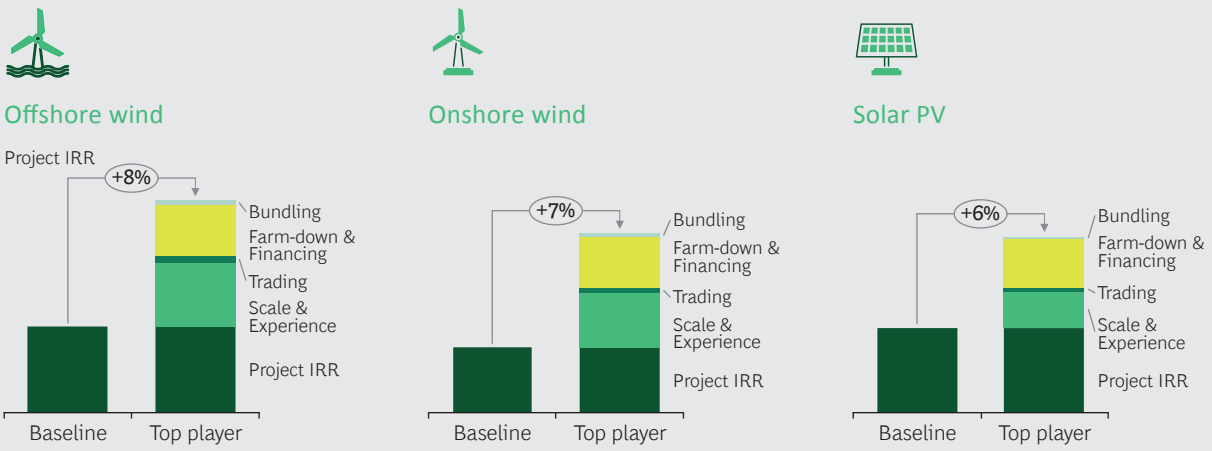


Renewable competitiveness strongly depends on the ability to secure low cost financing driven by a secure investment and regulatory framework

Notes: 100MW Solar PV system with fixed tilt; Numbers may not add up due to rounding. Solar PV in Vietnam in 2020: CapEx: 818k $/MW; OpEx: 7k $/MW p.a.; Lifetime: 30 years; Capacity factor: 20%; WACC in base case: 4% (80/20 debt equity, 8% return on equity, 3% debt rate; Solar PV in Vietnam in 2025: CapEx: 662k $/MW; remaining assumptions are the same as for 2020
Source: BCG analysis

We see levers to improve financing as a material opportunity for Vietnam to take action to further drive down costs that support a more aggressive transition to renewables. This includes policy and regulatory actions to create appropriate market conditions for investment, financing, and efficiency of local supply chains. We will cover more of this in the section on policy and regulations.

EXHIBIT 5 | Scale and experience allow to build market entry barriers and top player will be able to significantly "lift" returns



Source: BCG case work

Within the context of a vibrant Vietnam renewables sector, we see potential for Vietnam to develop a regional champion in renewable energy. Globally, we have observed that leading renewables players who are competitive outside their home markets have successfully leveraged scale and experience[17]. Scale allows renewables players to compete on price, while maintaining high returns. (See Exhibit 5.)

Within Vietnam, we have seen recent examples of success in developing globally competitive businesses, such as Vinfast in the automotive sector. We believe, with the right conditions in place, the same success can be achieved with a renewable energy champion. Many globally successful renewables players have grown through a strong domestic footprint prior to global expansion. For example, successful renewables players in Europe (such as Iberdrola, EDPR, and Enel Green Power) started developing renewables locally, then expanded in Europe, and are now successfully competing internationally on major renewables projects.

Building a successful renewable energy champion in Vietnam will require a different approach from a traditional energy business. Renewables require different business and operating models from traditional energy businesses such as oil and gas and conventional utilities.

In terms of business models, a regional or global renewables player will need to be exceptionally good at securing competitive financing, able to fund growth through active asset rotation, and be able to offer integrated power solutions to large customers. They will need to structure cross-border partnerships, particularly to capitalize on local insight to secure opportunities (such as land access, permits, and grid access).

In terms of operating models, successful renewable players (a) have fast and agile decision making processes to compete for opportunities in a dynamic market; (b) are geared to manage different technical challenges (intermittency, grid connection, and integration); (c) manage differences in people and culture (fast-paced commercial focus, driving repeatability in delivery).

Given these differences, our experience has shown that companies are most successful when they create a standalone renewables business with its own operating model, processes, and people. Many globally competitive renewables players have also pursued similar paths. Vietnam should consider separating a similar standalone renewable entity that can be promoted into a national champion.

Strategically, Vietnam will need to foster the growth of such a champion. Some of the steps in this path include: providing a platform to build local competitive advantage and building competitive muscle over time through exposure to competition; laying the groundwork for partnerships with regional players, including large utilities, energy investors, or oil and gas players looking to diversify; and supporting the business in financing while it builds scale. Finally, developing the RE sector and fostering an RE champion will need to be sequenced with the national agenda to change the market structure in power.

4. Manage and de-risk under- or over-investment in grid infrastructure

Moving to the future of renewables requires investments in the grid and infrastructure to solve specific technical issues and operational constraints. Anticipating and proactively managing these issues at a national level will help Vietnam manage the risk of over- or under-investment in infrastructure.

As an example, utility scale renewables and distributed energy solutions (such as solar and solar and storage) have different implications for the grid and the impact on investments. Distributed energy solutions can be very capital efficient for areas with no-grid access (to move Vietnam from 99.2% electrification to 100%) and for the edges of grid infrastructure, where maintenance costs can be high. Utility scale renewables typically require higher levels of grid investment due to intermittency of power production. Managing investments in the grid will require revisiting Vietnam's power sector master plan, in terms of the optimal investment scenarios with ramp-up of renewables.

Operationally, we have seen these challenges in multiple markets that offer relevant lessons for Vietnam. Outlined below are examples of common issues to anticipate and manage:

1. Capacity limits and reverse flow of electricity: legacy circuits not designed for large amounts of distributed energy which will require targeted investments to address

2. Frequency and voltage fluctuation: instability created by renewable energy and distributed energy resources (DER). In Germany, grid operators have installed smart inverters with only modest increases in cost

3. Load balance: shifting power from when it is produced to when it is needed. For example, in California and Hawaii there are extreme backfeed conditions between 10 am and 2 pm. These issues have been mitigated through distributed storage, storing energy/electricity, 'behind the meter' and on-site.

4. Smarter grid programs: Automation and smarter grid at low, medium, and high voltage. For example, companies like Flexitricity in the UK provide demand-response services by reducing demand or increasing generation with around ten minutes' notice, and sustaining this for approximately one to two hours. Flexitricity pays sites for being ready to respond to a short term operating reserve event (availability), and pays again for delivered energy (utilization).

The issues described above are common in many markets. The appropriate responses and solutions need to be contextualized and shaped for Vietnam. A case example of managing this issue is the German Grid Expansion Acceleration Act. This program involved early and significant public participation. It invited citizens to take part in open discussions about which grids should be expanded, when, where, and by how much.

Vietnam has a strong history of grid performance improvement, with key performance statistics (power loss, MAIFI, SAIDI, SAIFI) improving over the years[18]. However, at this point, the transition responses have a greater sense of urgency since many renewables projects under development will start generating energy in the next one to three years, while currently on average it takes three years to build a power grid project[19].

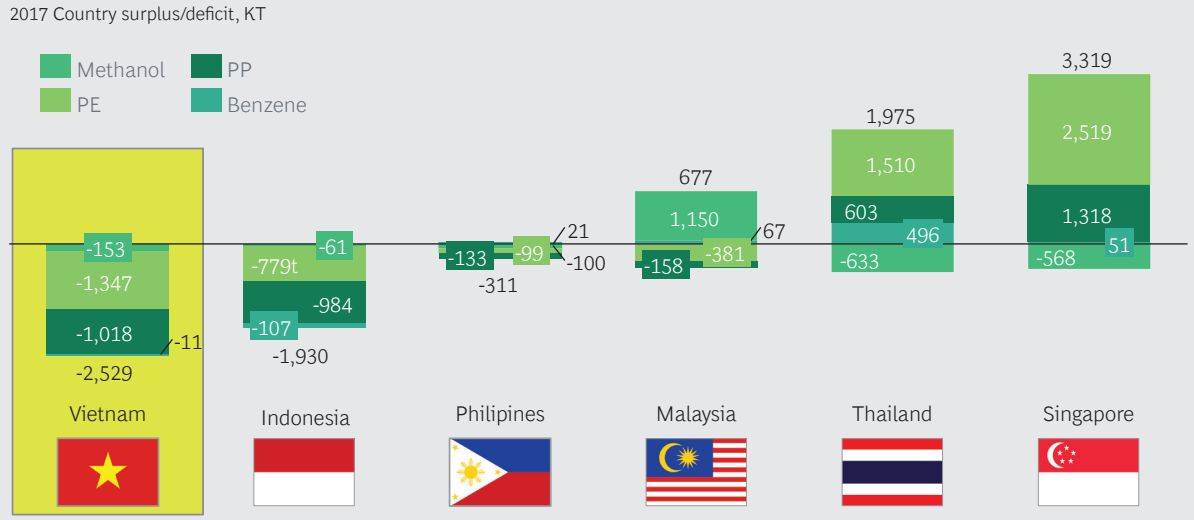
Successfully managing these issues requires coordinated strategies among Vietnam's various energy players, including the energy supply chain of vendors and suppliers. From our experience, we expect the path to successfully managing these issues to include both a macro strategy (national grid investment programs) and micro innovation (regional distributed energy and grid solutions).

One example of macro vs. micro strategy considerations in Vietnam is the Central vs. North and South regional energy systems. Today, Ninh Thuan and Binh Thuan provinces in Central Vietnam attract major solar investments. However, Central Vietnam consumes less energy than South and North Vietnam. This raises questions about the optimal level of solar investment in these provinces, and the associated investments in transmission under various scenarios to optimize local vs. national generation and grid investments.

5. Develop and accelerate the petrochemicals agenda

According to BCG ChemCom research, Vietnam has the highest growth rate of petrochemical capacity, at 15.9% CAGR for 2010 to 2018, among its ASEAN peers, yet, it is still the highest deficit importer for key petrochemical products . Even considering major investments in the pipeline, such as Vietnam's first world-scale cracker, Long Son Petrochemical Complex, coming online in 2022, the country remains a net importer of key petrochemical products. (See Exhibit 6.)

Exhibit 6 | Despite strong growth in capacity, Vietnam has trade deficits for key products



Source: Exhibit footer style.
[1]Exhibit footer no bold style (superscript is built in as nested style)

Global trade flows provide a surge in demand for primary petrochemical products such as ethylene and methanol. This situation is creating opportunities to invest further down the petrochemicals value chain. Vietnam's demand for petrochemical products is increasing. For example, plastic packaging in Vietnam has been growing at 25% per year due to strong food industry growth[21].

Vietnam has historically been protective of the industry, positioning petrochemicals as a strategic industry requiring national "security of supply." Learning from Japan, Vietnam can adopt controlled competition to allow a domestic price leader to emerge. We believe there is significant economic potential for the country through investing in creating a dynamic petrochemicals sector.

A well-developed petrochemicals sector can bring net economic impact to the country, security of supply for the domestic consumer economy, and global competitiveness to capture opportunities from global trade flows. We believe Vietnam should assess investments in the petrochemical sector against the full economic benefit, which includes multiplier impact of the broader sector, net impact considering the prices of imported petrochemical products, availability and cost of domestic feedstock sources such as gas, and broader economic impact of deepening technical capacity in the country.

6. Unlock full potential of domestic gas

Vietnam has one of the largest natural gas reserves in the region. Gas accounts for 48% of Vietnam's total oil and gas resources. However, only 6% of this rich natural reserve is under production or development, while 76% remains unexplored[22].

Challenges in ramping up domestic production has forced Vietnam to become a net importer of gas despite its domestic resources. Vietnam plans to import LNG from2021, reaching 5 million tons of LNG imported by 2025, 10 million tons by 2030, and 15 million tons by 2035[23].

Vietnam Block B and Blue Whale, both major gas developments, are illustrative cases in the public record. Underdeveloped infrastructure for transportation and an unclear pricing mechanism are cited as key causes that lengthened project development.

Some of the learnings from these projects for Vietnam include: (a) there is potential to deepen technical expertise within the State to expedite negotiation; (b) downstream gas assets should be detached in the negotiation as they create greater complexity and lengthen negotiations timeline; (c) there should be separate terms for gas and liquid content. Separate terms would allow overall gas developments to more attractive by adjusting fiscal terms of liquids. This could enable higher margins on liquids in exchange for lower margins on gas (justified by enabling greater domestic access and a cleaner fuel). Although this may lower government take overall, it is a means for enabling gas project development

The points discussed above, raise a question for gas and its market structure in Vietnam. Has Vietnam exhaustively pursued all levers at its disposal to exploit domestic gas? For example, are transfer prices between upstream and mid-stream and

customers optimized? Are all regulatory and policy levers fully leveraged to unlock gas potential? We believe this is an appropriate time to reassess all levers to fully unlock the potential of gas in the country. Our experience in multiple markets globally indicates there are a number of policy, regulatory, and pricing levers that countries have not fully explored to maximize their domestic resources. We describe this further in the next section, as it applies to the broader energy system, as well as gas.

7. Provide policy, regulatory, pricing, and investment certainty

Policy, regulation, pricing and investment certainty are critical enablers for Vietnam's energy transition agenda. Action is needed across a number of areas. We suggest three immediate areas of focus for Vietnam:

(a) **Enhance conditions to attract upstream oil and gas investments:** On a relative scale, Vietnam is considered to have moderate fiscal stability, a measurement that reflects historical changes in PSCs and built-in flexibility. However, Vietnam ranks low in terms of fiscal attractiveness, which reflects government take and level of up-front payment[24]. The average Vietnam government take between 2010 and 2017 is 22% higher than the world average.[25] Foreign investment is needed to meet projected oil and gas demand in Vietnam. Upstream investors typically consider a number of key factors when considering an upstream investment in a country. This includes entry costs, competition in the sector, and the bargaining power of resource and license owners. It is also important to recognize that different segments of upstream investors—whether they are global supermajors, super independents, exploration and production, or smaller independents—evaluate deals with different lenses. Vietnam can either consider how it can increase absolute take versus relative take to increase investment attractiveness, or implement de-risking policies and regulations that improve the risk-return perspective for investors in Vietnam. Vietnam may also need to consider how policy and regulation changes are designed and implemented in the sector. Currently the role is split, with MOIT setting policy, and PVN administering it. There is an open question as to whether this is the optimum method to steer and effect changes.

(b) **Create fair market conditions for renewables investments:** Renewables and distributed energy will require several policy and regulation enhancements with the goal of reducing barriers to investment in renewable power generation. This includes eliminating misplaced incentives for electricity, and supporting a transition to low-carbon pathways. The conventional approach to LCOE fails to take into account external costs of environmental, social, and health impacts. Taking into consideration those external costs, coal would have been more expensive than solar and wind in 2017 (12.38 vs, 8.84 vs. 8.77 US cent/kWh, respectively). Regulators need to have a clear understanding of post-tax and pre-tax energy subsidies. These subsidies implicitly favor conventional thermal sources of power and have an impact on national budgets. In a recent study by the IMF, after incorporating environmental damage from energy consumption, global post-tax subsidies reached $2 trillion, a step-change from pre-tax subsidies of $492 billion. Eliminating post-tax subsidies can raise government budget revenue, cut CO2 emissions, and positively impact air pollution[26]. To meet its 2030 renewable energy target in the country's Revised Power Development Plan

(PDP), Vietnam needs to attract $144 billion in investment, or approximately $10 billion per year. Considering these factors, developing a vibrant renewables sector and supporting a more aggressive transition to renewables will have broader economic and social benefits to the country.

8. Accelerate technology adoption and Industry 4.0 to enable these priorities

Developed countries and global energy players have been investing consistently in technology and particularly, Industry 4.0 technology. This investment has always been a long-term commitment, and is now helping these players achieve competitive advantages for the future. Vietnam has the opportunity to leapfrog and leverage 4.0 technology, applying key learnings and experiences to enable the seven other transformation priorities described above.

Driving cost competitiveness in the oil and gas sector: digital solutions are available from exploration to production. How an upstream player applies digital solutions is different at each step in this value chain[27], for example:

1. Exploration: application of machine-learning methods to reservoir modeling will speed up and improve the interpretation of exploration data.

2. Development and projects: digital modeling and simulation that enable companies to rapidly select development concepts.

3. Drilling and wells: integrated drilling automation systems can result in closed-loop, autonomous drilling.

4. Production: automatically analyzing data will improve operational performance

Driving energy efficiency across the value chain: digital is a key enabler. Advanced analytics, big data, and sensors are primary enablers in upstream, while downstream, consumers can optimize their consumption and reduce the cost of energy. Exxon, for example, is deploying proven technologies such as cogeneration, carbon capture, and storage to increase energy efficiency. BP, using energy efficiency technology, is limiting the emissions intensity of methane and reducing flaring of oil and gas.

Developing a regional champion in renewables, digital technologies can reduce development and engineering and construction costs, reduce operations and maintenance costs and increase production, reduce variability, and even create a new business model. For example, drones with infrared cameras are able to survey solar panels in operation and automatically detect failure for immediate intervention. Applying solar AI software algorithms that plot out the best designs, layout, and wiring for large solar PV plants can lower the solar LCOE by as much as 30%[28].

Managing grid and infrastructure investment: distributed energy solutions, smart grids, and energy efficiency/demand management are key digital solutions. For example, Flexitricity in the UK (described in an earlier section), provides demand response service. Its solutions are heavily enabled through technology and digital.

Developing a rapid petrochemicals agenda: digital transformation provides solutions across the petrochemicals value chain. A few notable use cases include integrated operation control and simulation through a decision support system, predictive maintenance to enhance asset integrity and reliability, automated material balance reconciliation and utilities optimization, collaborative and analytics-driven procurement, and advanced algorithm pricing to enhance profit margin.

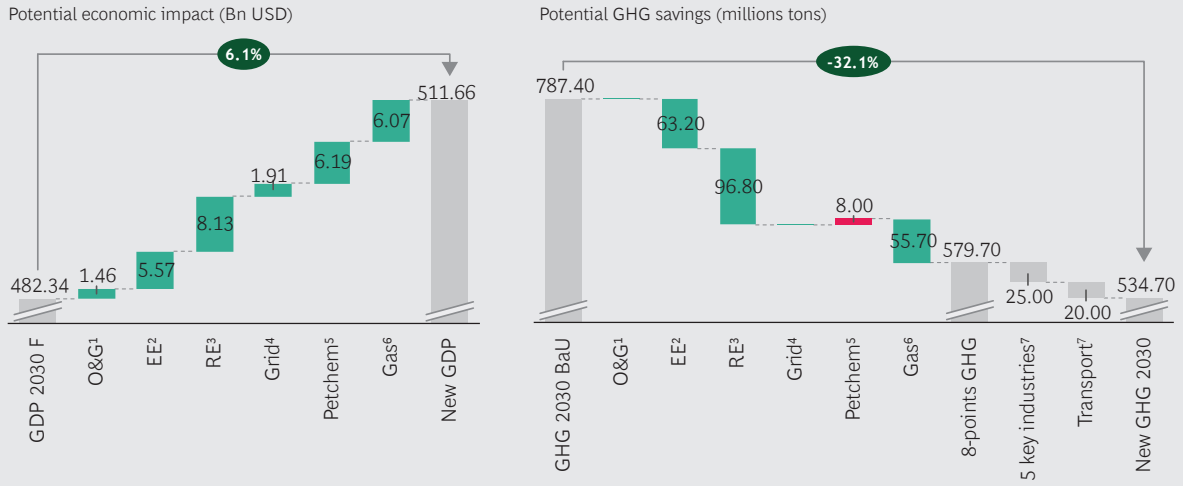
Providing policy, regulatory, pricing, and investment certainty: digital solutions promote transparency for policy changes. "Smart" solutions increase the ability to monitor and benchmark energy demand data in real time, increasing the ability to intervene and create new pricing models. Transparency is also necessary to build distributed energy resource policies that support the balance of the energy system. This in turn enables efficient market-based pricing.

Building Vietnam into a regional energy powerhouse

We believe Vietnam has to set bold ambitions for the energy sector. For example, to:

1. Become the number one renewables player in ASEAN
2. Become the most competitive oil and gas player in the region
3. Produce sufficient domestic energy and petrochemical products for economic growth, and become a positive exporter in selected areas

EXHIBIT 7 | Significant value to be unlocked for the economy and environment



Key assumptions: GDP growth is 6% 2018-2030, regulation, technology and industry 4.0 are enablers, and their impacts are included in other initiatives

[1] Achieve cost reduction $3.5/ boe due to high-technology and emission reduction is not calculated due to overlapping with EE initiative, [2] Vietnam realizes 80% saving of energy saving if reach average ASEAN level of energy efficiency, and Malaysia/Thailand level of CO2 emission/ GDP, [3] Vietnam doubles its RE generation compared to target in revised PDPVII by 2030, [4] Apply Germany investment to grid/ investment to RE ratio, [5] Vietnam adds 3 more petrochemical complexes that are as big as Long Son, emission from petrochemical reaches Thailand level, [6] Vietnam adds 20% on top of its natural gas master plan capacity, [7] Potential mitigation from 5 key industries (iron & steel, fertilizer, cement, pulp & paper, refining) and transport in 2030 from "Pathways to low-carbon development for Vietnam" by Asian Development Bank.

There is significant value to be unlocked. We estimate Vietnam has the potential to unlock $30 billion in GDP impact annually, while decreasing greenhouse emissions up to 30%, and creating new jobs and opportunities, and improving overall economic competitiveness. (See Exhibit 7.) We estimate the level of investment required to unlock this potential would be in the range of $100 billion over this period.

Looking ahead, we recommend practical actions to achieve this eight-point transformation agenda:

1. Upstream oil and gas players should launch operational productivity programs; heavily leveraging Industry 4.0 and digital technologies to achieve these objectives.

2. Energy players across the value chain should implement energy efficiency initiatives at scale, thinking through the appropriate approach to manage the investment program and digital applications.

3. Vietnam should foster a vibrant renewables sector and leverage the opportunity to set up a standalone, national renewable energy champion that uses domestic scale and experience to build a regionally and, in some areas, globally competitive renewables business.

4. The power and utilities sector should anticipate and carefully manage grid and infrastructure investments to guard against over- or under-investment as utility scale renewables and distributed energy solutions grow in scale. A comprehensive review of the masterplan of the energy system under various scenarios is a critical first step.

5. Vietnam can foster development of the petrochemical sector, evaluating and investing to develop the sector on a full macroeconomic impact basis. This should consider full multiplier impact to the country against investments needed to develop the sector

6. Vietnam should review gas market structure, incentives and pricing to accelerate development of domestic supply and attract investment into the sector.

7. Vietnam should nationally review and reassess selected policy and regulations to create the conditions to attract energy sector investments and enable an effective energy transition in Vietnam.

8. Both the public and private sector should accelerate technology and Industry 4.0 capabilities through targeted programs to fully unlock potential of the energy sector

Vietnam has a unique opportunity to transform the country's energy sector to meet its domestic energy demand, unlock material economic value, reduce greenhouse gas emissions, and create a concrete foundation for its economic growth and a healthy living environment. The path ahead will require bold ambition and the conviction of multiple players in the sector to take deep and meaningful action.

Notes [End note header style is Henderson Serif, 8 pt]

1. Source: MoIT estimates 71,337 ktoe in 2020 to 137,834 ktoe in 2035
2. Source: IEA, Southeast Asia Energy outlook, 2017
3. Source: Intended Nationally Determined Contribution of Viet Nam
4. Source: Intended Nationally Determined Contribution of each country
5. Source: Danish Energy Agency "Vietnam Energy Outlook Report 2017", BCG analysis
6. Source: Rystad Energy, BCG analysis
7. Source: BCG analysis, From cutting costs to building resilience in Upstream Oil, 2017
8. Source: Aramco website (https://www.saudiaramco.com/en/making-a-difference/planet/climateinitiative)
9. Source: Tracking SDG7, IEA, UNSD, WDI
10. Source: Danish Energy Agency "Vietnam Energy Outlook Report 2017", BCG analysis
11. Source: MoIT/ GIZ Energy Support Programme
12. Source: MoIT/ GIZ Energy Support Programme
13. Source: GWEC, 2017
14. Source: Nikkei Asian Review: B.Grimm, has partnered with Vietnamese construction company Xuan Cau to develop the largest solar power plant in Southeast Asia at a cost of $420 million last year
15. Source: Reuters: Thailand's largest solar energy company, Superblock Pcl, planned to invest 56 billion baht ($1.76 billion) to install 700 megawatts (MW) of wind farms in Vietnam
16. Source: Viet Nam News: Vietcombank, who has recently approved $33.55 million for BP Solar 1 project, HDBank, Vietinbank, Agribank, to name a few
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18. Source: EVN annual report 2016
19. Source: Nguyen Minh Quang from the National Load Dispatch Centre, VIR 2018
20. Source: BCG ChemCom (2018), Nexant, BCG analysis
21. Source: Vietnam Petrochemical Industry VIRAC, 2018
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About the Authors

Dave Sivaprasad, Managing Director and Partner, Sivaprasad.Dave@bcg.com

Asheesh Sastry, Managing Director and Partner, Sastry.Asheesh@bcg.com

Tuyet Vu, Principal, Vu.Tuyet@bcg.com

Lars Holm, Partner and Associate Director, Holm.Lars@bcg.com

Alex Dewar, Senior Manager, BCG's Center for Energy Impact, Dewar.Alexander@bcg.com

Quan Doan, Senior Associate, Doan.Quan@bcg.com

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Christopher Malone, Managing Director and Partner, Malone.Christopher@bcg.com

Alex Dolya, Managing Director and Partner, Dolya.Alex@bcg.com

Philip Hirschhorn, Managing Director and Senior Partner, Hirschhorn.Philip@bcg.com