The need for flexible internal combustion engine (ICE) power plants and their applications in Vietnam's future power system

VIETNAM POWER SYSTEM & CHALLENGES

The global energy landscape is in transition towards more flexible and sustainable energy systems. As the cost of renewables continues to decline, the number of new investments into coal-fired plants and other inflexible baseload technologies is decreasing. Vietnam has emerged as the hotspot for clean energy investment within Southeast Asia, driven by solar developments with cumulative installations expected to reach more than 5 GW in 2020. Power demand grew at an average rate of 10% annually from 2016 to 2020 on the back of a growing manufacturing industry and it is expected to grow at an average rate of 8% for the period of 2021-2030.

THE CHALLENGES IN VIETNAM'S POWER SYSTEM

- High electricity demand growth rate.
- Power shortages due to delay in development of large thermal power plants.
- Renewable energy integration and maintaining system reliability and resilience.

Currently, Vietnam's power system is facing various challenges, including the lack of an adequate supply of electricity to meet growing demand, environmental pollution, and delays in large thermal power plant projects. EVN and MOIT have been working towards finding quick solutions to reduce the risk of annual electricity shortages. Recently, a number of wind and solar power, and CCGT (LNG) power plant projects have been added to the Power Development Plan No.7 (Revised) to address the issue. As the share of renewable energy ("RE") will continue to increase, Vietnam's power system will face new challenges not only in maintaining system reliability and resilience, but also in balancing net load demand to ensure system stability. Without adequate and detailed planning, the overall cost of generation may increase, despite the addition of lower cost RE.

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STUDY OF INTERNAL COMBUSTION ENGINE (ICE) POWER PLANTS IN VIETNAM'S POWER SYSTEM

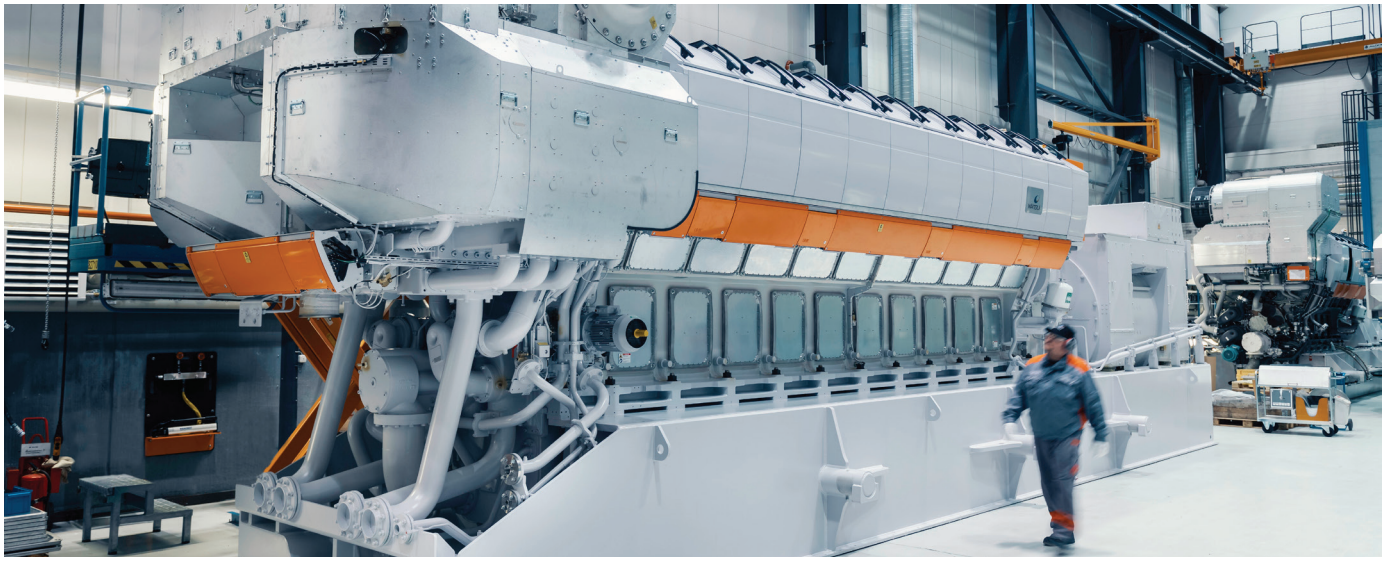
This study introduces a sustainable, reliable, and affordable type of power generation technology, the Internal Combustion Engine (ICE). ICE-based power plants can be built quickly and operate flexibly as an enabler for power systems with a high proportion of solar and wind power. Without flexible ICE-based power plants it will be difficult to balance the system and to provide critical power. Furthermore, significant RE penetration cannot realistically be achieved, and the savings by low cost RE will not be realized without ICE. An ICE can reach 100% capacity within just 2 minutes, can quickly be ramped up and down, and can be shut down and restarted without any operational penalties. This ability saves fuel, wear-and-tear as well as emissions, since running the engines idle is not necessary.

Internal combustion engine (ICE) plants provide ultimate flexibility with high efficiency, harnessing gaseous, liquid or biofuels. ICE based power plants are optimal solution for peaking power and grid stability services.

ICE-based power plants are different than conventional thermal power plants using Steam & Gas Turbines. These contemporary combustion engine plants provide ultimate flexibility with high efficiency, harnessing gaseous, liquid or biofuels. These plants can operate on baseload, provide peaking power, and also provide grid stability services. ICE power plants comprise standardized modular units, allowing for fast construction time (within 1 year only) and easy expansions. It is necessary to determine the optimal investment in new generation assets in Vietnam, and to study the role of ICE power plants using LNG in the grid from 2020 to 2050. Flexible ICE power plants are the key to ensuring demand is met in the short-term while enabling the smooth integration of renewables into the grid.

The analysis in the study is carried out using powerful modelling tools, such as BALMOREL, PDPAT and PLEXOS. The study has focused on the role of flexible power generation and the use of ICEs in Vietnam's future power system. The objective of the study is to optimize the future power system in Vietnam with the lowest total system cost, while maintaining system stability and reducing emissions.

The study has considered different scenarios in different planning horizons: long-term (2020-2050), medium-term (2020-2030) and short-term (2020-2025) for the future power development plan of Vietnam's power system. These alternative scenarios reflect different situations, such as delays in committed power plant projects until 2025, lower renewable prices with increasing competition, and capacity optimization until 2050 using BALMOREL modelling software.



An internal combustion engine

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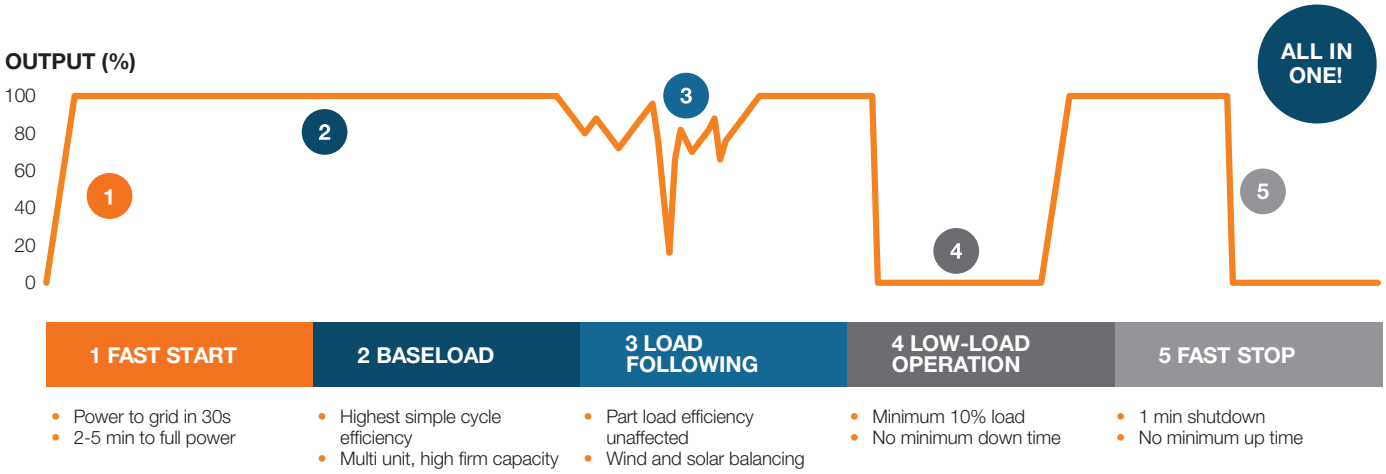

Operating modes of an ICE

RECOMMENDATIONS

In the short-term, IE recommends building 650 MW of ICE power plants in the South during 2022-2023 to support the high energy demand from 2022 to 2025, especially as Vietnam is expected to experience delays in the delivery of some coal and CCGT power projects in the South.

This Vietnam power system study carried out by the Institute of Energy (IE) under the Ministry of Trade and Industry (MOIT) recommends adding internal combustion engine (ICE) power plants from 2022 onwards into Vietnam's power system. The ICE power plants need to be built in the South with a total capacity of 650 MW during 2022-2023. These ICE power plants will support the high energy demand by 2025, especially as Vietnam is expected to experience delays in the delivery of some coal and CCGT power projects in the South. Additionally, drought conditions could create a risk of power shortage in the country. In the long-term, the needed capacity of flexible ICE power plants to provide reserve capacity, supply peak demand, and balance the renewable generation in the grid will be 2.5 GW in 2030, 10.6 GW in 2040 and 13.4 GW in 2050. With ICEs in the system, total system cost will be reduced by 180 million USD/year in 2030, and similar savings can be achieved in the future years by building more ICE power plants.

In the long-term, planning and policy authorities are strongly recommended to include ICE power plant projects in the Power Development Plan No. 8 (PDP8) with an installed capacity of 2.5 GW in 2030, 10.6 GW in 2040 and 13.4 GW in 2050 to provide reserve capacity, supply peak demand, and balance the renewable generation in the grid.

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total installed capacity of ICE (MW)	400	650	650	650	650	650	1250	1850	2450
North Vietnam (MW)							300	600	900
South Vietnam (MW)	400	650	650	650	650	650	950	1250	1550

Proposed capacity of ICE power plants in the period 2022–2030

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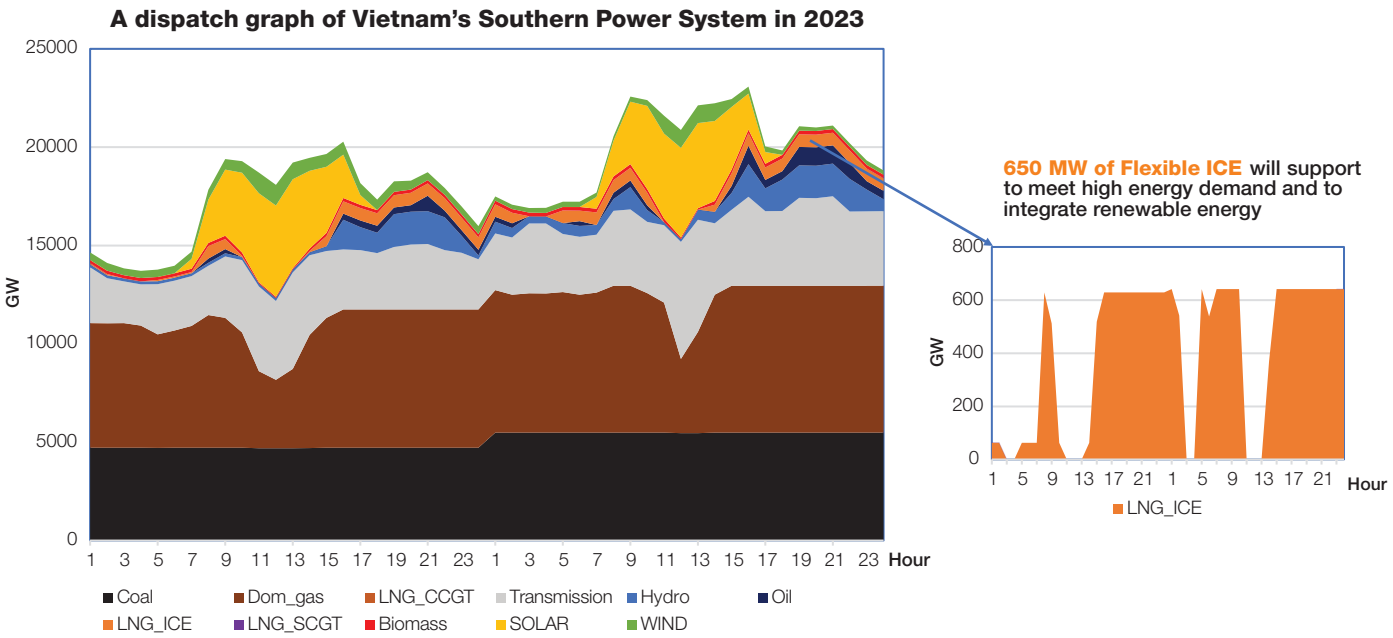

This study proposes to develop a mechanism for reserve capacity payments for flexible power plants, and develop an ancillary services market for the Vietnam grid.

With all the benefits provided by ICE power plants to the power system of Vietnam, as showed in the modelling study, IE strongly recommends that the planning and policy authorities include ICE power plant projects in the Power Development Plan No. 8 (PDP8) starting from 2022-2023 with a capacity of 650 MW in the Southern power system. To ensure the financial viability of the ICE power plant project, this study proposes to develop a mechanism for reserve capacity payments for flexible power plants, and develop an ancillary services market for the Vietnam grid.

An internal combustion engine (ICE) power plant

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