Quantifying global power transformer demand and supply amid accelerated grid modernization

A data-driven assessment of plant-by-plant manufacturing capacity and country-level demand to address supply-demand balance and price evolution

ABSTRACT

The power transformer industry is undergoing unprecedented strain amid record demand from grid build-out. This study presents a comprehensive analysis of the power transformer supply chain, integrating grid and transformer demand forecasts with an assessment of manufacturing capabilities across 324 production facilities in 51 countries. Results reveal a widening supply-demand gap since 2019. Strategic capacity planning, enhanced workforce development, and supply chain optimization are crucial for meeting future grid infrastructure needs.

KEYWORDS:

demand, grid, manufacturing, power transformer, supply chain

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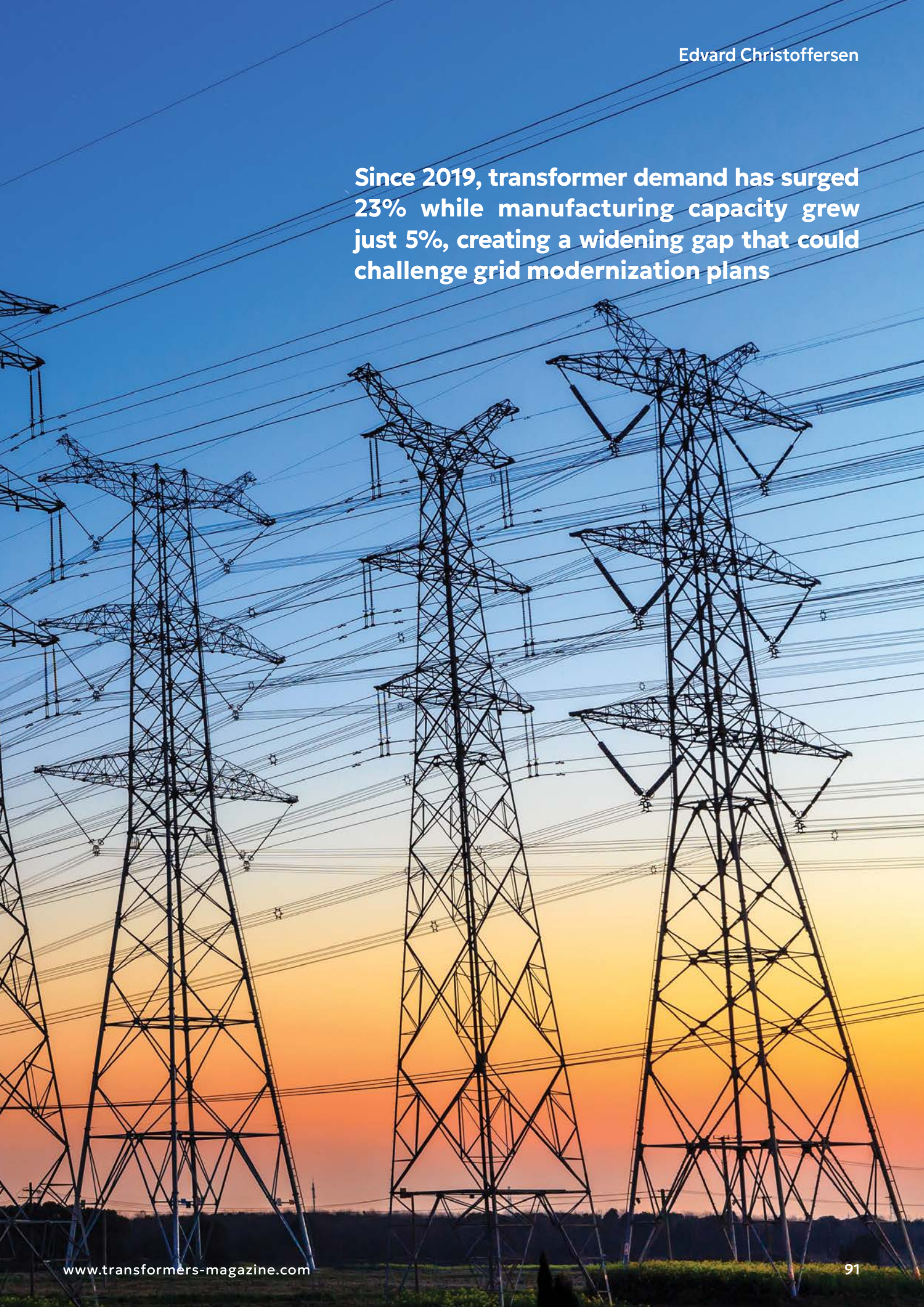
Since 2019, transformer demand has surged 23% while manufacturing capacity grew just 5%, creating a widening gap that could challenge grid modernization plans



Power transformers have become a critical bottleneck in the global energy transition, with supply shortages threatening to slow down grid expansion and modernization efforts worldwide

1. Introduction

An enormous scaling up and overhaul of grid networks worldwide is required to accommodate growing global power demand, which will be met through a fast-paced renewable energy buildout. Power demand and generation capacity growth coupled with aging infrastructure will impact demand for critical power equipment, including power transformers [1]. The power grid component supply chain is challenged by high prices, lead times and supply deficits, with power transformers currently being among the most severely undersupplied grid equipment [2]. This makes power transformers a potential inhibitor of power network installation and modernization demanded by the energy transition and broader electrification of society, with grid networks being the largest end-use application for power transformers [3]. Meanwhile, available comprehensive data on supply capabilities and demand projections for transformers remain limited, weakening buyers, manufacturers, researchers, and policymakers from having a clear view of the market. This study presents a global power grid and transformer demand market size model and establishes a new database of manufacturer plants with production capabilities. Based on these data, we present the current market status and forecast for power transformer supply and demand, with power transformers in this study referring to transformers having a rating of above 10 MVA. This study aims to inform strategic decision-making by equipping the industry with insights needed to make informed high-level strategic decisions to meet evolving power system requirements.

2. Methodology

This study employs a multi-model approach that integrates quantitative analysis, qualitative market insights, and extensive proprietary data to estimate global power transformer demand and supply up to 2050. The methodology draws on established data sources – such as official trade flow statistics [4], population [5] and GDP [6] figures, and public grid expansion plans – alongside a proprietary project-level energy database [7] covering over 300,000 projects and 5,000 companies.

Three interlinked models form the analytical framework: (1) the grid demand model, (2) the transformer demand model, and (3) the transformer supply model. Each component focuses on a distinct but complementary aspect of the market.

2.1 Power grid demand modelling

Grid requirements are estimated using regression-based methods that incorporate GDP growth, population trends, electrification rates, and grid modernization initiatives. Where available, country-level or market-level targets (e.g., capacity expansion goals) are used to adjust unconstrained model outputs. The model produces yearly estimates of both grid length in kilometres and capital expenditures in USD. These outputs are generated with sub-national granularity down to administrative level 1 (state-equivalent in most countries). Voltage-level segmentation and the split between new and replacement grid activities are informed by field research, expert interviews, and historical data on grid extension projects. Regional variations in contract costs and public price indices are used to translate expansion and replacement needs into local USD spending estimates.

2.2 Power transformer demand modelling

Building on the grid demand forecasts, the transformer model projects demand for power transformers rated above 10 MVA. Sub-national factors such as population density, industrial clusters, and power plant developments help identify where new installations or replacements are likely needed. Historical data from official trade flows (e.g., UN Comtrade) and known manufacturing capacities serve as key calibration points, ensuring model outputs do not underestimate demand in regions with significant domestic production. Voltage levels and power rating distributions within each administrative area reflect findings from expert interviews, publicly available databases of installed transformers, and field research.

2.3 Power transformer supply modelling

To complement the demand analysis, the study assesses global manufacturing capacity and supply dynamics through a plant-by-plant review of 324 facilities operated by 196 manufacturers. Data come from multiple sources, including bill of lading records, public tender outcomes, government databases of manufacturing licenses, and approval lists from major buyers. Company reports and news releases further clarify production capabilities. Satellite imagery and manual reviews track factory footprints over time, highlighting expansions or newly built facilities. These spatial observations are combined with data on utilization rates, product portfolios, and announced investments. Structured interviews with industry stakeholders and open-source spatial datasets provide additional context on operational constraints and the extent of each facility's focus on power transformers.

2.4 Bringing the three models together

All datasets - ranging from macroeconomic indicators to site-specific manufacturing

A plant-by-plant assessment of 324 facilities operated by 196 manufacturers worldwide reveals global production capacity, combining satellite imagery with trade and tender data

information - are processed using robust data pipelines. The final demand-supply model iterates through bottom-up calculations (e.g., sub-national transformer requirements) and top-down validations (e.g., national-level GDP and trade data). Results for 1990–2050 include annual estimates of transformer units, capacity (MVA), and monetary values in USD.

Reconciliation at multiple aggregation levels ensures historical reliability and alignment with recognized industry benchmarks. By uniting grid expansion forecasts, local transformer demand, and detailed manufacturing capacity assessments, the study provides a transparent and comprehensive view of power transformer supply and demand trajectories through 2050.

3. Results and discussion

3.1 Power grid demand

Grid development in the coming decades requires a considerable surpass of historical rates to accommodate increasing power demand, power generation capacity, and refurbishment of aging infrastructure [1]. Grid expansions, as highlighted in Fig. 1, are estimated to move the global grid network beyond 99 million kilometres in 2030 to approximately 152 million kilometres by 2050. Asia is found to contribute more than half of this decade's total additions, with China and India, respectively, the world's first and third-largest power consumers being the largest growth countries. The power grid is expected to remain the largest end-use sector for power transformers, and increasing investments in grid scale-up and overhaul will be a primary driver for grid equipment demand going forward, including power transformers.

By 2050, the global power grid will stretch to 152 million kilometres—nearly double today's network—with Asia accounting for more than half of the expansion

The global power grid will stretch 83 million kilometres in 2025 (Fig. 1). High- and extra-high voltage lines, which generally make up the transmission network, comprise some 6 million kilometres, while the medium- and low-voltage lines generally representing distribution networks make up over 92% of the global network at some 76 million kilometres. While high- and extra-high voltage lines make up only around 8% of total network length in 2025, they are found to amount to a larger share of 42% of investments.

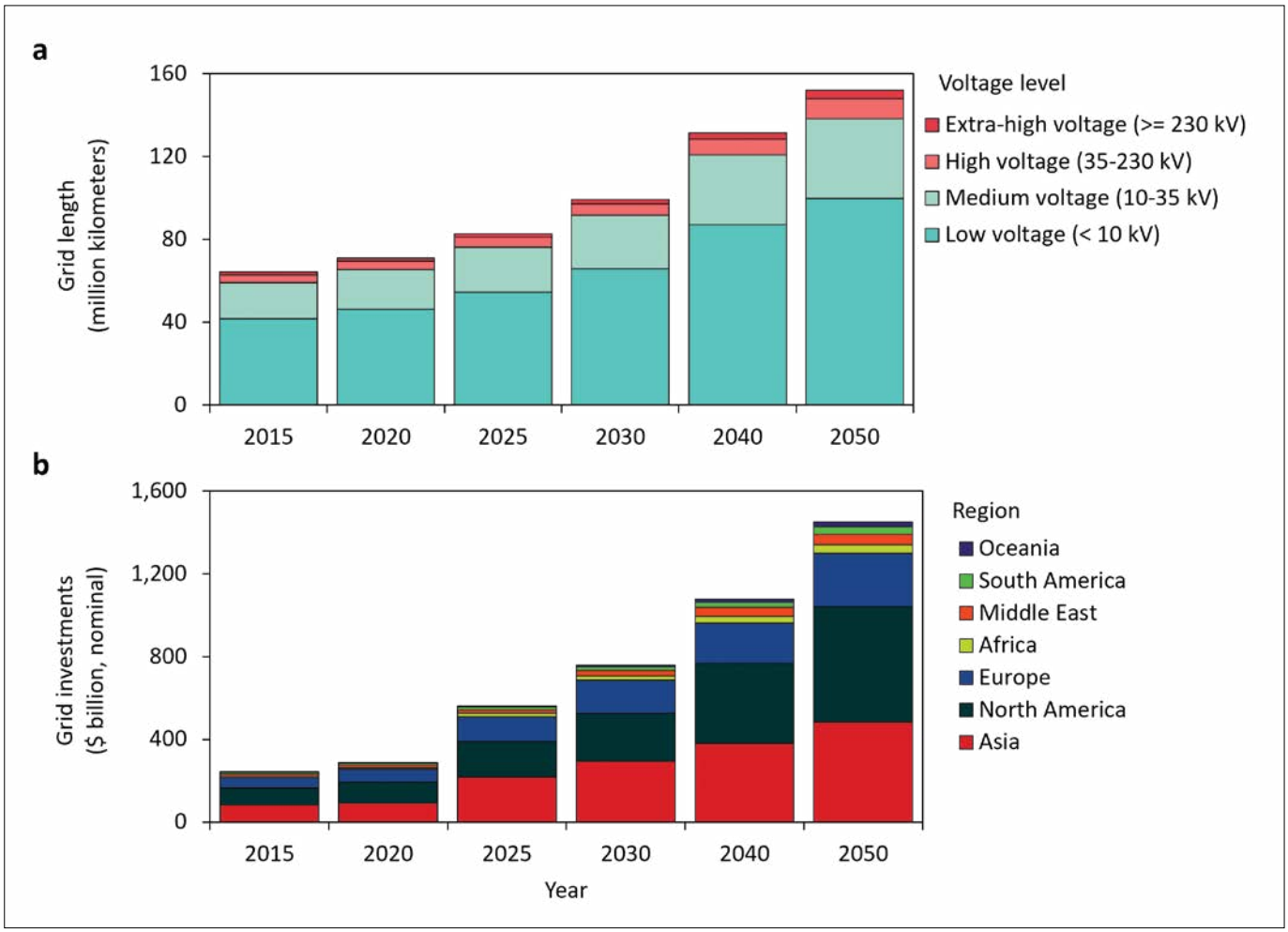


Figure 1. Global power grid expansion in incremental years in terms of a) system length by voltage level, b) capital investments by geographical region.

The power transformer market is set to reach $70 billion by 2030, driven by grid expansion and aging infrastructure replacement in major economies like China, India, and the US

With growing power demand, renewable generation capacity buildout and aging infrastructure replacements as primary drivers, power networks are estimated to require an expansion of nearly 17 million kilometres by 2030 and expand to a total length of 152 million kilometres by 2050. The expansion will demand investment

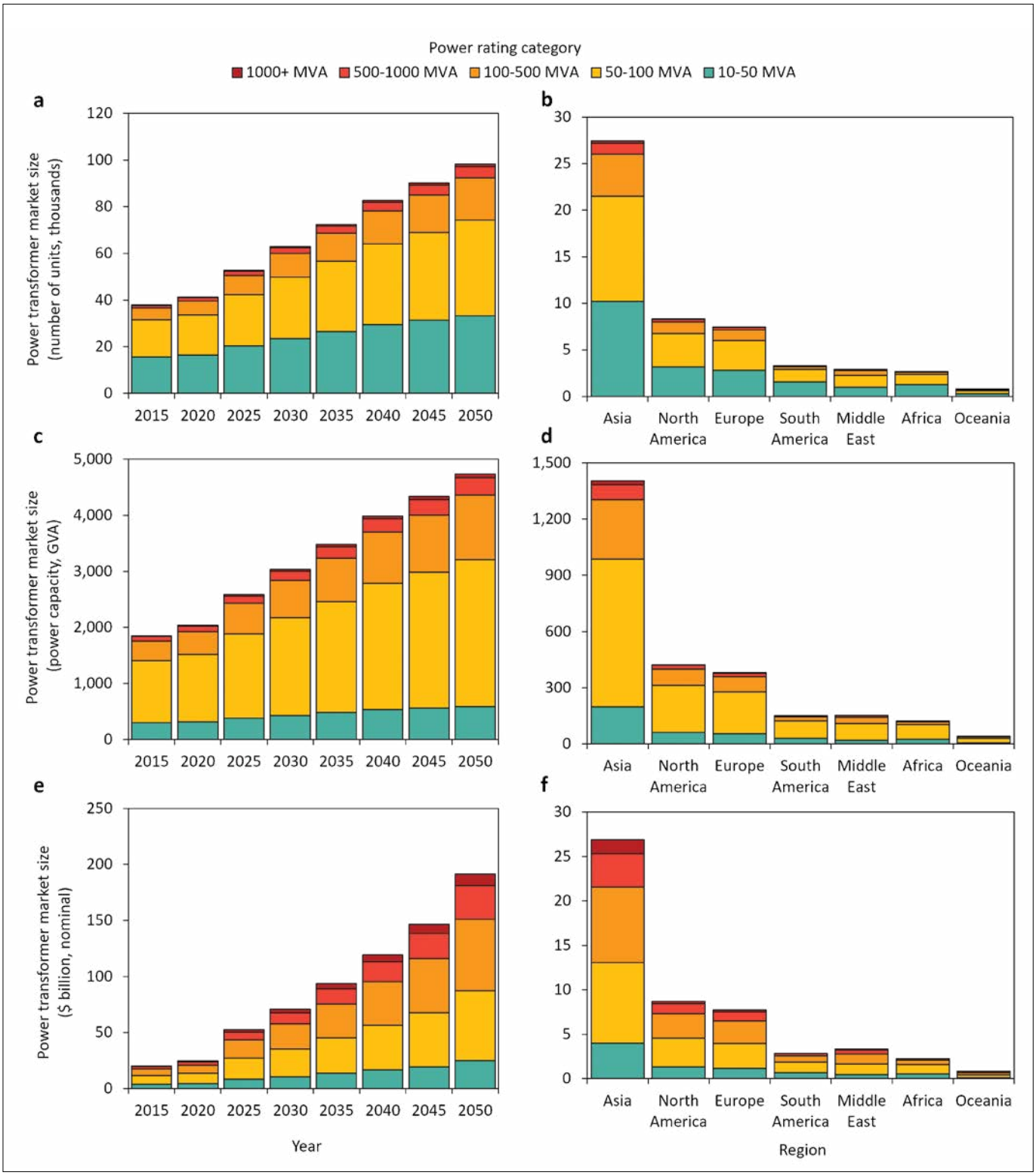


Figure 2. Power transformer market size for transformers with a rating above 10 MVA by power rating category, displaying global demand in terms of a, b) thousands of units, c, d) power capacity, and e, f) nominal USD billion for incremental years from 2015 to 2050 (a, c, e), supplemented by a geographical region breakdown for the year 2025 for each market size metric (b, d, f).

to grow significantly compared to the average of around $300 billion a year seen in the last decade. Asia and North America are forecast to demand the highest growth in both length and investments, with China making up nearly 30% of 2025 investments.

3.2 Power transformer demand

The global market size for power transformers is estimated to be $53 billion in 2025, reaching $70 billion by 2030 (Fig. 2). Grid buildout and rehaul are identified as the primary driver for projected growth. The monetary market size is set to outpace capacity demand, which is further set to outgrow unitary demand, suggesting that the combined effect of general inflation and transformer manufacturing costs will drive the continued rise of already elevated transformer prices and that the average size of transformers will increase due to evolving power demand and generation capacity trends. While annual spending is set to grow 5.3% from 2025 to 2035, annual unitary demand is forecast to experience a lower growth rate of 2.8%, slightly below the figure for power capacity demand estimated at 3.0% over the same period. China, India, and the US will remain the three largest markets for transformers, with their collective market share increasing to nearly half of the global market size in power capacity terms from 2025 until 2030. In Europe and the US, the replacement of aging infrastructure is found to be a particularly strong driver of transformer demand, with replacements making up around 30% of power capacity demand by 2030, compared to an average rate of 16% across the rest of the world.

Transformer market size data was compared with international trade flow data derived from UN Comtrade [4] using harmonized system (HS) 6-digit product code: 850423 – Liquid dielectric transformer, capacity > 10 MVA. It was verified that all major demand regions have significant domestic manufacturing capabilities, given that international trade constitutes only around 13% of global demand in 2023.

The market size of power transformers in 2025 is estimated at 2,588 thousand units (Fig.2a), 2,672 GVA (Fig.2c) and $53 billion (Fig.2e), with Asia comprising

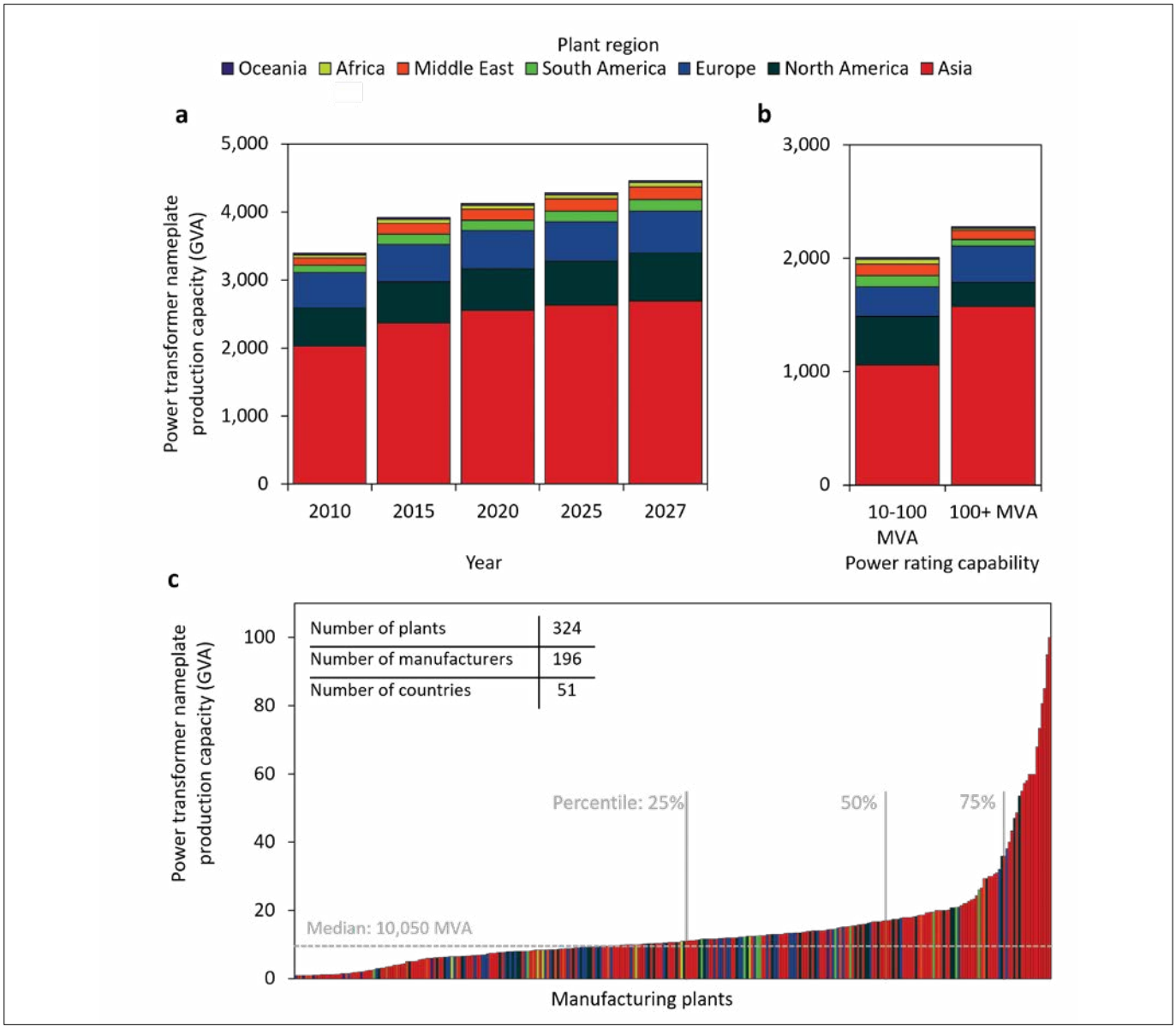


Figure 3. Power transformer nameplate production capacity by a) incremental years by region, b) split by power rating production capability category for the year 2025, c) with a cumulative overview of the annual production capacity of the 324 plants tracked in the study for the year 2025.

Asia holds 60% of global production capacity and half of all plants capable of manufacturing large transformers above 100 MVA, but most supply is catering regional demand.

around half of the market for all three metrics. The unitary, capacity and monetary market size is estimated to grow with a compound annual growth rate (CAGR) of 3.2%, 3.4%, 5.9% from 2025 to 2035 respectively, with a lower CAGR of 2.1%, 2.2%, 4.9% from 2035 to 2050. The market size in the number of units grows slower than the capacity, which again grows slower than the monetary market, suggesting that the average power rating of units will increase and that monetary unit prices will increase. Asia is projected to experience the largest growth rate in absolute terms, while Africa is projected to experience the largest relative growth rate towards 2050.

3.3 Power transformer supply

A large share of power transformer production capacity is concentrated among major international manufacturers in Asia, Europe and North America, supplemented by smaller regional players serving local markets (Fig. 3). The established manufacturing capacity database estimates total nameplate capacities above estimated demand levels, but it is known that supplier orderbooks are increasing and lead times remain elevated [8], suggesting that nameplate capacities do not accurately describe absolute manufacturing output due to utilization rates below nameplate capacities, or that the supply model consistently overestimates plant capacity. Still, it is believed that the evolution of nameplate capacity gives a representative view of the change in supply capabilities over time.

Asia is estimated to make up nearly 60% of all production capacity, half of which is in China, with most of its plants catering to regional supply, aligned with domestic supply chain reporting [9]. China holds the largest number of manufacturing plants, and most of the largest plants are above the 50th percentile in size (Fig. 3c). Around 130 companies were identified as capable of manufacturing large power transformers above 100 MVA, more than half of which are headquartered in Asia with only a quarter of which produce transformers above 1,000 MVA.

Total identified additions in the period 2024 to 2027 amounts to 216 GVA (Fig. 4a). North America is identified as having committed the largest aggregated capacity additions between 2024 and 2027, also being the region expected

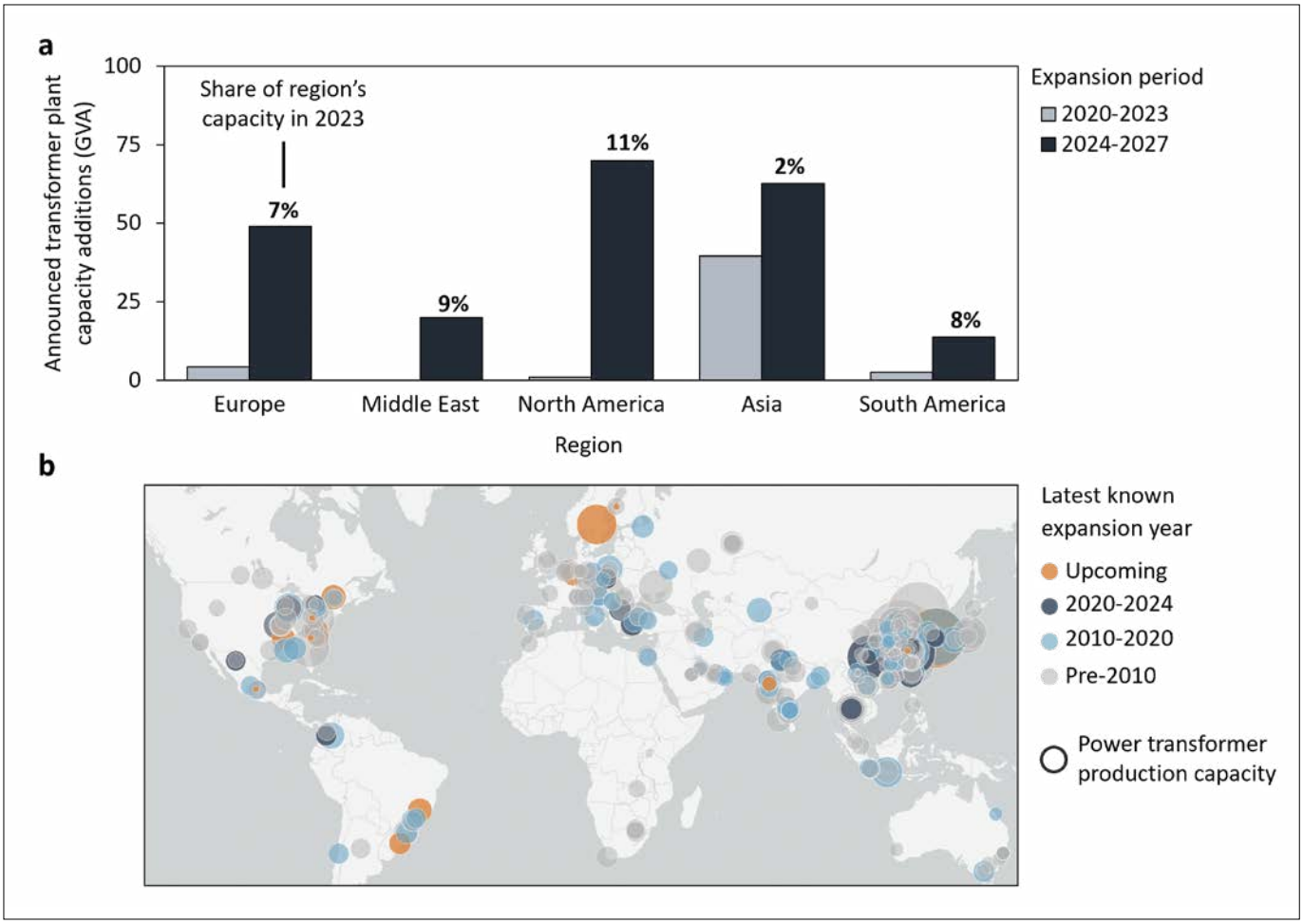


Figure 4. Recent and upcoming announced power transformer plant capacity additions by geographical region, highlighting **a**) upcoming plant expansion's share of regional capacity and b) geographical manufacturing plant overview.

to expand its production capabilities the most in relative terms. While Asia is found to add some 60 GVA capacity over the 2024-2027 period, it represents only a 2% increase compared to their total capacity in 2023.

3.4 Power transformer supply and demand balance

A comparison of the evolution of plant capacity and demand since 2010 in Fig. 5a reveals a widening divergence between growth in supply and demand, with alignment unlikely to be achieved in the short term, considering currently announced commitments by major suppliers and typical lead times of expansion investments. Since a relatively balanced market in 2019, transformer demand has outgrown capacity additions, with comprehensive end-market demand growing by 23% since 2019, while nameplate capacity is estimated to have risen by less than 5%. Based on known current expansions, most of which will materialize in one to three years due to lead times on machinery and training, overcapacity is unlikely in the short term. It is noted that it is likely that several unannounced plant expansions are taking place, particularly through labour acquisition and utilization gains, which are not included in this study, as the study captures only physical plant size expansions and public announcements.

The balance between supply and demand across major geographical regions given in Fig. 5b is found to be well-harmonized. Asia and Europe are identified as the only two regions with a higher fraction of manufacturing capacity than end-user demand compared to global totals.

The mismatch between supply and demand evolution has led to a rise in power transformer unit prices, Fig. 6. The average prices for imported units rose 41% from 2020 to the second quarter of 2024. It is expected that prices will stabilize in the longer term once notable expansions and utilization ramp-ups from major suppliers come online to restore balance to supply and demand. A prolonged period of low utilization and capacity downsizing has made it challenging to access new and skilled labour.

Conclusion

This study's quantitative modelling of power transformer demand and supply for units rated above 10 MVA reveals that industry growth, propelled by extensive grid expansions and the ongoing replacement of aging infrastructure, continues to outpace manufacturing capacity. Market size demand projections indicate a CAGR of 5.9% (monetary in USD) from 2025 to 2035. On the supply side, although many manufacturers, especially in Asia, are actively expanding their production capabilities, skilled labour shortages and uncertainty about long-term demand have constrained their ability to keep pace.

A plant-by-plant review of 324 facilities operated by 196 manufacturers in 51 countries shows that nameplate capacity theoretically exceeds current demand;

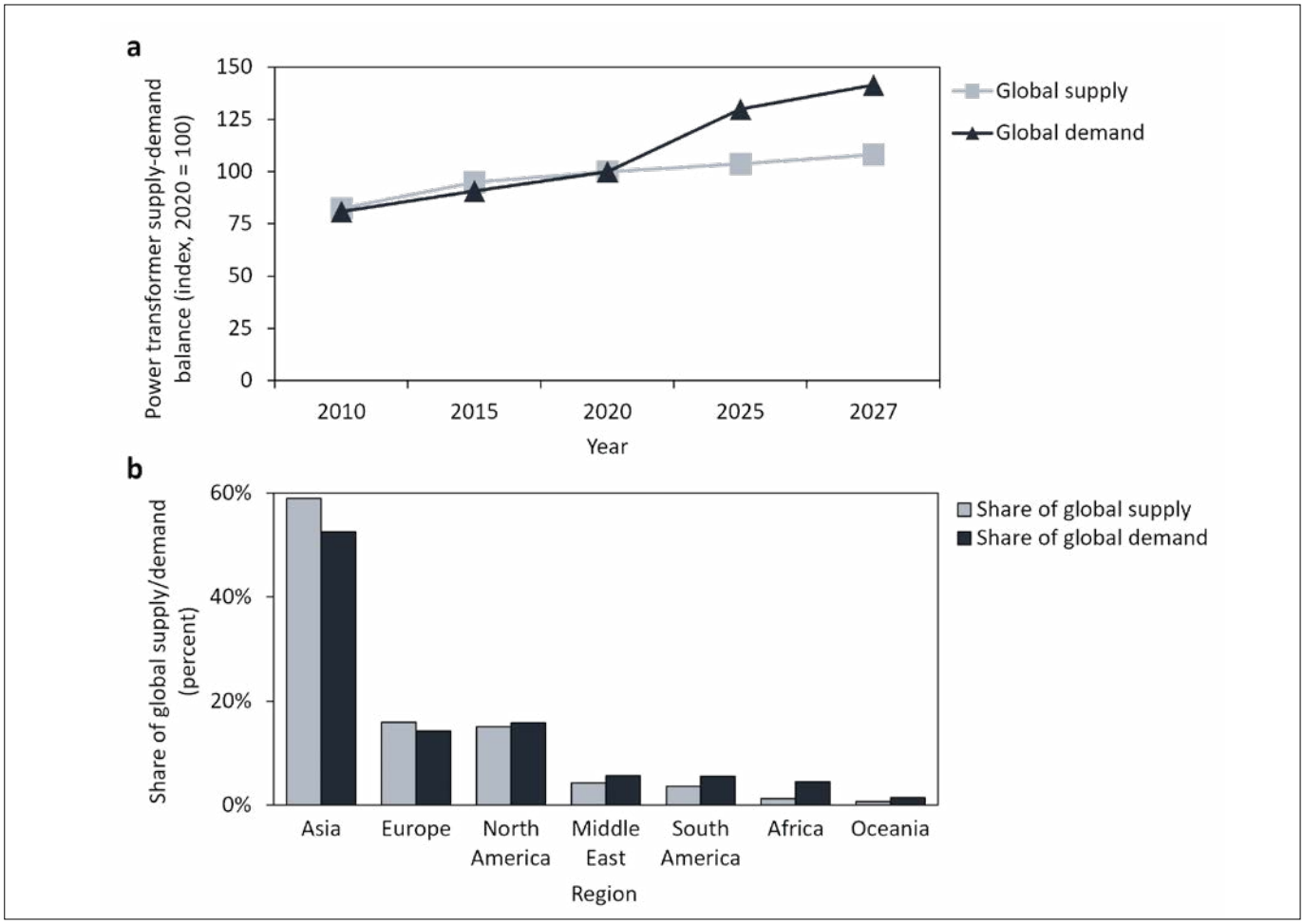


Figure 5. Power transformer supply and demand balance as a) a comparison between the evolution of nameplate production capacity (square) and estimated market size (triangle) with indexed to 2020, and b) a regional supply and demand concentration comparison.

however, real-world utilization rates and operational bottlenecks contribute to persistent supply deficits. This mismatch, reflected in prolonged lead times and rising price indices, underscores the pressing need for strategic capacity planning, improved labour force development, and streamlined supply chains. By addressing both the short-term constraints and long-term challenges identified in this study, the power transformer industry can better align manufacturing capabilities with global demand, ensuring the reliable and sustainable development of power networks worldwide.

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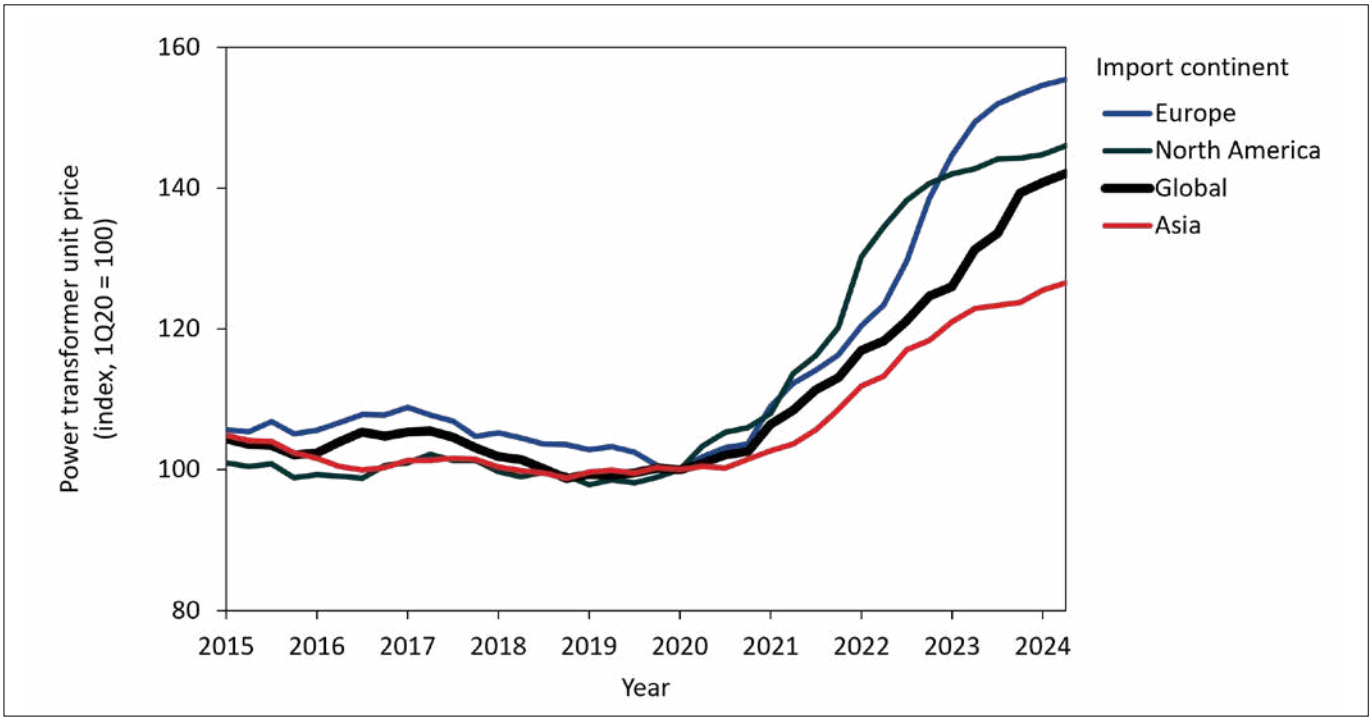

Figure 6. Power transformer unit price index by selected import regions [4]