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MURAT YUREKTEN

Chairman and CEO at ENPAY Transformer Components

The evolution of Enpay Transformer Components

ENPAY Endustriyel Pazarlama ve Yatirim A.S. was founded by my father, Mr. Selim Yurekten as a trading company in Istanbul in 1978. After many years trading in materials for transformers, he started a manufacturing activity for transformer insulation in 1989. I joined the company in 1992-1993, working for the business whilst completing my MBA studies, and once I graduated I returned to Istanbul to devote myself to the company. By this time, we had just started to produce magnetic cores in ENPAY for current transformers, and we rapidly extended our product range to stacked laminations for voltage transformer cores and similar transformers. ENPAY has always been an International supplier and we were focused on exporting as much as possible. In the late 90s, we brought high-performance products into our product range and introduced nickel-iron cores for high-accuracy measurement for current transformers. In doing so, we were able to offer customers a new raw material supplier from the USA. This enabled ENPAY to open the first European transformer segment as an alternative to well-established central European suppliers. Once we developed all types of so-called "wound cores" we quickly developed current transformers; bushing-type CTs and ring-type CTs.

In 2003 I became the majority shareholder in ENPAY and by this time we had also

invested to produce distribution, power and shunt reactor transformer cores. In 2005, in order to be closer to our customers in Central Europe, we set up a new manufacturing base in Slovakia, at the time mainly for current and voltage transformer cores. I established the global company name "ENPAY Transformer Components" and this is now used for all other international ENPAY transformer businesses.

We continued to grow strongly internationally, as market demand surged, driving ongoing investments across both Turkey and Slovakia. The significant investment in core cutting took place after 2013 when we increased our core cutting capacity by more than 100 % across both plants.

On the insulation components side of the business, we had an approach in 2006 from a large OEM to invest in China for high-voltage insulation components. However, I had other plans to expand upstream in insulation products back home, and in 2007 we started studying an investment in transformer board making, the main raw material we use for components. The investment was initiated in 2008 and we realised this investment in record time by early 2009 when we started a technical marketing phase with large OEMs. After having tested our materials for several years and completing numerous audits we established ENPAYBOARD®, our transformer

board brand for producing insulation components.

Shortly afterwards we took the insulation business international. We realised a greenfield investment in Vadodara, Gujarat, India for insulation components in 2009. At the time 765 kV projects were developing in India and we decided to produce shunt reactor cores and current transformers as well at the new plant. Further European expansion came in 2016 when I decided to build an additional plant in Bulgaria, this time a dedicated plant for Insulation. The same year we also formed a JV with Maschinenfabrik Reinhausen for servicing OLTCs in Turkey, and this company now is a successful subsidiary of MR.

The Covid pandemic rocked supply chains in 2020 and to further strengthen ENPAY's position we built a steel fabrication plant in Slovakia in 2021 and also

Murat Yurekten holds a BA degree in Management and an MS degree in International Business.

Started working in ENPAY in 1993. Became a board member, deputy Chairman and General Manager in 1994. He became the majority shareholder in 2003. Delegated board member in 2009. Chairman and delegated board member in 2013.



ENPAYBOARD® II plant

The significant investment in core cutting took place after 2013 when we increased our core cutting capacity by more than 100 % across both plants

one in Turkey in early 2022, to supply fabricated parts for the fully assembled transformer cores. We also started to produce nanocrystalline ribbon in Turkey by investing in a foundry. ENPAY is now strongly positioned to support the future growth of nanocrystalline materials within Europe.

By 2021, with our plant in Bulgaria established as a full-scale supplier, I decided to invest in a further transformer board, ENPAYBOARD® line in Turkey. The learnings from the pandemic played a key role in my decision for the location of this investment. Once decided the relentless work started, this time with all the restrictions of the pandemic. ENPAY team delivered again, completing this in-

vestment in record time against all odds. We estimate that after this investment, our total production capacity will be between 15–20 % of the global output for high-density transformer boards.

ENPAYBOARD®

Pre-compressed pressboard is an electrical insulation material made of cellulose pulp of high purity. Cellulose pulp for pressboard is electrical grade, unbleached softwood kraft pulp, obtained by the kraft cooking process which dissolves the lignin matrix and forms purified wood pulp. The quality of the softwood in this process is of paramount importance to achieve high electrical and tensile strength.

ENPAYBOARD®, premium quality pressboard branded by ENPAY Transformer Components has been produced and supplied to customers globally since 2009. Cellulose pulp used in the production of ENPAYBOARD® is obtained from quality soft wood such as pine, fir and spruce, known for their long fibres. International quality systems are combined with sophisticatedly programmable board machines for continuous monitoring of process steps.

Following a series of fine processes, the slurry of pulp and purified water are layered on a collection drum forming wet board layers. Finally, the wet board is dried in a special process of hot press for board production.

The excellent quality of ENPAYBOARD® is maintained by seven simultaneous quality detectors, integrated into the production process of ENPAYBOARD®. Two online metal detectors, including a high-precision X-ray metal detector, complete a surface quality check with

high-resolution cameras. These provide instantaneous control of thickness, density, moisture content and in-process delamination detection.

Each batch of ENPAYBOARD® undergoes a series of routine tests according to requirements of IEC 60641-3-1 carried out by ENPAY high voltage insulation laboratories endowed with state-of-the-art test equipment. Statistical controls in line with international standards, as well as strict adherence to cutting-edge technology, enable consistency and continuous improvement of quality.

High-voltage insulation components made of ENPAYBOARD® have been used as premium quality insulation in power transformers, operating at the highest voltage levels of UHVAC and UHVDC. The superior quality of ENPAYBOARD® enables full design flexibility of critical insulation components, giving customers outstanding properties for high-voltage transformers in service.

The technical knowledge, investments and expertise which have been built up within ENPAY enabled us recently to create our own centres of excellence. ENPAY Slovakia is now a dedicated focus factory for transformer cores and ENPAY Bulgaria is a focus factory for insulation components. Our laboratories for grain-oriented electrical steels, transformer cores and high-voltage insulation are internationally accredited.

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Our main markets are Central Europe, India and Turkey, and we have customers in all corners of the world. The European, Turkish and Indian markets are vibrant with many OEMs in transformers. Our customer base is power and distribution transformer makers, including HV shunt reactors, and we are still a major supplier of cores to the current and

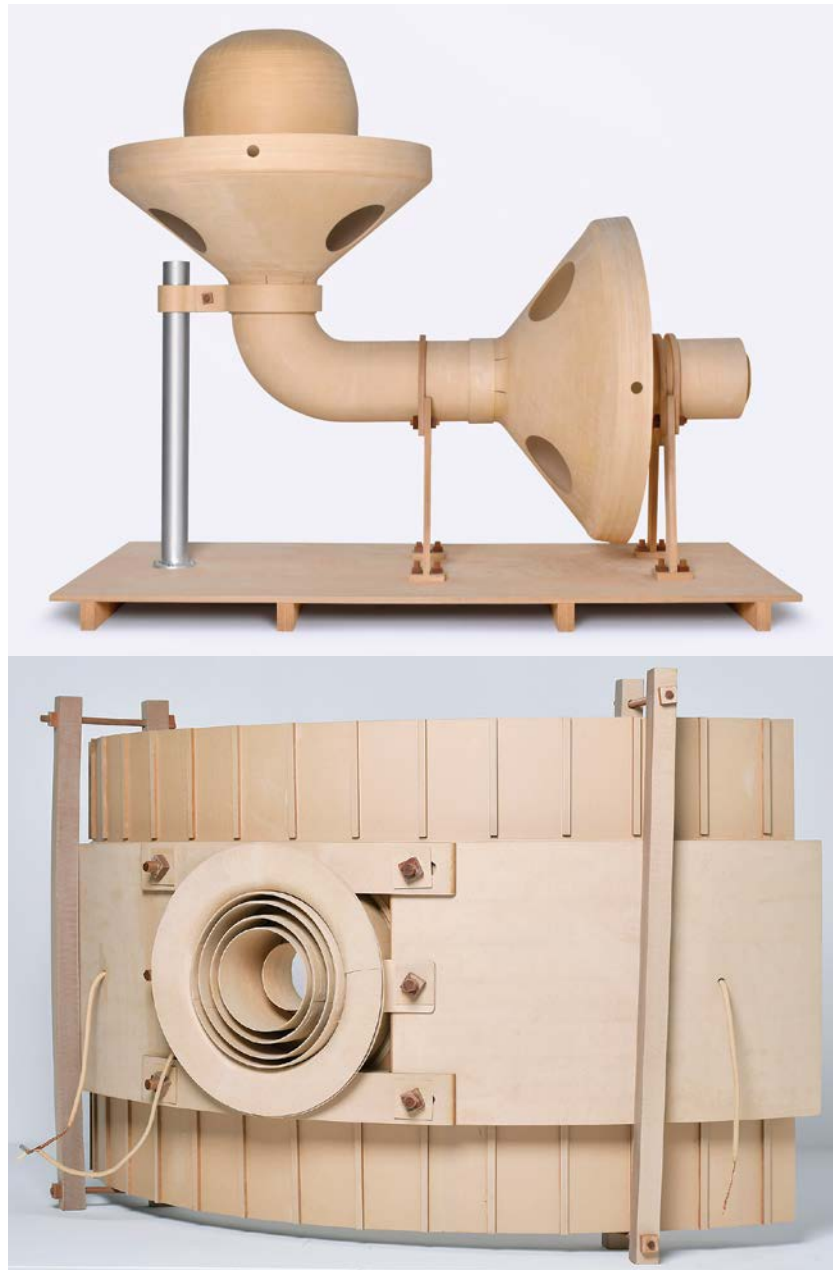
voltage transformer makers, as well as traction transformers.

Our rapid and continuous investments over the years across multiple sites, components and materials have required a very agile approach. Developing four new greenfield businesses has required relentless work, not just in project management but also in business development. ENPAY has built experienced management teams as well as MIS, quality assurance and quality control systems, and OHS management processes in all its companies. The start-up spirit never left us, in fact, this keeps on supplying the resources required for the entrepreneurial drive and continuous improvement culture of the company. The key to sustaining the spirit of continuous improvement is to carry forward the business culture from the early stages of a start-up, where you often work in survival mode, and stay in this mode as the company matures. The activity of starting a company never really ends. Every



ENPAYBOARD® II plant

The investment in transformer board making was initiated in 2008 and we realised it in record time by early 2009, when we started a technical marketing phase with large OEMs



Exit insulation 765 kV and middle exit

time you invest and increase the capital, you effectively renew the company.

ENPAY Transformer Components is an international company which can flexibly support customers at a local level. The key to our business model is our central approach to planning, supported by local management teams close to our customers. ENPAY now plays a key role in a consistent, reliable and sustainable supply of high-quality components to the global transformer industry.

The rapidly evolving transformer industry

We have seen the transformer industry requirements and those of the supporting supply chains change significantly during the last 20 years. Globalisation and dramatic growth between 2000 and 2008 drove the growth of outsourcing transformer components from laminations to insulation components. The rapidly changing grid requirements continue to accelerate further development of the expertise ENPAY can offer its customers.

During the last decade, the transformer market has focused increasingly on efficiency performance. EU Ecodesign measures such as Tier 1 came into effect in 2015 and more recently Tier 2 in 2019, alongside similar measures in other global regions. This switch in focus has driven developments in technology, materials, and expansion in processing automation. ENPAY's continuous investment includes new automated lines capable of slitting and cutting materials down to 0.20 mm and noise testing of fully assembled and clamped cores.

The transformer market is forecast to continue to grow strongly and there are several global trends which underpin the growth rates detailed below:

Table 1. Transformer growth rates

	Total demand in 2021 (MVA)	Total demand in 2035 (MVA)	% growth
Generator transformers	423637	578464	% 37
Systems transformers	1020437	1446543	% 42
Distribution transformers	817147	1775371	% 117

Revised Clean Energy Package

In the first half of 2019, the European Union adopted the Clean Energy Package, a new energy legislative framework whose aim is to further the role and importance of the Energy Union and ensure delivery of the EU's Paris Climate Agreement commitments.

The new policy framework introduced the first "national energy and climate plans" through a new governance system. The package also outlined specific measures which include a 40 % cut in greenhouse gas emissions compared to 1990 levels and a binding renewable energy target of at least 32 %. Furthermore, in 2021, this target was increased to 40 %. Globally generation capacity from wind and solar is set to double, and by 2028 will represent 27 % of the total generation sources. These forecasts were made before the energy crisis of 2022, caused by the Russian-Ukrainian war, and are only set to rise further as regions accelerate efforts to reduce their consumption of Russian oil and gas. Recently, Europe's REPowerEU has increased the renewables target further to 45 % and pledged to accelerate the implementation of renewable generation projects and reduce red tape.

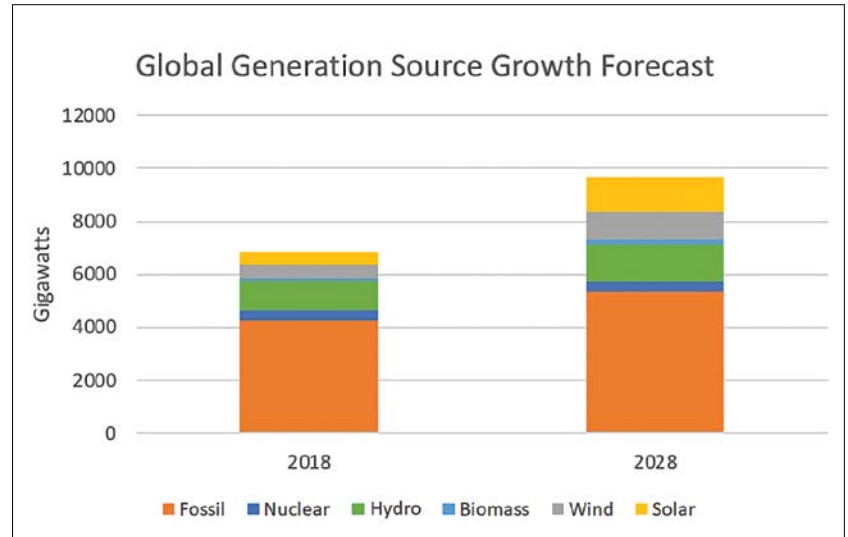
ENPAY Transformer Components supports the growth of demand for transformers within the renewable sector, offering in-house steel fabrication for clamped dry-type cores and extensive noise testing.

In recent years, because of fluctuating demand for electricity, there has been a drive to transfer higher and higher megawatts of electrical power from the generating stations to the users. Transmission losses are reduced by high-voltage AC or DC applications. Thanks to the availability of advanced insulation materials and optimized manufacturing practices, it is now possible to have transformers with voltage ratings up to 1200 kV. This voltage range requires advanced insulation materials, insulation design tools and state-of-the-art smart solutions.

Impacts of megatrends on transformer supply chains

All sources of generation capacity, globally set to grow by 3.48 % CAGR until

Last year, we decided to invest in a new EN-PAYBOARD® line in Turkey and again our team completed this investment in record time against all odds



Source: Goulden Transformer Report 2021-2031



We estimate that after the investment in the new ENPAYBOARD® line, our total production capacity will be between 15-20 % of world output for high-density transformer boards

2028, drive transformer demand within the grid to link the new capacity. And the growth of renewable generation sources is also driving rapid growth in battery storage solutions. As stated by the Economist, in June 2022, “Decarbonisation of electric grids reliant on renewables requires long-duration energy storage”.

Bloomberg New Energy Forecast predicts 30 % annual growth for the glob-

al energy storage market by 2030. In 2021, 10G W/22 GWh of storage was deployed, with the world reaching 27 GW/56 GWh of cumulative installations by the end of the year.

What does this mean for the transformer market? Each battery storage installation requires a bank of transformers to enable the management of this bidirectional electricity flow and throughout the grid will require more

transformers to manage energy storage produced by more variable sources of generation, like solar and wind.

Further demand for transformers will be generated by the development of high-capacity EV charging hubs, such as Europe’s most powerful EV charging hub recently installed in Oxford. Unlike any other UK charging hub, the site is directly connected to National Grid’s high voltage transmission network via a four-mile underground cable, which will deliver 10 MW of power to charge hundreds of EVs quickly and simultaneously without putting additional strain on the local electricity network or requiring costly upgrades. ENPAY is a long-established supplier of HVDC transformer cores and insulation to large European OEMs involved in such projects, including GE and Siemens across Europe.

Finally, the EU and many other regions have taken measures to improve the efficiency of newly installed transformers with measures such as Ecodesign Tier 1 and 2 within Europe, mirrored by similar policies in other regions such as India, China, and the USA. Significant exemptions exist within these legislative frameworks, and within the EU this includes pole-mounted transformers, offshore and dry-type transformers. In addition, a report published by the Council of European Energy Regulators in March 2020 demonstrated little significant change in distribution losses within Europe, despite the improved efficiency requirements for new transformers. This suggests that the future review of the Ecodesign legislation, due in 2023, ought to look to reduce

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Power transformer core and shunt reactor core

exemptions and focus on accelerating the replacement of older grid infrastructure, which often includes transformers dating back to the 1950s. Historically, high energy prices in Europe in 2022 could guarantee a rapid payback on any remaining 1950s transformers within the European grids and deliver significant energy savings to support the REPowerEU initiative.

These legislation requirements have seen significant changes to the design criteria for new transformers, including active core materials and insulation. Many transformer makers continue to outsource their transformer components. This enables them to release in-house capacity to adapt to increasing demand and draw on competency excellence within the suppliers of components.

ENPAY Transformer Components supports transformer OEMs throughout Europe, India and the Middle East ensuring uninterrupted supplies of transformer cores and insulation components throughout the disruption of the Covid pandemic. ENPAY is strongly positioned

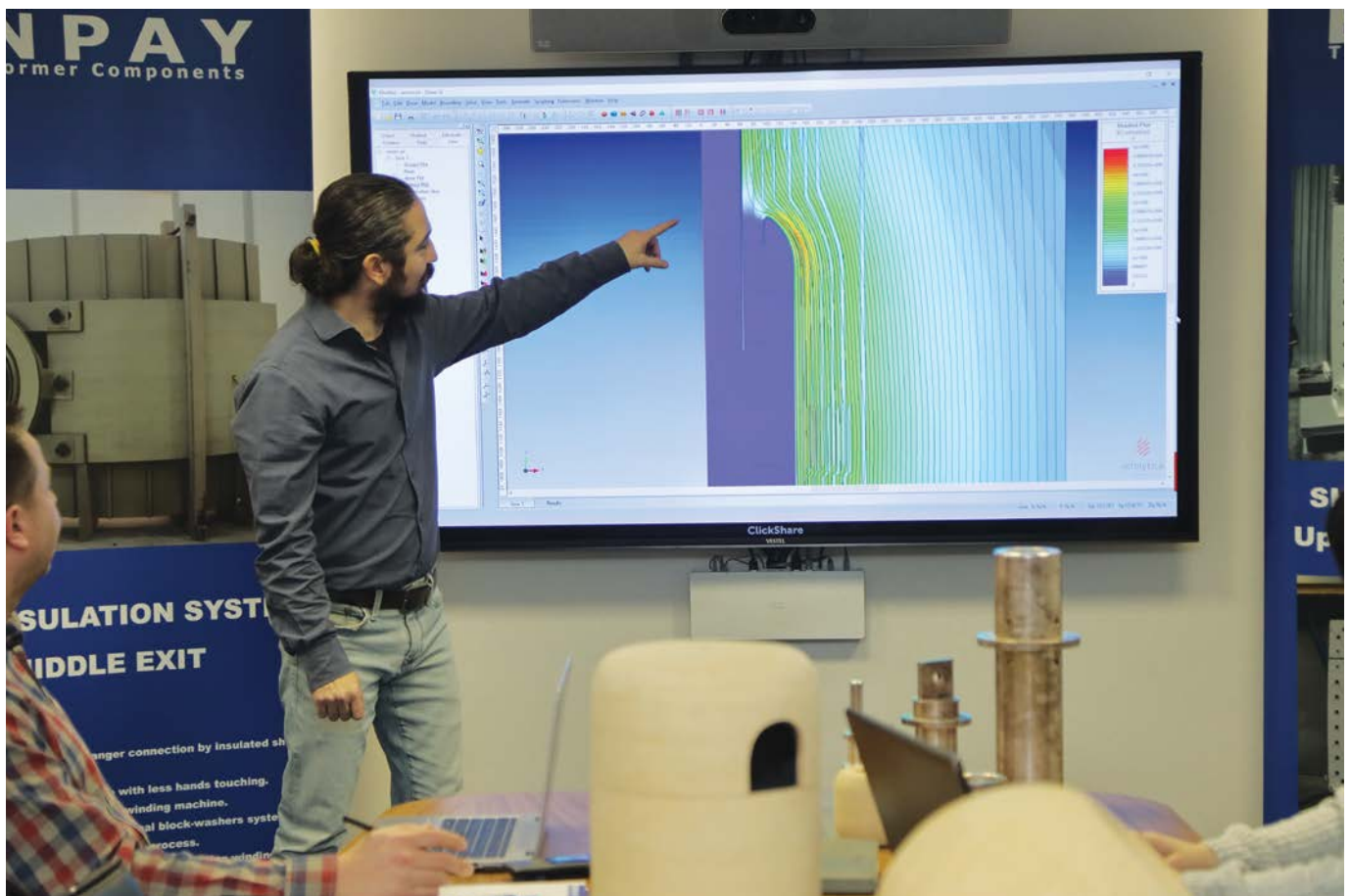
Our continual investment and ongoing development of the company to align with the transformer industry's evolving needs demonstrates ENPAY as a leading example of how sustainable supply can enable the growth of the industry

to support its global customers with consistent and reliable delivery of quality products because the business has built sustainable supply chains to withstand global conflict and fluctuations in national security.

Our continual investment and ongoing development of the company to align with the transformer industry's evolving needs demonstrates ENPAY as a leading example of how sustainable supply can enable the growth of the industry.

ENPAY Transformer Components is a centre of excellence for transformer cores and insulation components. We are experts in what we do, not only in mate-

rials and component manufacturing but also in design and engineering solutions for our customers. All in all, it is our demanding customers, competitors and the competitive atmosphere we live in, that provide us with the drive to reach higher, invest and achieve more over the years. Our company culture is defined by the relentless energy of our workforce driving improvements for the industry, not wasting any resources, starting with time. Our continual investment and ongoing development of the company to align with the transformer industry's evolving needs demonstrates ENPAY as a leading example of how sustainable supply can enable the growth of the industry.



Empay HV insulation design work