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Hasn't the energy market already been completely restructured?

After roughly 25 years since the introduction of renewable power generation on an industrial scale, one would think that today's energy market would be largely restructured and divided with a clear preference for renewable power generation. And that's not just in Germany or Europe, but worldwide.

One might therefore assume that fossil fuel power plants are a thing of the past and are no longer being built. However, as part of the current modernisation of all power plants, coal-fired units in particular are to be replaced by renewable energy sources for climate protection reasons. Furthermore, the priority given to renewable energy is generally reducing the full-load operation of thermal power plants, and fuel costs for gas-fired power plants are rising significantly for importing countries. This is making the construction of new thermal power plants increasingly unprofitable. At the same time, many thermal power plants of all sizes and ages are being decommissioned prematurely or are being placed in grid reserve – as is the case in Germany, for example.

A more in-depth analysis that also considers demand reveals a different picture, illustrated here by the example of coal-fired power plants: Figure 1 compares, country by country, historical new construction projects of the last 10 years with planned new construction projects for the coming years. For clarity, the new construction champions China and India are not shown in Figure 1. With 458 GWe of historical projects and 216 GWe of planned projects, China still surpasses all other comparisons. Even India, with 107 GWe of past projects over the last 10 years and 81 GWe of planned new construction projects, falls far outside the two scales.

Besides these two new-build champions, the map primarily features countries with strong economic growth and those with their own fuel resources. These are mainly located in Central and Southeast Asia, but also in Southeast Africa. The concentration of these countries on the left side indicates that they currently have relatively few coal-fired power plants and see a real need to catch up in this technology. Affordable self-sufficiency in fuel and electricity supply, coupled with reliable grid stability, are the driving forces here.

New gas-fired power plants are in even greater demand, even in countries like Germany, which eventually aims to generate 100% climate-neutral electricity. This is especially true for countries with their own gas reserves and existing gas infrastructure.

How does the used market for thermal power plants relate to this?

In short: It's holding up well! As a marketer of used power plant equipment under the troveo© brand, we have seen a largely constant number of available used plants for the past 10 years, although this number has declined slightly since the global COVID-19 pandemic. Currently, we estimate approxi-

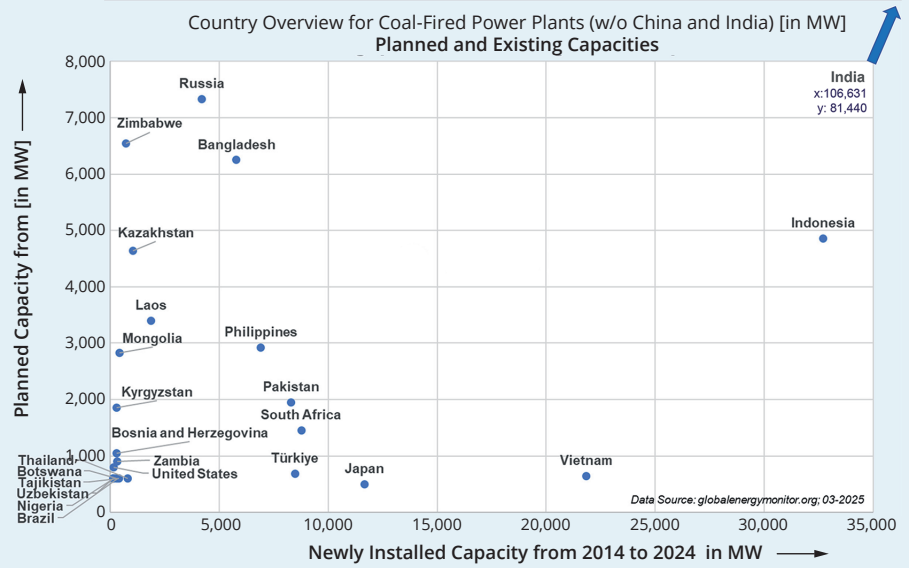

Figure 1: Country overview regarding the construction of new coal-fired power plants

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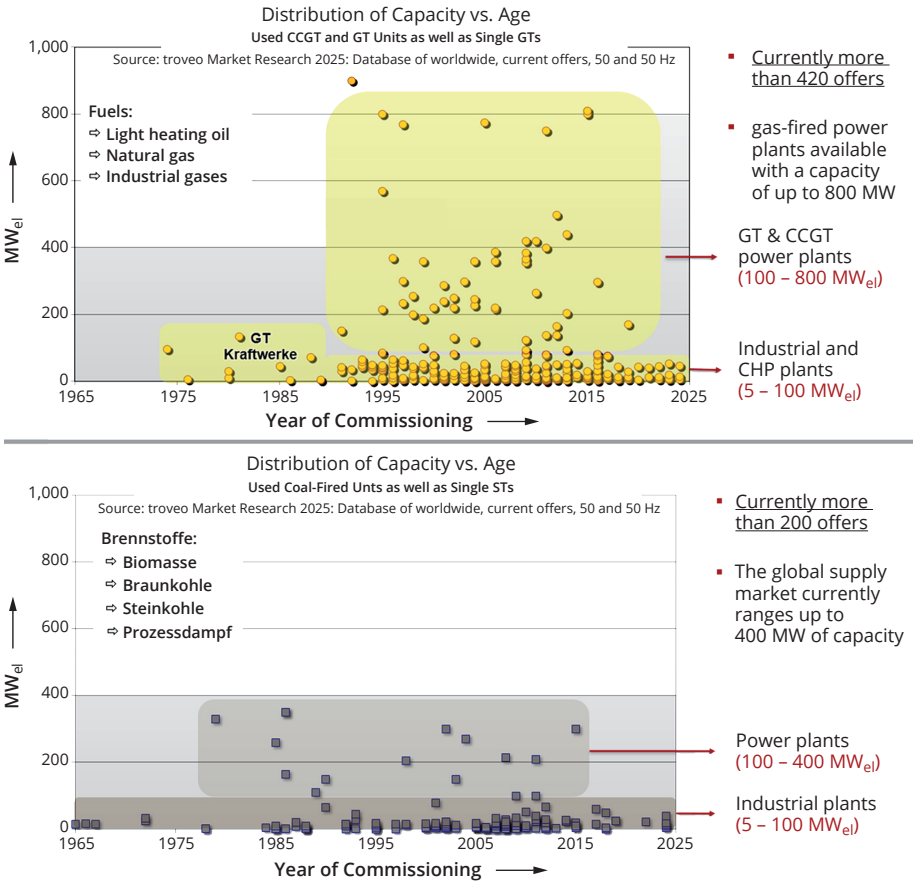

Figure 2: Global supply market for used gas and coal-fired power plants

mately 420 valid, bilaterally negotiable offers for gas-fired power plants, compared to approximately 200 offers for coal-fired power plants. These figures mostly refer to complete plants or units, and to a lesser extent to turbine-generator sets. Figure 2 shows the current distribution of these offers with regard to year of construction and capacity. Since around 1990, used gas-fired power plants with capacities up to 800 MW and of all ages have been available. For coal-fired power plants, some units are significantly older, and the current upper capacity limit is currently only around 400 MW. It is noteworthy that in both cases, extremely new plants are also available, but only in the capacity class up to approximately 100 MW.

The more than 600 offers for direct purchase shown in Figure 2 illustrate that many plant operators or owners expect added value from selling compared to scrapping. Additional offerings via tenders or auctions are not shown here, as these activities cannot be centrally recorded.

Is the sale of used equipment just empty theory?

On the one hand, compared to new purchases, there are very few published case studies of successful power plant relocations. This is due to the usually very restrictive confidentiality agreements in place at the time of contract signing. Who wants to admit that he bought used equipment? And success only becomes apparent upon the successful recommissioning of the used equipment, which at this late stage is no longer newsworthy – the purchase itself is already a thing of the past.

On the other hand, by no means all offers lead to a successful sale. Lack of demand at the right time, outdated technology, excessively high price expectations and overly complex contract structures are just some of the potential obstacles. Furthermore, the market for marketing platforms is fragmented; there is no Amazon or established online market leader like for instance in the real estate sector.

Nevertheless, there is a dominant motivator for the market: the significant price reduction compared to purchasing new equipment, as illustrated in Figure 3. Our general comparative calculations for approximately 15-year-old power plant units with capacities between 100 and 300 MW show that, for coal-fired power plants, the total investment costs can be reduced by up to 35%. In countries with low labour costs, the reduction is even greater, as the proportion of imported equipment is even higher. For new construction projects in Western countries, the share of plant equipment, excluding installation, is approximately 50% of the total construction costs.

For open-cycle gas-fired power plants without waste heat recovery units, the technical component accounts for approximately 70% of new construction costs. Consequently, up to 50% of construction costs can be saved by using refurbished equipment. For combined cycle gas turbine (CCGT) plants, the potential savings lie somewhere in between.

What does this mean for operators of existing thermal power plants?

The above market analysis raises the following questions for the managers of existing plants:

- Should you try to sell the still operational equipment from a plant that is being or has already been decommissioned?
- Until when should such assets be maintained or preserved?
- What should happen to the spare parts in the warehouses, which are full of unused components and parts?
- Is it worthwhile to continue keeping the extensive documentation?

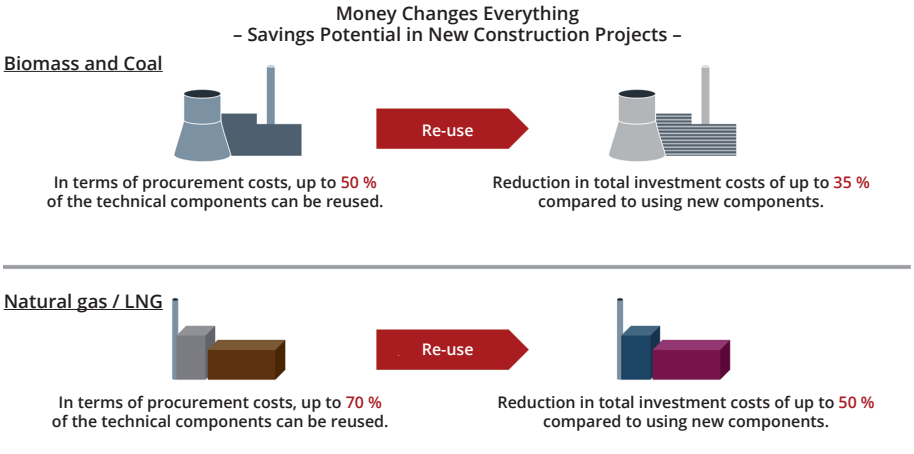

Figure 3: Price savings as the main motivation for buying used

In proactively answering such questions, company management plays a crucial role; it sets the course. Three general options are available when existing power plants reach the end of their operational life:

1. For example, in countries like Germany, Austria and Finland: Extending the plant's operation as much as possible and retaining staff is achieved by including the plant in the so-called grid reserve. In Germany, a further advantage of this option is that operators can continue to claim a portion of their capital costs. For this, they need an appraisal of the capital commitment costs, i.e., the residual value at the start of the grid reserve, from an appraiser or consultant recognised by the Federal Network Agency. Our troveo© team has already prepared numerous capital cost appraisals for the relevant transmission system operators based on market prices as of a specific date. The Federal Network Agency accepts our appraisals, and the grid operator calculates the financial compensation directly with the plant operator.
2. A decision needs to be made as to whether the existing power plant, including its spare parts inventory, should be offered on the used equipment market. As soon as decommissioning is imminent, it's a good time to have the plant's technical components assessed by an external and neutral consultant and to have a fair residual market value calculated. The residual market value often differs significantly from the plant's book value: Firstly, older plants are recorded in the books at zero euros. However, these plants are still fully functional and have been regularly maintained, with their main components regularly repaired or even replaced, thus representing an attractive purchase with a residual market value well above zero euros. Secondly, nearly new plants that have to be decommissioned prematurely as part of the energy transition have a lower market value than their book value. This is because market value is determined by supply and demand, and buyers ultimately expect a substantial discount on the new prices. A detailed valuation, for example, using the troveo © valuation method, reveals realistic and comprehensible expectations regarding potential sales. Knowing the fair market value, especially compared to the scrap value alone, allows decision-makers to determine the appropriate decommissioning strategy for their existing plant.

   The optimal time for marketing begins once the decommissioning date is set and maintenance costs are reduced to the bare minimum. As illustrated in Figure 4, however, the sale can also take place after decommissioning, although it is always advantageous for a potential buyer to see and evaluate the plant while it is still operational.

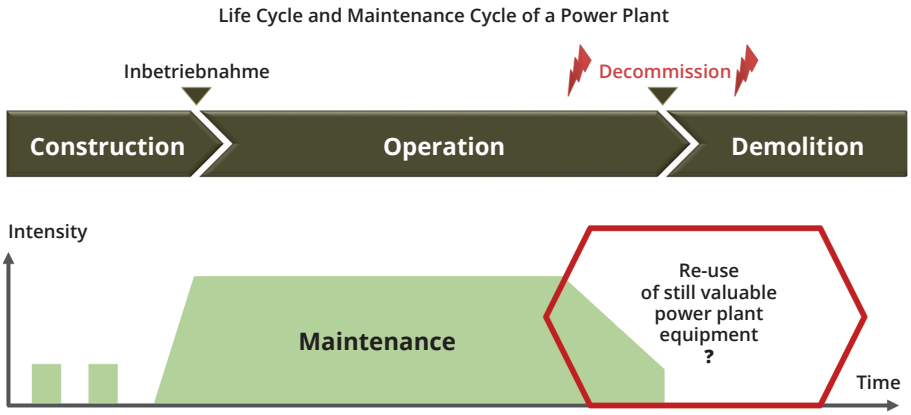

Figure 4: The time window in the product life cycle for a marketing attempt

   For some, often higher-value equipment, such as pistons or turbomachinery, the manufacturer may take them back for reconditioning or for their spare parts inventory. However, the greatest added value is offered by reselling to a subsequent user, especially if the seller is not under time pressure before decommissioning or dismantling. In these cases, attempting a sale involves some additional effort, but if successful, it can lead to even more attractive returns.
3. As a last resort, the power plant and its spare parts can be scrapped, usually in combination with the dismantling of the entire plant. Depending on the size of the project, such items can be handed over to a recycling company as part of a complete package.

As a plant operator, examine all three options in good time, utilise your still valuable plant equipment by selling it at its residual market value, and do not wait until the plant becomes a mere scrap object.

What does this mean for buyers of used power plant equipment?

Our market analysis raises the following questions for operators of existing plants and investors of new plants:

- Should you, as the operator, try to buy used components for still operating systems in order to replace obsolete or defective ones?
- Should investors in countries such as those shown in Figure 1 perhaps acquire used power plants or power plant equipment instead of focusing on the construction of entirely new and therefore capital-intensive power plants?
- Should energy suppliers or operators of industrial plants that require their own electricity production at least consider and evaluate purchasing equipment on the used market?

The demand side of the market „ticks" differently than the supply side: For interested buyers of existing power plants or individual, used power plant equipment, the following considerations are important:

1. The prospective buyer operates an industrial plant, such as a paper mill. They need a reliable and ideally inexpensive electricity supply to keep production costs as low as possible and remain competitive in the market. They can better control and manage energy costs if they produce their own electricity. Therefore, a used plant that can be acquired quickly and cheaply is essential for such buyers to prevent production downtime or to secure future production expansions.
2. The prospective buyer is a private investor who has acquired a concession for fuel supply, such as coal mining or gas production. For them, optimising upfront capital costs is essential: they need an ideally small, modular or medium-sized plant in top condition with relatively few operating hours, which can be transported and assembled quickly. A used plant that meets these criteria is therefore very attractive to this group of investors, predominantly in developing countries.
3. The interested party, an energy supplier operating a conventional power plant selling to the electricity market, urgently requires critical components such as compatible pumps, turbines or similar equipment to maintain production. A targeted search on the used equipment market allows them to find suitable replacements at very low cost.

What factors are important for a successful business transaction in the used goods market?

As described above, sellers and buyers in the second-hand market have different interests, which makes closing a deal complex. Coupled with this, there are also different success factors for each party. The most important ones are summarised in Table 1.

Table 1: Checkpoints and therefore success factors for selling and buying used assets

Seller	Buyer	Buyer
Focus on complete units and individual main components	Focus on complete units or assemblies for a new construction project	Focus on main components for a replacement purchase
Operator	Investor	Manufacturer / Re-Seller / Operator
with the following prioritisation:	with the following prioritisation:	with the following prioritisation:
1. Availability / Time constraint	1. Available / operational	1. Available / operational
2. Selling price (above scrap value)	2. Fuel and efficiency	2. Technical Match
3. Probability / Risk	3. Price / re-construction time	3. Price / access time
	4. Established technology	4. Common models

A seller should primarily allow for sufficient time and, if possible, preserve or safeguard the condition of his equipment. As long as the selling price exceeds the scrap value and the seller's own expenses, a sale is always profitable. In contrast, the risks for a seller are comparatively low and easily manageable, such as the payment risk or the risk of accidents during dismantling by the buyer.

According to Table 1, buyers differ somewhat between investors in new construction projects and plant operators or intermediaries: In both cases, buyers incur certain risks when purchasing used equipment, as manufacturer warranties are generally no longer valid. It is therefore important that the plant components and machines are still operational before purchase or will function again after relocation.

On the buyer side, the interests of investors in new construction projects and buyers for other reasons are similar, but not identical. For investors, the key factors are the overall system's compatibility with their own decision criteria, particularly performance and fuel types, as well as rapid availability. Similarly, for plant operators or intermediaries, compatibility with the required technical components, for example, for replacements after damage, and rapid availability are paramount. Supply bottlenecks from manufacturers can be another factor.

Only in third and fourth place do rank factors like low purchase price and quality for both buyer groups. Regarding the purchase price, the buyer already assumes a significant discount compared to the new price. Nevertheless, negotiations are still common. The quality factor often encompasses well-known, mostly Western manufacturers or widely available types and models.

The remaining service life time only matters if there are several technically suitable offers in parallel. In that case, the buyer usually chooses the newer system.

We can use case studies to demonstrate how to meaningfully and systematically apply a resale approach and to recommend potential follow-up strategies. This review is based on a method that has already proven successful in numerous projects.

First, an operator or owner should clarify his expectations for a resale. Besides the proceeds, time and patience are essential factors. Potential proceeds can be derived from the new prices of comparable components, as well as the age, mileage, and condition of the component being valued, and from relevant market data. Ideally, potential proceeds should be compared to the expected scrap values to realistically assess and compare the additional revenue from the resale.

How does the operator make a decision?

Once an operator deems a resale possible, the next step is to analyse the global market and assess the chances of success. This process is aided by a hypothetical evaluation – ideally structured according to a set of criteria – to determine which components would be acceptable from a buyer's perspective. Based on these results, the operator can then make a well-informed and transparent decision regarding a potential sale, one that is „market-based" and comprehensible to management.

When conducting the valuation according to the troveo© valuation method, the focus is on evaluating power plant components that can achieve the highest value on the market for used equipment. These components vary depending on the type of power plant: For coal-fired power plants, all components are evaluated as shown in Figure 5. These components are of particular value to potential buyers, firstly because of their role in the operation of the power plant and secondly because of their very high procurement costs or long delivery times.

When selling gas-fired plant components, as shown in Figure 6, there are fewer categories even for combined cycle gas turbine (CCGT) plants because there are fewer ancillary systems. Here, the turbine-generator set plays the central role in terms of cost.

The seller ultimately decides which plant components are to be dismantled for sale. Planning documents, other technical documents, and manuals have additional value for the buyer.

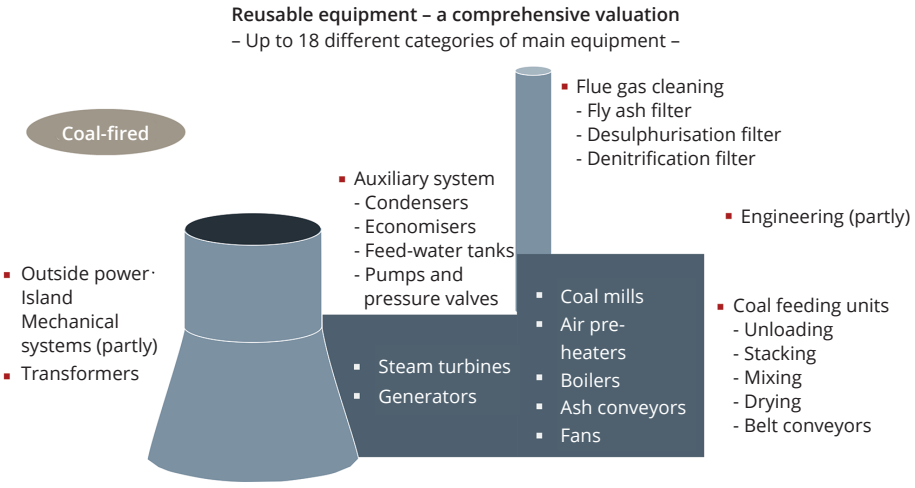

Figure 5: Reusable components of a coal-fired power plant

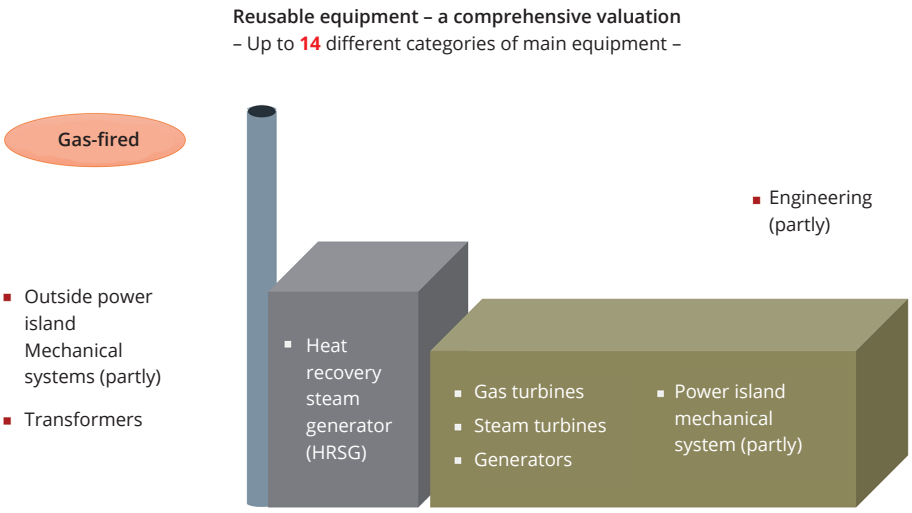

Figure 6: Reusable components of a combined cycle power plant

What is behind the troveo© valuation method?

As with almost any study, an appraisal includes data collection, monetary analysis and calculations, as well as results documentation and presentation. The appraisal is conducted at the level of the main components, which, as with feedwater pumps or transformers, can occur multiple times. Key data include the year of manufacture, operating hours and, depending on the category, one or two typical performance parameters, which can be easily found on the nameplates. Based on the component type and performance values, the approximate current new price is derived from a database. The buyer then compares his potential savings against this new price. Age and operating hours determine the residual value, in this case as a percentage of the new price. This residual value later serves as a guideline for the asking price, should a sale be pursued. A comparison with scrap values calculated from direct or database-driven metal weights then reveals the potential added value from a re-sale. Finally, the experienced appraisal team assesses the chances of selling each individual item, ranging from rather likely to very unlikely.

Figure 7 shows a practical example of a 100 MW steam turbine generator set, which had been in operation for 15 years at the valuation date. In this case, the fair selling prices, separated into turbine and generator, are each significantly higher than the scrap value. The plant operator has opted to attempt to sell the set with a bidding period of more than one year.

How is a sale successfully completed?

As previously described, permission to publish such information is rare. Here we present a cross-sector re-sale, from electricity generation to industrial steam generation: Our practical example from 2019 to 2020 is the sale and dismantling of a used, 100 MW_{th} steam boiler, built in 1983, weighing approximately 800 tons, from a coal-fired power plant for recommissioning to provide industry process heat in a plant located 2,500 km away.

After a detailed review of the buyer's desired parameters, a comparison with the existing boiler revealed that the buyer's technical requirements and time constraints could be almost perfectly met by an offer from Western Europe. Further processes, such as dismantling, temporary storage with protective coating, transport, and reassembly of the boiler, were also taken into account. Figure 8 shows impressions of the dismantling and removal. Recommissioning was completed only about 12 months after the contract was signed, to the buyer's complete satisfaction. The seller also considers the transaction a success story.

Example – Excerpt from a 2024 coal-fired power plant valuation

Category:	Price of new [1]:	Sale price estimate:	"Lost" scrap value:	Net value on sale[2]:	CoS [3]:
7. Turbine 1x steam turbine (100 MW) HP, MP, LP incl. peripherals, 2009	Approx. 14,740 T€	10.7 % of new 1,577 T€	Weight 232 t 75 T€	1,502 T€	
10. Generator 1x Generator (125 MVA; 6 kV), incl. exciter, circuit breaker, protection, 2009	Approx. 4,180 T€	10.7 % of new 447 T€	Weight 160 t 141 T€	307 T€	

1) of reusable items, without assembly; depending on technology and manufacturer
2) less scrap value, before brokerage commission
3) chance of successful sale within ca. 2 years

high
medium to high
medium to low
low

Figure 7: Valuation example with possible additional revenue above scrap value

Example – a successful case of reuse

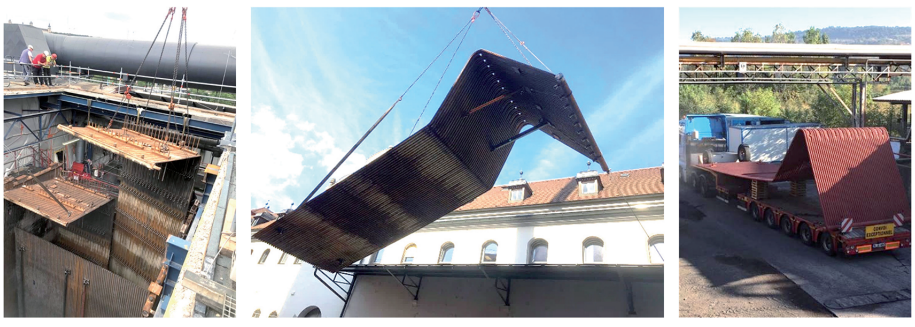

Figure 8: Dismantling of a sold, used coal boiler

What sales options are available?

Finally, the choice of sales method or sales channel is made. Direct tendering, auction through an auction house or bilateral sales via agents or marketing platforms, such as www.troveo.de, each have their own risk and opportunity profile. Tendering through one's own purchasing department is often time-limited and involves complex pre-contractual documents and conditions. Since potential buyers need time and flexibility to inspect the equipment, such tenders often fail to attract bidders or only scrap dealers submit offers. Auctions, depending on the specified minimum bid, more frequently result in a sale, but are only successful for highly marketable, expensive components from well-known manufacturers. For complete systems, as with tenders, only scrap dealers bid. Bilateral sales promise higher returns but are by no means always successful. It is no coincidence that most existing real estate properties or used vehicles are offered via marketing platforms and sold as direct sales.

To the point!

The more commitment the seller brings, the higher the revenue potential!

Whether this can pay off should be systematically determined beforehand, both for the entire system and for individual, still highly valuable components, as well as, where applicable, for existing spare part stock. This article presents the second-hand market, its success factors and a criteria-based valuation approach. Ultimately, the decision to sell on used assets rests with the system operator. And the buyers determine the sale's success. You just have to try. I

Kurzfassung

Ist eine Nachnutzung gebrauchter Kraftwerkstechnik sinnvoll?

Die Energiewirtschaft befindet sich in stetigem Umbau, was laufend Erneuerungen der weiterhin benötigten Kraftwerkstechnik erforderlich macht.

Was passiert also mit den bestehenden, noch betriebsbereiten Anlagen und Komponenten?

Lohnt es sich noch, Geld und Mühe in einen Verkauf zu stecken?

In diesem Artikel, der auf realen Marktdaten und Erfolgsgeschichten basiert, geben wir einem Überblick über die Situation im Gebrauchtmarkt für thermische Kraftwerke und zeigen Optionen für Betreiber und Investoren gleichfalls:

- *Für Betreiber, die mit einer Stilllegung konfrontiert sind, gibt es einen Markt für gebrauchte Anlagentechnik, und es ist eine Überlegung wert, die Anlage da zu platzieren, bevor diese einfach nur nach Gewicht verschrotten lassen.*
- *Die Käufer von obiger Anlagentechnik auf der anderen Seite legen den Schwerpunkt auf zwei Aspekte: Den reduzierten Kapitalkosten für die Blöcke und/oder benötigte Komponenten und die Verkürzung der Lieferzeiten.*

Je mehr Engagement der Verkäufer mitbringt, desto höher das Erlöspotential. Die für diesen Markt maßgeschneiderte troveo© Bewertungsmethode hilft dem Verkäufer schneller und faktenbasiert eine Entscheidung zu treffen und die richtigen Ansprechpartner zu erreichen sowie die Verkaufskanäle zu nutzen. I

Abstract

Does it make sense to continue to use second-hand power plant equipment?

The energy industry is undergoing constant change, which requires ongoing innovation in power plant technology.

So what happens to existing plants and components that are still operational?

Is it still worth investing money and effort in selling them?

In this article, which is based on real market data and success stories, we provide an overview of the situation in the used market for thermal power plants and show options for operators and investors alike:

- *For operators facing decommissioning, there is a market for used plant technology, and it is worth considering placing the plant there before simply scrapping it by weight.*
- *On the other hand, buyers of the above plant technology focus on two aspects: Reduced capital costs for the units and/or required components and shorter delivery times.*

The more commitment the seller shows, the higher the potential proceeds. The troveo© valuation method, which is tailored to this market, helps sellers make faster, fact-based decisions, reach the right contacts and utilise the right sales channels. I

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