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DEFINITIONS & ASSUMPTIONS

1. **Remanufacturing:** The process of producing a like-new or better performing PCB from an end-of-life PCB while preserving its form.
2. **Recycling:** The process of reducing the PCBs to its component materials that are then used to produce various new forms.
3. **Reconditioning/Repair:** The process of servicing defunct PCBs, involving the replacement or repair of faulty parts. This is an unorganized sector with the manufacturers as well as a host of other third-party players offering these services.
4. We assume that the recycling process might result in a host of new products that could include PCBs. The remanufacturing and reconditioning processes, on the other hand, yield only fully-functioning PCBs.

3. GLOBAL PRINTED CIRCUIT BOARD – MARKET OVERVIEW

3.1 PCB TYPES

Printed circuit boards are virtually present in almost all the electronics devices we use currently on a daily basis. They are present in TVs, computers, smartphones, mobile phones, washing machines, coffee makers, ovens and refrigerators etc. They are generally made of metal circuits, chips, ICs, components, cables and sockets on plastic laminates. There are many types of PCBs and the following are the most common types used:

FR-2 Phenolic

This type of PCB is manufactured using a synthetic resin bonded paper. It is a composite material made by combining paper with plasticized phenol formaldehyde resin. It is primarily used in manufacturing low-end consumer electronic devices.

- FR-4 Epoxy

These circuit boards are made from woven fiberglass cloth combined with an epoxy resin binder. The material as such is flame retarding, has zero water absorption and high mechanical strength. The FR-4 boards need to meet high flammability requirements like the UL 94 V-1 and are characterized by their electrical insulating quality, in dry or humid conditions. Brominated epoxies dominate the majority of the FR-4 boards manufactured.

- FR-4 High and ultra-high performance

These boards are made of polytetrafluoroethylene (PTFE) with different resins used which include bromine or phosphorus based flame retardants. FR-4 high performance boards are used in high end applications like servers, military and aerospace applications primarily. These environments need boards with high electrical properties like dielectric permittivity (Dk), loss tangent (DF) etc. for reliability purposes.

3.2 WASTE HIERARCHY

The global waste management practices generally speak about the 3R Principle – Reduce, Reuse, and Recycle. Each of these terms has a meaning and explains the effect it has on waste management.

4. EXECUTIVE SUMMARY

The global PCB market in the report has been analyzed based on the different product types, end use industries, components used, materials used, and geographic regions. These markets are broken down into segments and sub-segments, providing exhaustive value analysis for the years 2011, 2012, and forecast to 2018. The PCB recycling market has also been discussed and analyzed in detail with explanation provided regarding the recycling processes used, smelting methodology and step by step production of PCB. The PCB recycling market is also combined with analysis and context from the PCB remanufacturing and PCB reconditioning markets. Each of these broad segments are further segmented and analyzed in this report.

The global PCB manufacturing market is expected to increase its market size from around \$62.3bn in 2013 to around \$xx in 2018, growing at a CAGR of 3.6%. The market volume is also expected to increase to 32 billion units and 3.92 million tons by 2018, growing at 3.8% and 5% respectively. The PCB remanufacturing market is also expected to grow at an impressive CAGR of xx% and the PCB reconditioning market at xx% during the forecast period of 2013 – 2018.

Analyzing the competitive landscape of the global printed circuit boards market for 2012 IndustryARC is of the opinion that Nippon Mektron Ltd (Japan) had the top position with a market share of around 3.9% followed by Unimicron Technology Corp (Taiwan) with a share of 3.7%. Considering the high level of market share fragmentation the top 6 companies had a combined market share of only 18% in the industry. Other players in this market include TTM Technologies (USA), SEMCO (Korea), Nanya PCB (Taiwan), Young Poong Group (Korea) etc., which together make up around 10% of the market.

Table 14: GLOBAL PCB RECYCLING MARKET, BY GEOGRAPHY, 2011 - 2018 (KILO TONS)

Region	2011	2012	2013	2014	2015	2016	2017	2018	CAGR (2013 - 2018)
North America	xx	xx	xx	xx	xx	xx	xx	xx	xx
South America	38.3	44.8	50.0	51.8	53.1	53.9	55.4	58.3	3.12%
Asia Pacific	xx	xx	xx	xx	xx	xx	xx	xx	xx
Europe	xx	xx	xx	xx	xx	xx	xx	xx	xx
Middle East & Africa	12.8	xx	xx	xx	xx	xx	xx	xx	xx

Source: IndustryARC Analysis

5. GLOBAL PRINTED CIRCUIT BOARD – MARKET LANDSCAPE

5.1 MARKET SHARE ANALYSIS

The global printed circuit board manufacturing market in 2012 was dominated by Nippon Mektron Ltd (Japan), Unimicron Technology Corp (Taiwan), Hannstar Board Corp (Taiwan), Zhen Ding Technology Holding Ltd (Taiwan), Ibiden Co Ltd (Japan), Tripod Technology Corp (Taiwan) with market shares of xx% respectively. They jointly dominated the market with a combined market share of around 18.3%. Considering the high level of market share fragmentation these 6 companies were the top players in the industry. Other players in this market include TTM Technologies (USA), SEMCO (Korea), Nanya PCB (Taiwan), Young Poong Group (Korea) etc., which together make up around xx% of the market. The overall market landscape shows that Taiwan based companies are gaining larger parts of the revenue share followed by Japan and Korea. US and Europe based companies are limited to niche areas in PCB manufacturing and as such do not have significant market share apart from TTM Technologies.

5.2 COMPARATIVE ANALYSIS

5.2.1 PRODUCT BENCHMARKING

There are different key players in the various product segments depending on the end users of the products. The products related to PCB market of the top 6 companies are discussed below.

TABLE 1 KEY COMPANY PRODUCTS, PCB MARKET

1. Unimicron	2. Nippon Mektron	3. Tripod
Rigid PCB	xx	xx
Flexible Printed Circuit	xx	xx
IC Carrier	xx	xx
IC Test & Burn-In	xx	xx

TABLE 8 NUMBER OF PCB MAKERS IN NORTH AMERICA, 2004 – 2012

Year	No of Factories
2004	519
2005	485
2006	xx
2007	xx
2008	xx
2009	xx

2010	xx
2011	xx
2012	xx

Source: IndustryARC Analysis

The countries present in continents like North America and Europe are relatively more developed with high standard of living. This factor spurs up the labor and production costs for PCB. Adding to it are the fuelling prices of metals required for PCB manufacturing. Therefore the electronic gadget manufacturers present in these regions outsource the PCB manufacturing. There were about 2000 PCB manufacturing units in USA in 1980s which is reduced now to less than xxx. Similar conditions exist in Europe creating an adverse impact on PCB manufacturer's economic condition. Although the governments in these regions have come out with new legislations to promote recycling of e-waste in order to create new employment opportunities but no step has been taken towards the steep decline in PCB manufacturing.

TABLE 11 KEY PCB COMPONENTS MARKET PRICES, \$/KG, 2013

PCB Component	Price (\$/Kg)
Copper	xx
Iron	xx
Tin	xx
Nickel	xx
Lead	xx
Aluminum	xx
Zinc	xx
Silver	xx
Gold	xx
Palladium	xx
Bismuth	xx
Chromium	xx

Source: IndustryARC Analysis

The above discusses the average market prices for the key metal components present in the PCBs and other electronic ICs of the products. Gold for example is the costliest with a price of \$xx per kg and the cheapest metal is Iron with a price of \$xx per kg.

SCRAP PRICING:

Scrap pricing is done at different levels and varies according to the type of scrap being sold. If it involves the circuit boards, the scrap circuit board index for example, measures the value of commodity metals proportionally weighted to their share in a pound of scrap circuit boards. This price for example has declined to \$xx per pound in November, with the average selling prices for nearly all metals in the index down for the month.

The index basically covers the estimated intrinsic values of the metal content in the disposed PC boards, while recycling values would also account for the costs involved in actually extracting metal from boards, including freight, sampling charges, assay assessments, smelting, refining, process loss, return on investment, and penalties for various elements, including beryllium, bismuth and nickel. Some consumers label PC board material as mid-value. Lower-value scrap includes monitor and television boards. Higher-value scrap includes motherboards as well as network and video cards.

TABLE 16 GLOBAL PCB MARKET, BY PCB BOARD TYPE, 2012 - 2018 (\$MILLION)

Region	2012	2013	2014	2015	2016	2017	2018	CAGR (2013 - 2018)
Rigid 1-2 Sided	xx	xx	xx	xx	xx	xx	xx	xx
Standard Multilayer	xx	xx	xx	xx	xx	xx	xx	xx
HDI/Microvia/Build-up	xx	xx	xx	xx	xx	xx	xx	xx
IC Substrate	xx	xx	xx	xx	xx	xx	xx	xx
Flexible Circuits	xx	xx	xx	xx	xx	xx	xx	xx
Rigid Flex	xx	xx	xx	xx	xx	xx	xx	xx
Others	xx	xx	xx	xx	xx	xx	xx	xx

Source: IndustryARC Analysis, IPC, WECC

The above table gives a breakdown of the global PCB market by the different product types. The rigid flex type PCB market is expected to grow the fastest with a CAGR of xx% in all the product type segments. This market is expected to increase from around \$xx in 2013 to around \$xx in 2018. HDI PCB boards are the second fastest growing product type. They are expected to increase their revenue share from around \$xx in 2013 to around \$xx in 2018, growing at a CAGR of 4.8%.

Rigid flex PCBs are relatively new segment in the market compared to the matured market of the HDI product type. Rigid flex boards can be designed in 3D space and help produce desired end shape of the customer requirement. They are primarily used in military and aerospace applications but also can be deployed in cell phones and digital cameras. HDI PCBs on the other hand offer much higher wiring densities per area than standard circuit boards, with finer lines and spaces, smaller vias and higher connection pad density.

9. GLOBAL PCB REMANUFACTURING MARKET – ANALYSIS AND FORECAST

9.1 MARKET OVERVIEW

PCB reconditioning and remanufacturing is the testing, repair or upgrading of obsolete electronics for resale. Some remanufacturers build whole units from individual recovered components (hard drives, mother boards, etc.). Most companies extract PCBs, repair, rework or recondition them on their own or by third party logistics (3PL) companies who send them or sell them the scrap. Some established companies like Acer, Lenovo, and Samsung for example also do it on a larger scale as part of their overall product or device reconditioning program. This helps them in extracting maximum value of end of life electronics, reduce their carbon footprint and supplement their raw material needs with reconditioned components.

PCB De-manufacturing is a part of the remanufacturing process in that it is used to disassemble electronics device to capture re-sellable parts and recyclable materials. These products may or may not be used in the reverse logistics program.

Reverse Logistics is a relatively new but well established concept wherein an obsolete electronic item like a smartphone, laptop, PC or refrigerator is returned to the manufacturer through the distribution system, which may include involvement of retailers like BestBuy, Wal-Mart and distribution companies like UPS, Avnet, Arrow etc. The below steps explain the remanufacturing process in more detail:

- Any of the defective components like capacitors, resistors, ICs etc. are replaced.
- Sockets, components which are broken, loose are replaced or fixed.
- The boards and the devices which are repaired are then cleaned.
- The PCBs and the power supplies are then tested under load.
- Remanufacturing process is initiated to replace or repair other components like displays, cables in the electronic device before sent for selling.

Remanufacturing similar to recycling helps in reducing the e-waste problem by extending the life cycle of an electronic device. Most devices are xx% functioning with problems arising due to outdated or malfunctioning components. Simple replacement and reconditioning makes them work as brand new and can be resold in countries or markets where low cost products

TABLE 25 GLOBAL PCB REMANUFACTURING MARKET, BY VOLUME (MILLION MT), 2011 – 2018

PCB Remanufacturing	2011	2012	2013	2014	2015	2016	2017	2018	CAGR (2013 - 2018)
Volume (M Tons)	0.077	xx	xx	xx	xx	xx	xx	xx	xx

Source: IndustryARC Analysis

The global PCB remanufacturing market is expected to increase in volume from around just .08 million tons or xx kilo tons in 2012 to around xx kilo tons in 2018, growing at a healthy CAGR of xx% during 2013 -2018.

9.2 MARKET ANALYSIS BY GEOGRAPHY

The below table describes the market value of the global PCB remanufacturing market during 2011 – 2018 with respect to the different geographic regions.

TABLE 26 GLOBAL PCB REMANUFACTURING MARKET, BY GEOGRAPHY, 2011 - 2018 (\$MILLION)

Region	2011	2012	2013	2014	2015	2016	2017	2018	CAGR (2013 - 2018)
North America	xx	xx	xx	xx	xx	xx	xx	xx	xx
South America	xx	xx	xx	xx	xx	xx	xx	xx	xx
Asia Pacific	xx	xx	xx	xx	xx	xx	xx	xx	xx
Europe	xx	xx	xx	xx	xx	xx	xx	xx	xx
Total	xx	xx	xx	xx	xx	xx	xx	xx	xx

Source: IndustryARC Analysis

MARKET – TRENDS & DATA SOURCES

TRENDS

- ❖ High demand from smartphones and media devices in consumer electronics, coupled with resurgence in industrial automation segments, is the main growth driver.
- ❖ China is the leading producer with a major market share, followed by Japan and South Korea.
- ❖ PCBs constitute around 9% of weight and 4% of mass of all WEEE (Waste Electrical and Electronic Equipment), currently of more than 10 million tones
- ❖ The EU aims to recycle around 85% of WEEE by 2019 which is 10m tones or 20 kg per capita from the current 2m tones or 4 kg per capita.

SOURCES

- ❖ Internal database on device shipment numbers in consumer electronics, medical devices, industrial machinery, defense and automotive verticals.
- ❖ White papers and newsletters from global associations, trade bodies like IPC, NECA, NEDA, EIPC and WECC.
- ❖ Annual Reports and presentations from top PCB and recyclable PCB companies from different geographic regions.
- ❖ Paid interviews with executives (CXOs, Managers, VPs, AVPs, Business Development Personnel and distributors) from the PCB industry.
- ❖ Questionnaires and telephonic interviews.

RESEARCH METHODOLOGY

The quantitative and qualitative data collected for the optical sensor market report is from a combination of secondary and primary sources. Research interviews were conducted with senior executives and/or managers of leading PCB manufacturers & distributors. These Key Opinion Leaders (KOLs) were then provided a questionnaire to gather quantitative and qualitative inputs on their operations, performance, strategies and views on the overall market, including key developments and technology trends. Data from interviews is consolidated, checked for consistency and accuracy, and the final market numbers are again validated by experts. The global market was split by products, services and geography based on different factors like primary and secondary sources, understanding of the number of companies operating in each segment and also KOL insights.

We have used various secondary sources such as directories, articles, white papers, newsletters, annual reports and paid databases such as OneSource, Hoovers and Factiva to identify and collect information for extensive technical and commercial study of the PCB manufacturing & recycling market.

The key players in the market and its value chain were identified through secondary research and their market opinions were also gathered in a similar way through telephonic interviews and questionnaires. We have also studied the annual reports of these top market players. Interviews with key opinion leaders such as directors, managers, marketing personnel were used extensively in understanding the need and emergence of PCB Market.

THE ARC ADVANTAGE

An analytical model lies at the core of our process, ensuring logical consistency throughout our research. We complement the model with secondary data and interviews with industry experts to reflect the latest trends. With our final expert validation, we provide you with only the most accurate and actionable intelligence.

THE ARC PROCESS

Analytical Method	Base Method	Consolidation Method	Delphi Verification
<ol style="list-style-type: none"> 1. Granular breakdown of drivers into factors 2. Validate all factors in terms of their present impact on the market 3. Assign weights to these factors in terms of their relevance and impact on the market 4. Build the Analytical Model 	<ol style="list-style-type: none"> 1. Get a top-down estimate of the market 2. Follow it up with a bottom-up estimate of the market 3. Check for consistency and new growth factors that are relevant over the next 10 Years 4. Build the Base model 	<ol style="list-style-type: none"> 1. Granular breakdown of drivers into factors 2. Validate all factors in terms of their present impact on the market. 3. Assign weights to these factors in terms of their relevance and impact on the market. 4. Build the Consolidated Model 	<ol style="list-style-type: none"> 1. Verify the findings of the model with experts from across the value chain 2. Verify the findings with players across small and large enterprises 3. Tweak the model and add new factors 4. Finalize the ARC Model

ANALYTICAL MODEL → BASE MODEL → CONSOLIDATED MODEL → ARC MODEL

ABOUT US

IndustryARC was started by a group of young, passionate professionals along with extensively experienced industry veterans across various business segments. Our focus and expertise is mainly in the field of analytics, market research and consulting. Our singular goal is to provide accurate and affordable research to our clients.

Our research team has expertise in diverse fields like Automotive, Chemicals, Consumer Product & Services, Electronics, Food & Beverages, Healthcare etc., However diverse the expertise maybe, everyone in our team shares one common trait - we love data and we love providing solutions to clients using that data even more! Seeing your business flourish based on our solutions and strategy is what we love the most!

IndustryARC publishes more than 30 reports on an annual basis in the mentioned Industries. Our reports are in-depth and high quality reports that can help decision makers frame better strategies for their business requirements. These reports can be further customized as per your needs.

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