CRM Vision Workshop

Scope

List of critical raw materials at EU level (in alphabetical order):

Antimony	Indium
Beryllium	Magnesium
Cobalt	Niobium
Fluorspar	PGMs (Platinum Group Metals)[1]
Gallium	Rare earths[2]
Germanium	Tantalum
Graphite	Tungsten

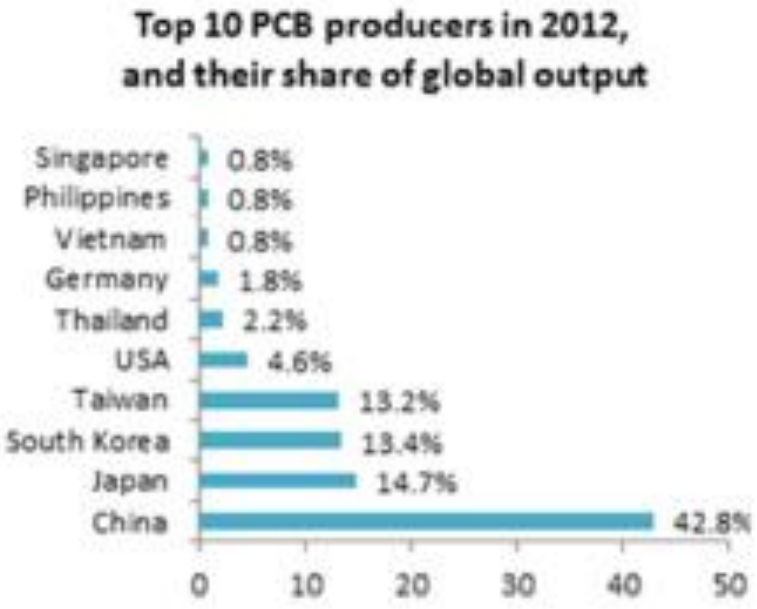
[1] The Platinum Group Metals (PGMs) regroups platinum, palladium, iridium, rhodium, ruthenium and osmium.

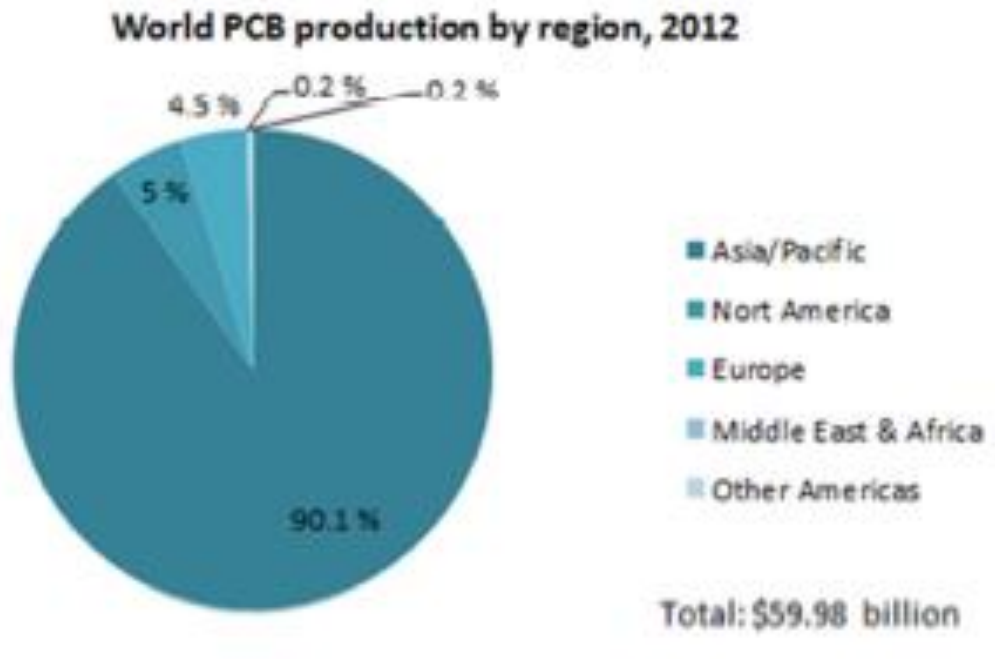
[2] Rare earths include yttrium, scandium, and the so-called lanthanides (lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium)

Scope – Printed Circuit Boards and Electronic components

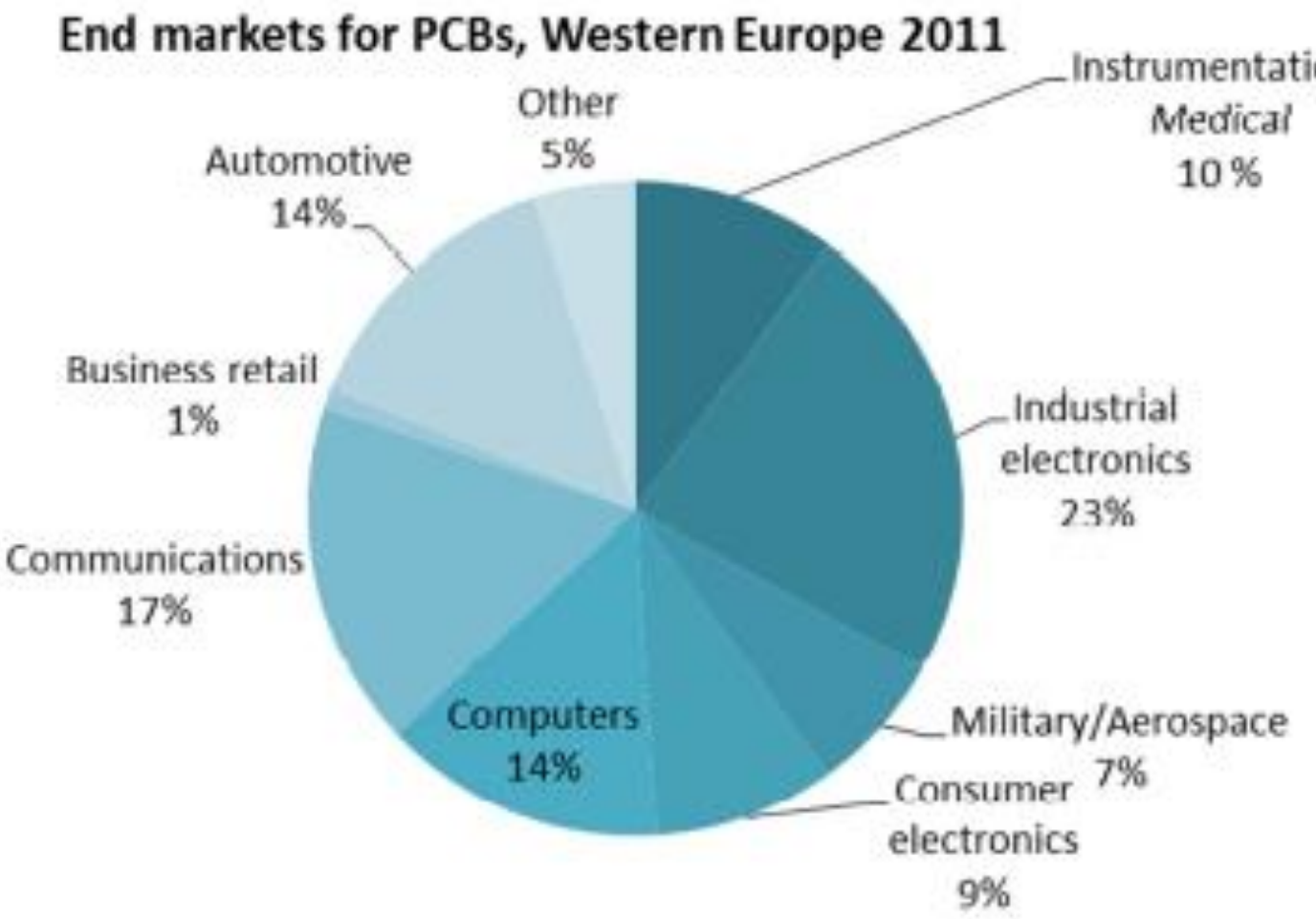
Printed circuit boards (with components)	**CRM content**
Printed circuit board (bare without components)	
Plating	**Pd - not very common generally Ni/Cu and Au are used**
Components	
Capacitors	Ta, Pd, Nb
Resistors	Ru, Ta
Semiconductors	Ga, Ge, In, Sb, Ta
Transistors	Ga, Ge
Electronic and integrated circuits	
Capacitors	Ta, Pd ,Nb
Resistors	Ta, Ru
Semiconductors	Ga, Ge, In, Sb, Ta
Transistors	Ga, Ge
Connectors	Pd Ru, Be

Top PCB producers in 2012 and PCB production by region





End markets for PCBs in Western Europe 2011



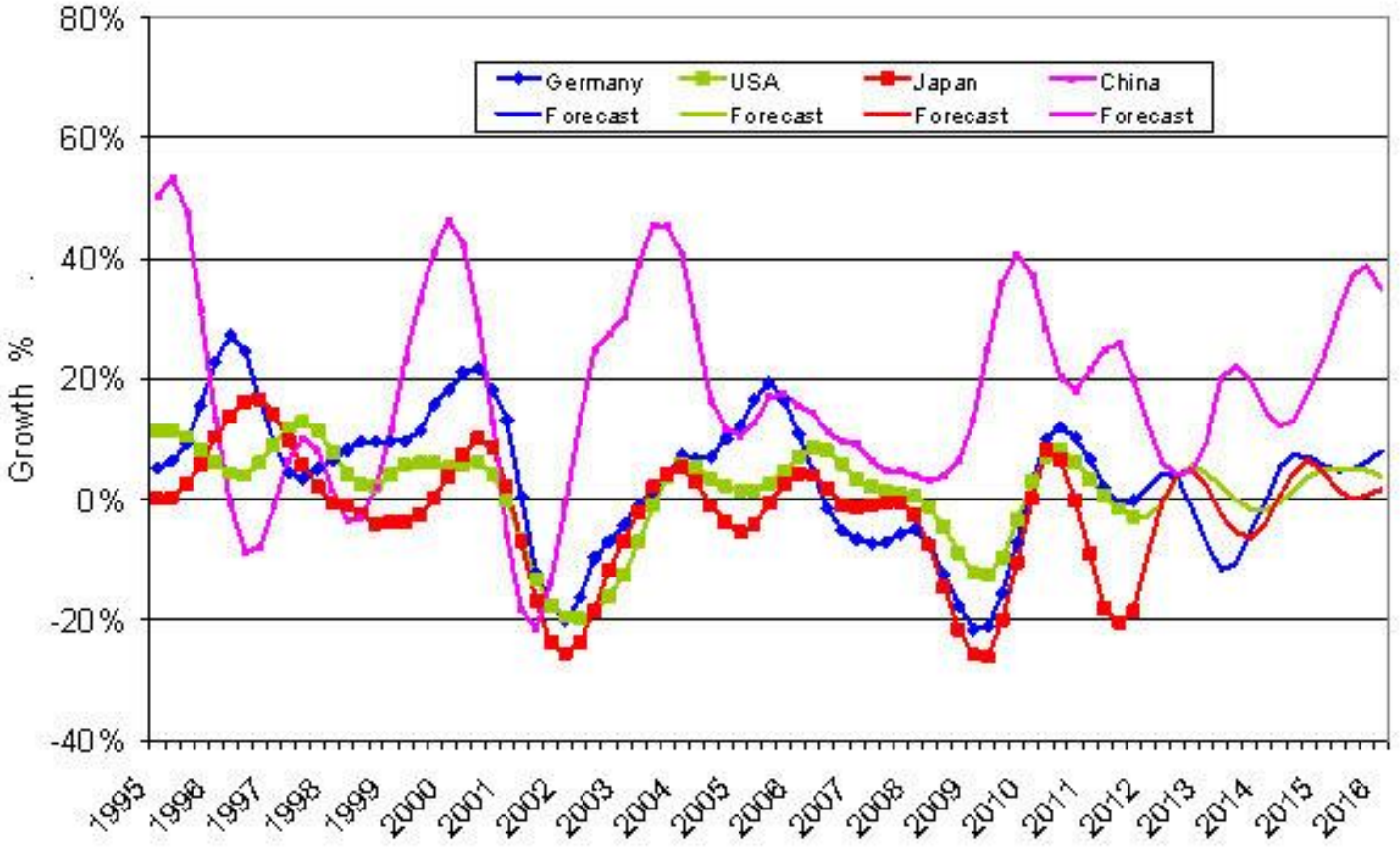
Electronics production forecast 2021

ELECTRONICS PRODUCTION
2009 - 2021

$Bn	2009	2011	2013	2015	2021	CAAGR '09-'15	CAAGR '15-'21
Computers and Office	$396	$433	$474	$500	$617	4.0%	3.6%
Communications Infrastructure Equipment	$157	$174	$192	$213	$281	5.2%	4.7%
Consumer and Portable Electronics	$298	$319	$341	$400	$479	5.0%	3.1%
Automotive Electronics	$105	$129	$158	$161	$237	7.4%	6.6%
Medical Electronics	$77	$85	$93	$103	$134	5.0%	4.5%
Military and Aerospace Electronics	$118	$129	$140	$151	$189	4.2%	3.8%
Total Electronics Production	$1,242	$1,382	$1,541	$1,679	$2,171	5.2%	4.4%

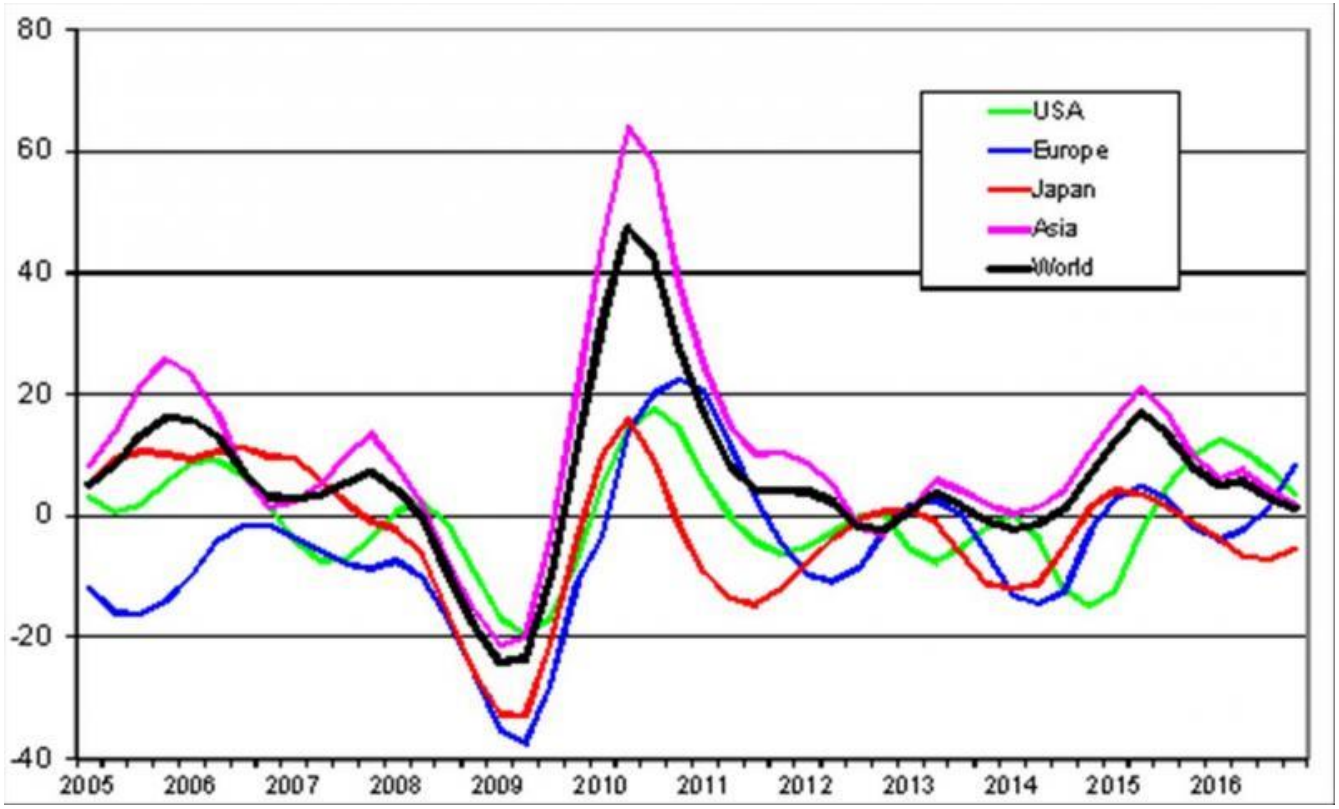
Source: INEMI 2013 Roadmap

PCB production forecast 2016



Source: BPA 2012

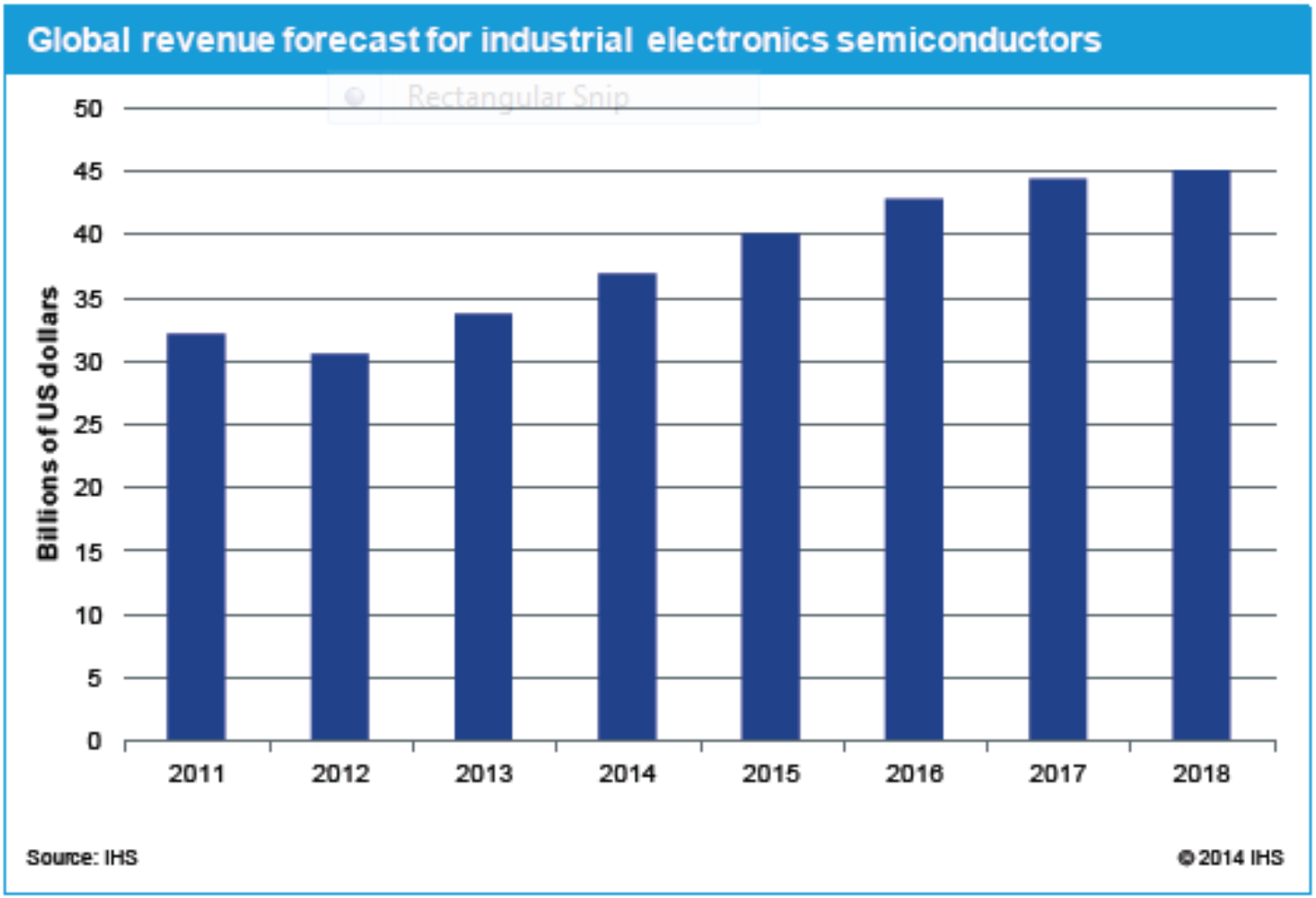
PCB production forecast 2016



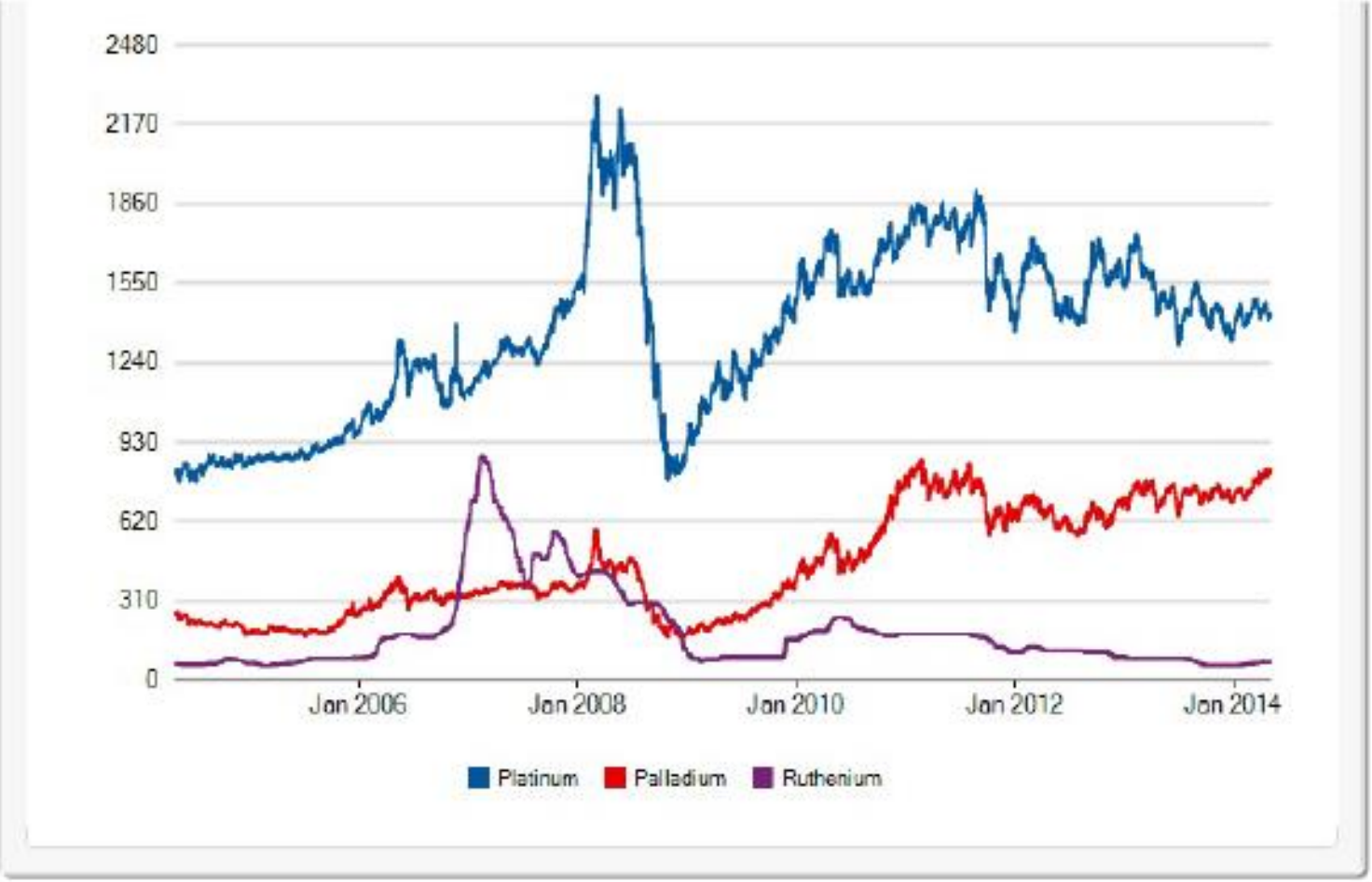
Global PCB market value will increase from $56.6 billion in 2011 to $68.5 billion in 2016, China's share of production will increase from 45% to 51%

Source: BPA 2013

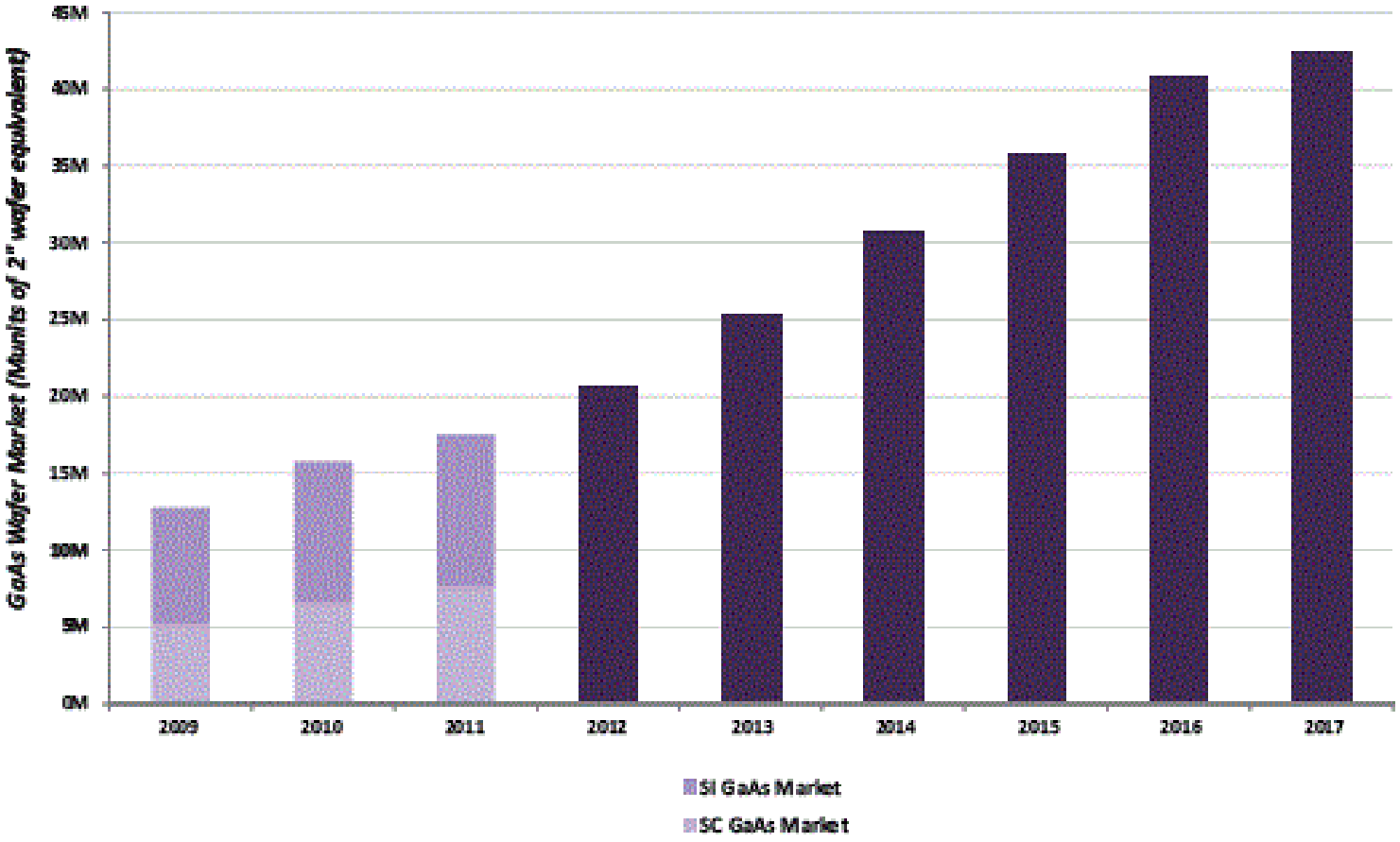
Forecast industrial electronics semiconductors 2018



Price development of Pd, Ru and Pt

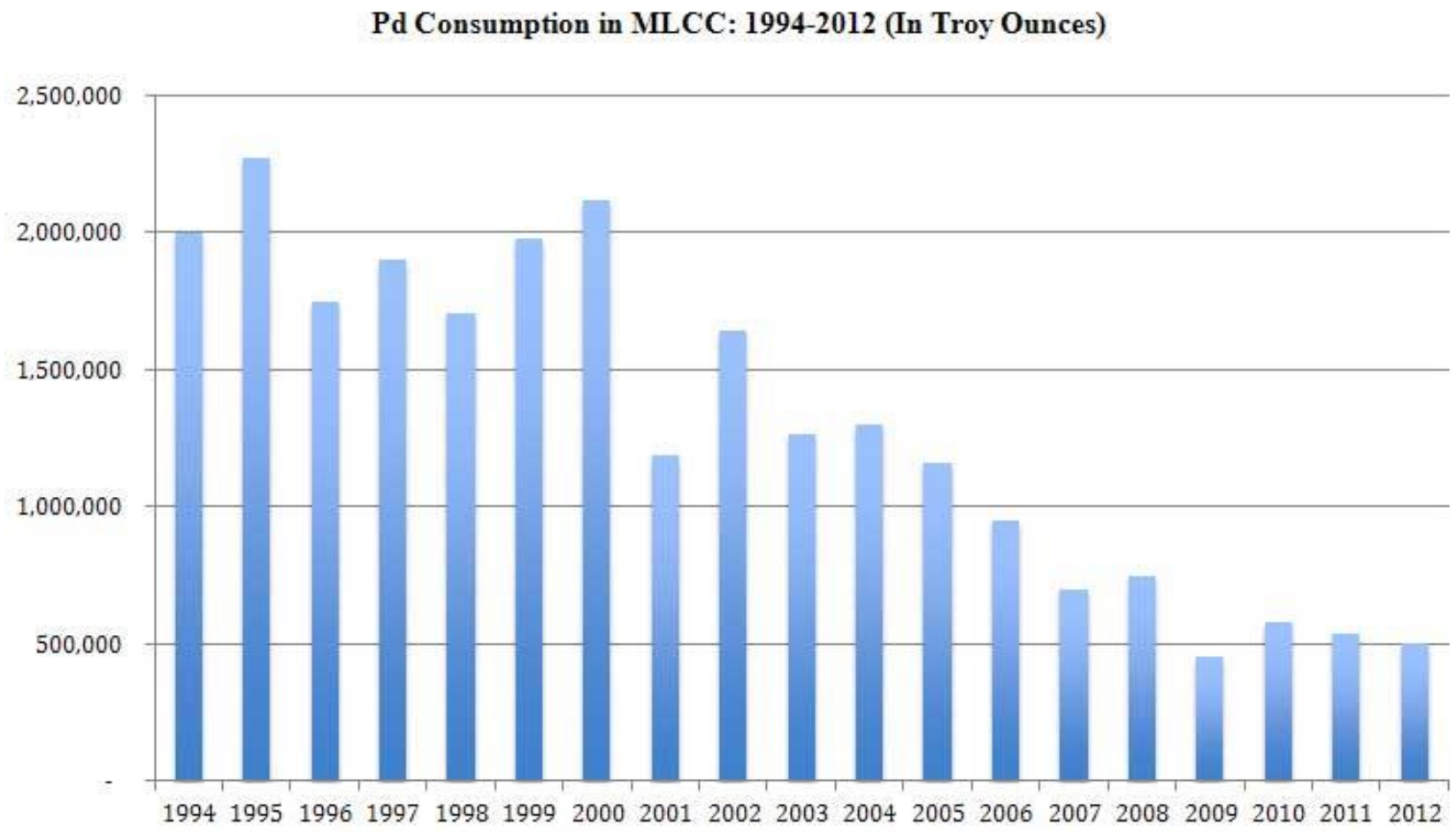


Gallium Arsenide market forecast 2017



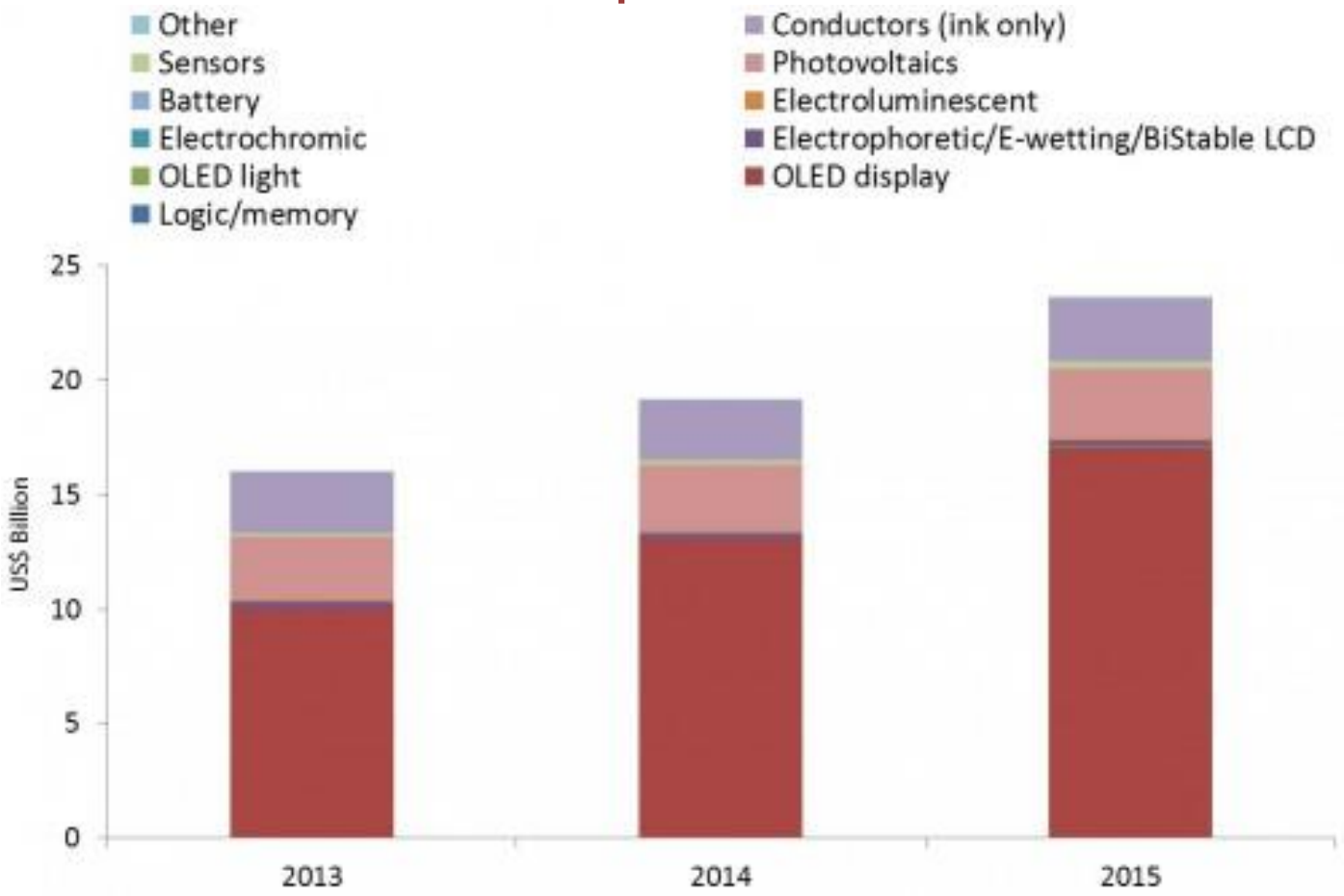
Source: [GaAs Wafer Market & Applications]

Palladium consumption in multilayered ceramic capacitors



Source: [Paumanok Publications, Inc]

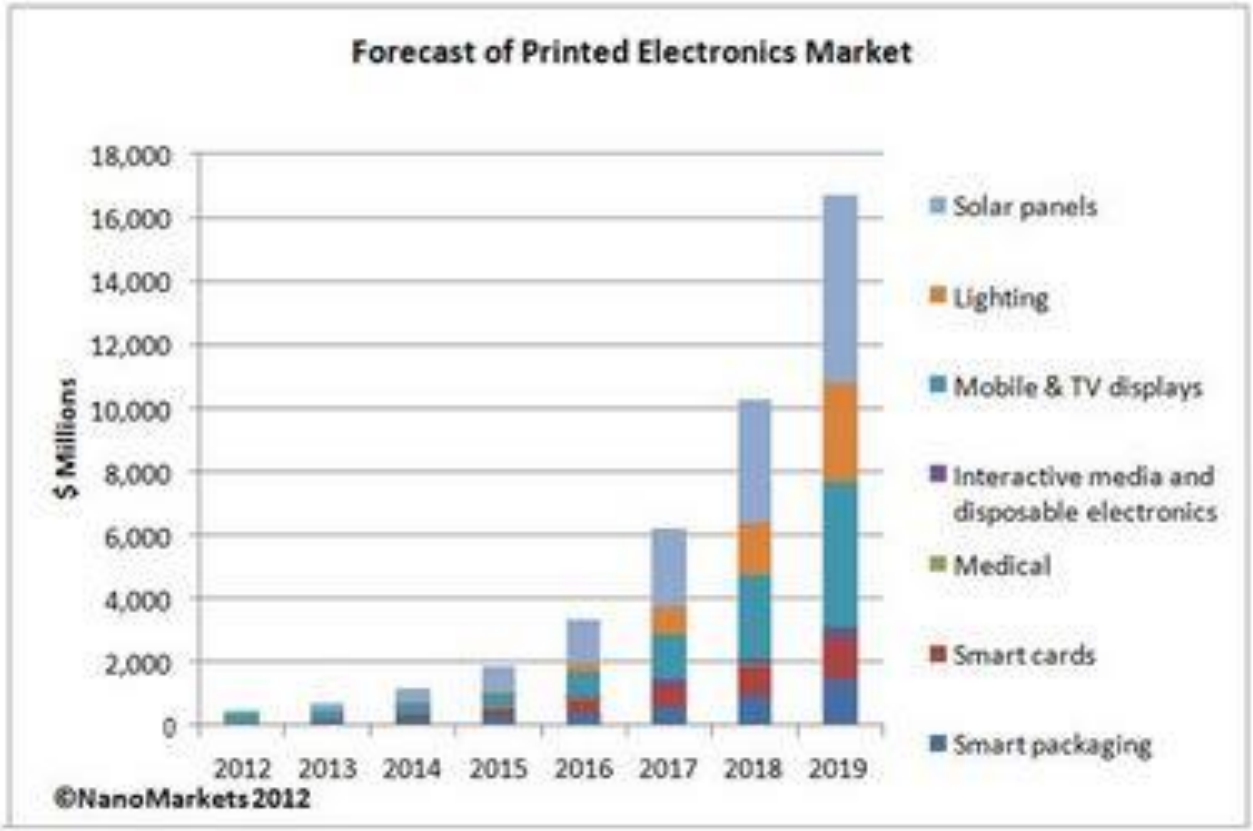
Flexible, organic and printed electronics – expected impacts



Source: IDTechEx 2014

http://green.tmcnet.com/news/2014/04/14/7776951.htm

Printed electronics forecast



Printed Electronics Market Forecast from NanoMarkets

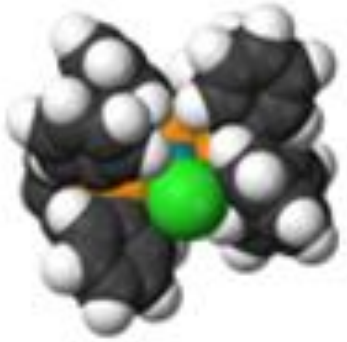
Source: NanoMarket

What is substitution?

Substance for Substance

Process for Process

Service for Product



New Technology for Substance

Landscape / drivers

- Trends in electronics
  - Ubiqitous electronics
  - Green electronics
  - Flexibility, recyclability
- Green image
- Pressure from NGOs and public
- Legislation and regulation
  - Restrictions of toxicl materials
  - REACH
  - Platinoide legislation
  - Green public procurement guideline
- Price is an important driver if it becomes extra high ->performance
- New business in EU
- Standardization
- Mining

Restraining issues:

- Long time to be able to substitute
- New CRMs
- Safety issues
- No pressure for substitution from the end users
- Energy vs. material efficiency

- Recyclability,
- Environmental protection,
- Safety

Policy initiatives

- Policies to support recycling to ensure the availability of (the recycled) CRM
- Strategies made in collaboration with industries and other stakeholders
- Environmental protection policies
- No single country is able to change the situation, must be done European wide in collaboration – in collaboration even worldwide
- Awareness and transparency; what raw materials the products include
- Responsibility: from EPR to IPR
- Design the materials for recycling and recycling organized

Market initiatives

- Research exists; to bring the results to market needs more support
- Financial support is needed for industry to develop substitution solutions
- Large scale R & D covering the whole value chain; Closed loop business models
- Reuse is developing
- Stockpiling of CRMs
- Devices with new functionalities

Research initiatives

- H2020: funding mechanism should support better industry participation – less byrocracy, bigger projects
- Funding is too strictly limited to specific topics, integration on systems level is needed
- Specific research targets (e.g. material by material substitution) can only be funded nationaly, bigger efforts on EU or global level

- Cleansky 2;
- Green Elec- easier recyclability
- Graphene research
- Substitution of Indium

- Plating manufacturing: from subtractive to additive manufacturing

Research initiatives

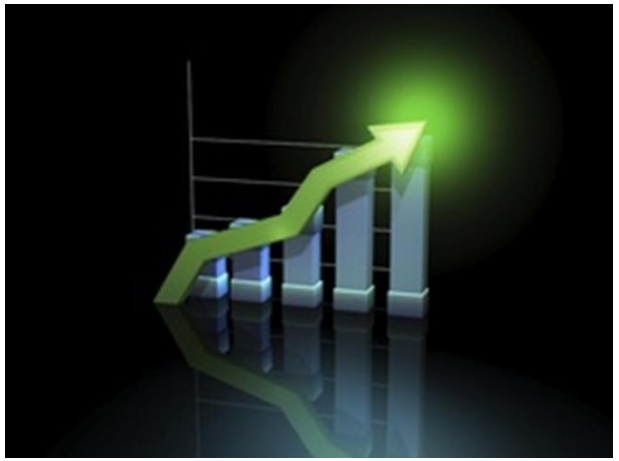
SUBSTANCE FOR SUBSTANCE • **Cobalt replacement**	**PROCESS FOR PROCESS**
SERVICE FOR PRODUCT	**NEW TECHNOLOGY FOR SUBSTANCE** • Plating manufacturing: from sustractive to additive manafacturing • Augmented reality

PCB – forwards to Vision 2030

Currently about 90 % of the production in Asia/Pacific

Market and product expectations:

- Embedded components e.g. in carbon fibre
- Flexible electronics
- In home monitoring
- Safety & Security
- Manufacturing 3.0
- PCB higher temperature resistant
- Privacy related technology



Key drivers for substitution

- Where recycling & reuse are not the option – e.g., miniaturisation and embedded in different materials
- Performance main driver but varies based on specifics of the application e.g. GaN 'wrong way substitution'
- Availability of CRM

R&D funding to address gaps – types of ways to fund substitution

Collaboration