OE-A Roadmap for Organic and Printed Electronics

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IPC APEX EXPO
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Las Vegas, NV.

OE-A
www.oe-a.org

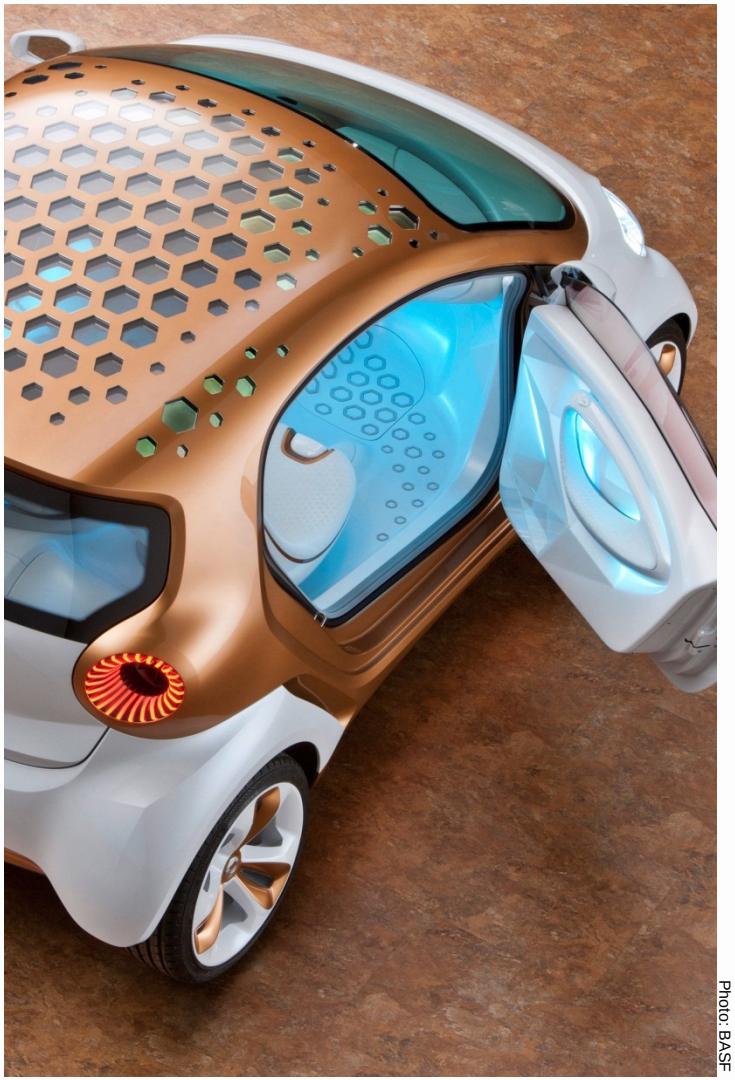
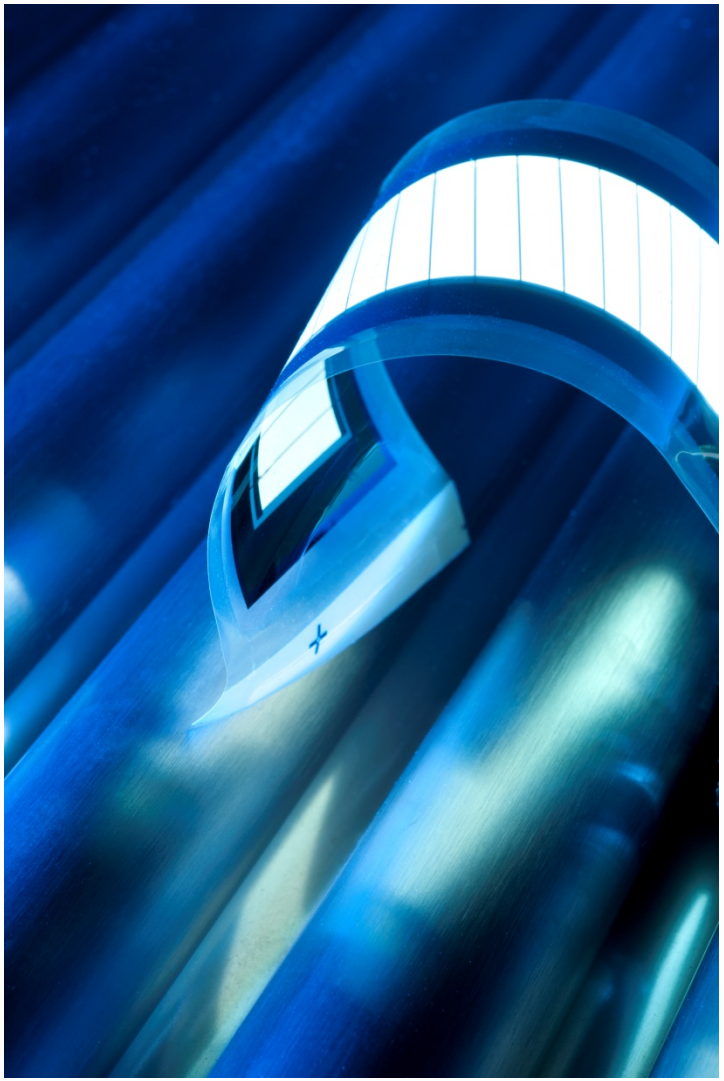


Photo: BASF

Outline

- Introduction OE-A
- Global Network
- LOPEC
- 5th Edition of the OE-A Roadmap
  - Applications and Technologies



Printing Meets Electronics

Printing

Chemistry

Printed Electronics

Microelectronics

Source: Heraeus, manroland, Infineon, Karl Knauer

Organic and Printed Electronics

Organic and Printed Electronics is

- thin
- lightweight
- flexible

and enables

- low-cost electronics
- new applications
- single-use electronics

by large area, high volume processing

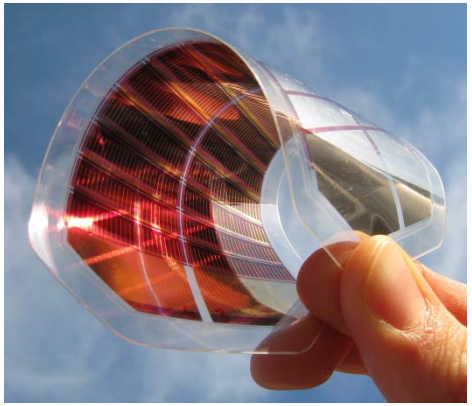
Enables:

- Electronics everywhere
- Ambient intelligence

What is Organic and Printed Electronics?

Active and passive organic devices: transistor, IC, antenna, ...)

Multifunctional systems



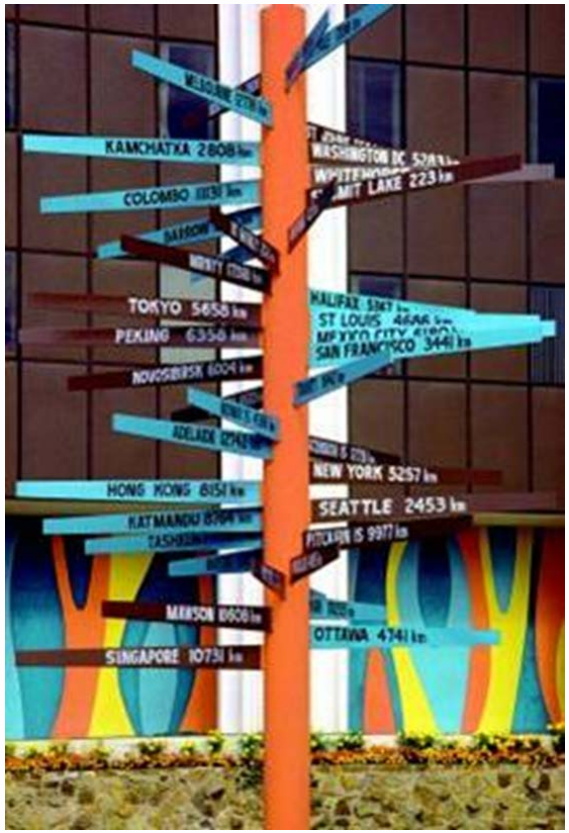
Power supply (organic photovoltaics, flexible battery, ...)

Displays and lighting (OLED, electrochromic, electrophoretic,...)

Sensors (touch, temperature, pressure, gas, …)

OE-A – Overview

- Global industry association for organic and printed electronics, driven by over 220 international members
- Our members represent the entire organic electronics value chain:
  - Component & material suppliers
  - Equipment & tool suppliers
  - Producers / system integrators
  - End-users
  - R&D institutes
- Benefits of OE-A membership:
  - Networking Opportunities
  - Frequent Working Group Meetings
    - Europe, North America, Asia
  - LOPEC
  - Industry Roadmaps
  - Demonstrator Projects
  - Industry Visibility

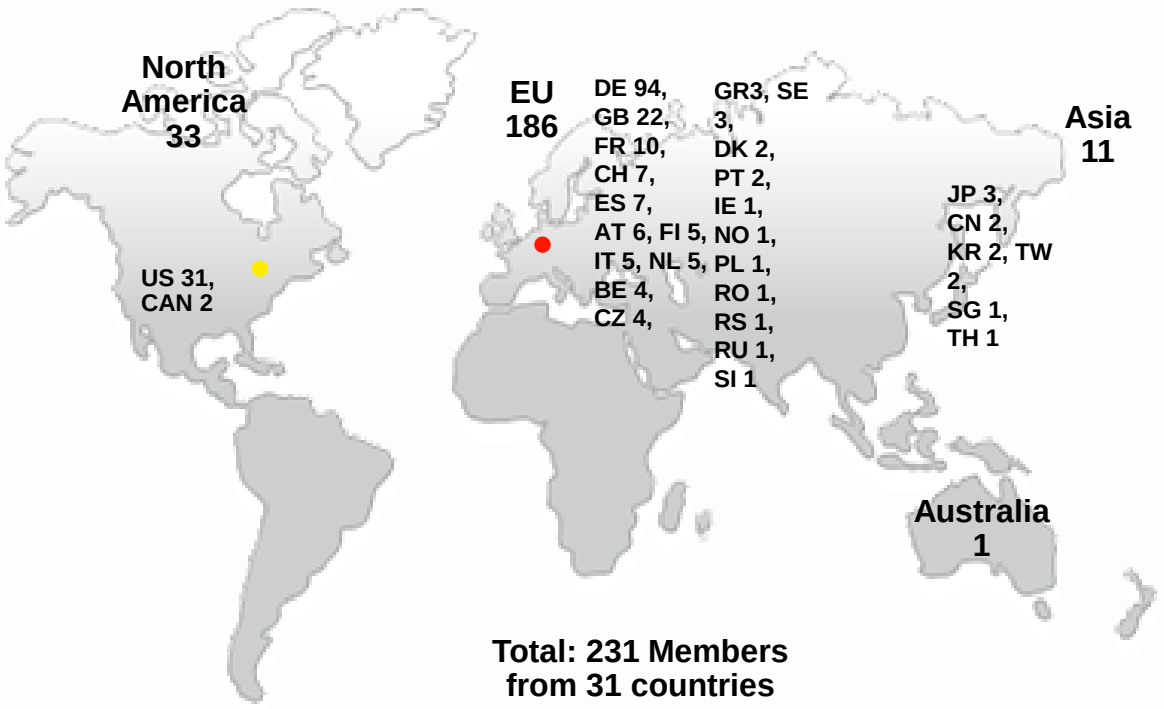


Global Approach

Establish a global network

OE-A is active in

- **Europe**
- **North America**
- **Asia**



Total: 231 Members from 31 countries

(as of November 2013)

Headquarters:

- **Frankfurt, Germany**

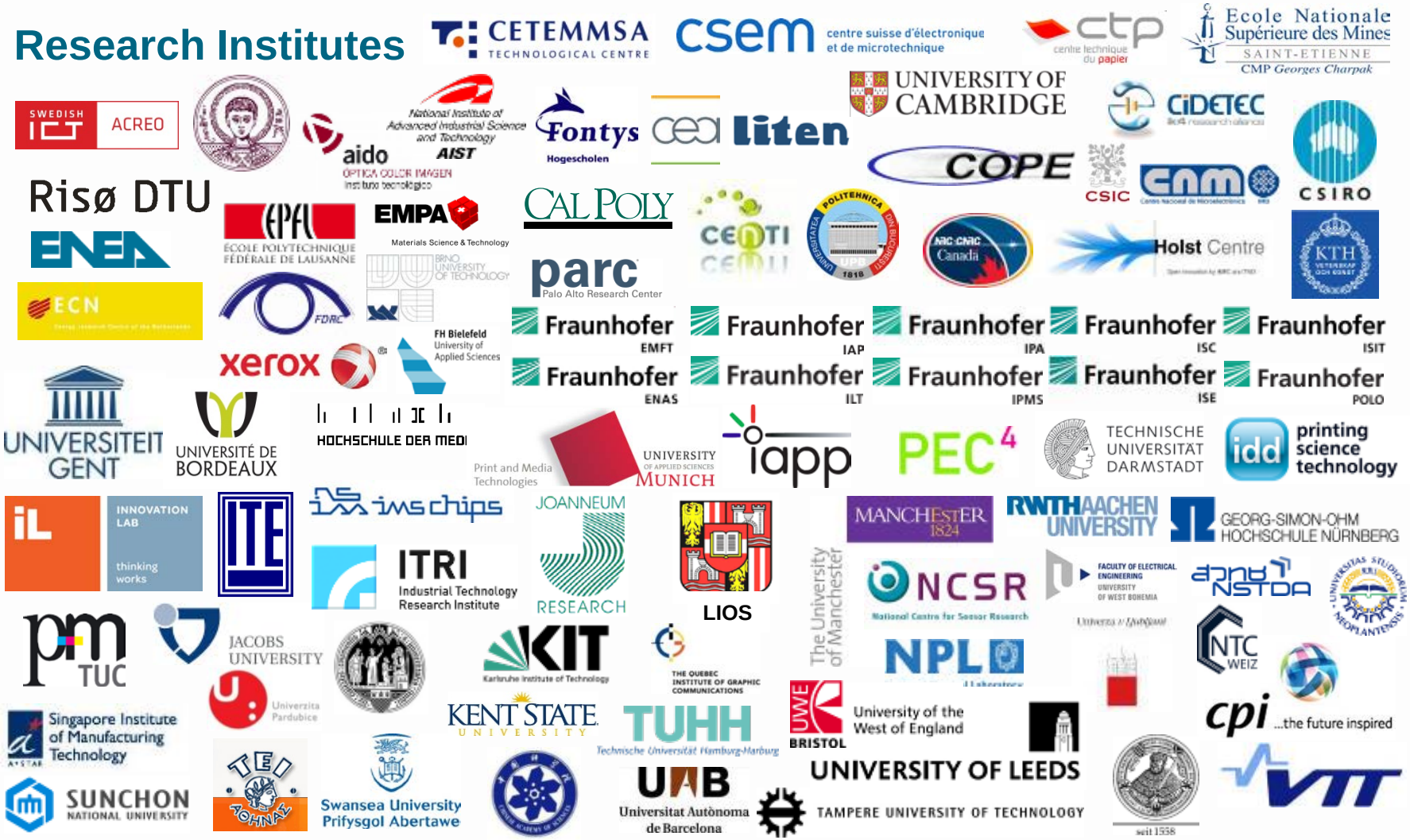
North American Office:

- **Pittsburgh, PA., USA**

200+ Members Representing the Entire Value Chain (1)

200+ Members Representing the Entire Value Chain (2)

Research Institutes



Global Approach North America

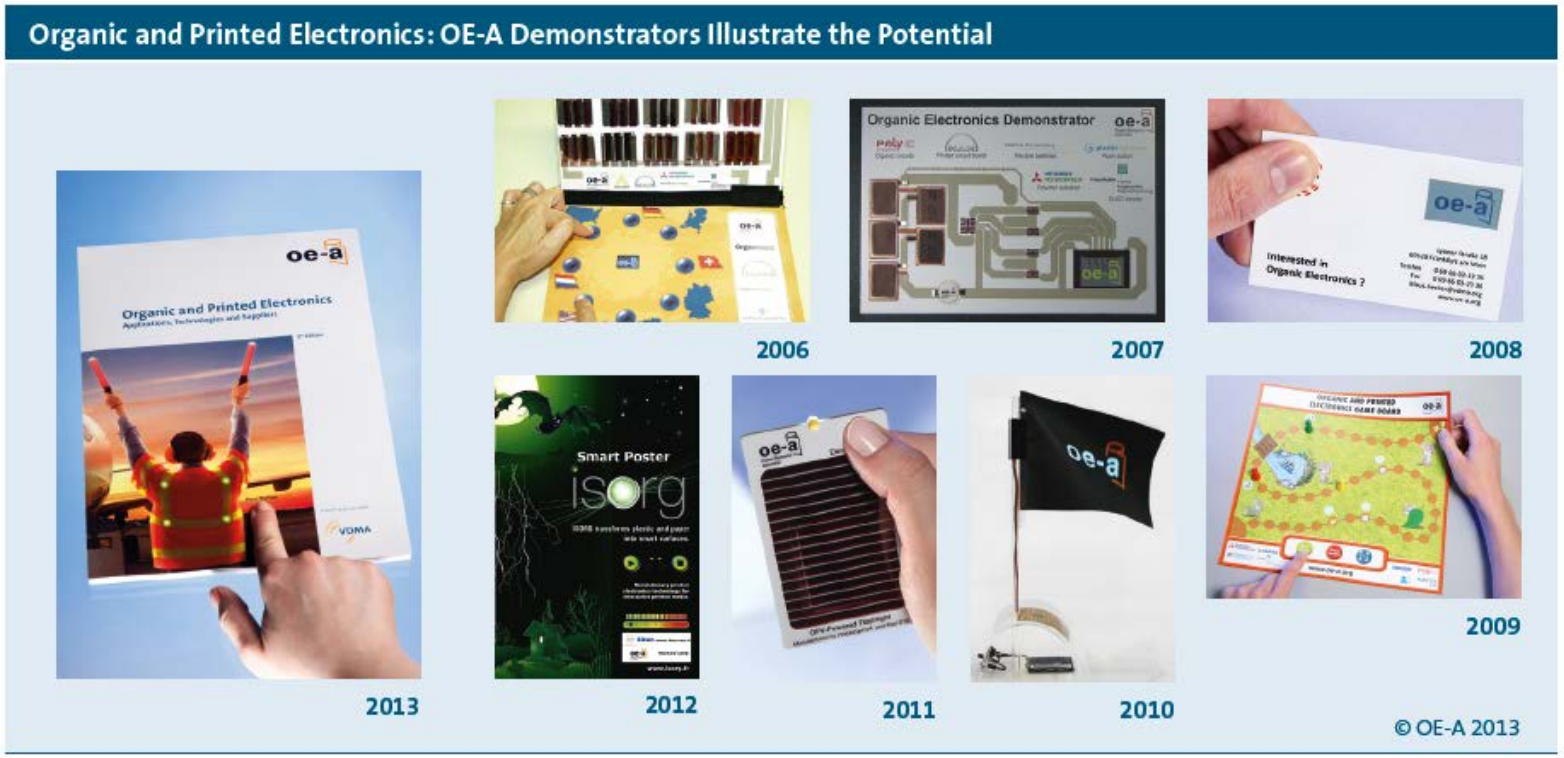
- Quarterly Working Group Meetings
- Next Meeting:
  - 20th NA Working Group meeting
  - Hosted by Kent State University
  - March 12/13, 2014
  - Kent, OH. (Cleveland area)

- Frequent Presentations at Conferences and Trade Fairs in North America
- Installation of a North America Chapter

- North American office
  Barbara M. Fisher
  +1-412-828-0370
  barbara.fisher@oe-a-na.org

Collaboration is the Key to Success
OE-A Demonstrator Projects

- OE-A supports and facilitates cooperation
- Key activity of the OE-A since 2005
- Illustrate the potential and the integration possibilities of organic and printed electronics



LOPEC 2014, May 26-28, 2014

www.lopec.com

- **New Munich Trade Fair Centre, Germany**
- **Provides the central marketplace for Organic and Printed Electronics**
  - 1,800+ attendees
  - 120+ international exhibitors
  - 180+ presentations
- **Exhibition**
  - Largest industry exhibition in the field
  - On-site production on demo line
- **Conference**
  - Business conference
  - Technical conference/Scientific conference
  - Pre-conference seminars




- **10% discount for OE-A members**

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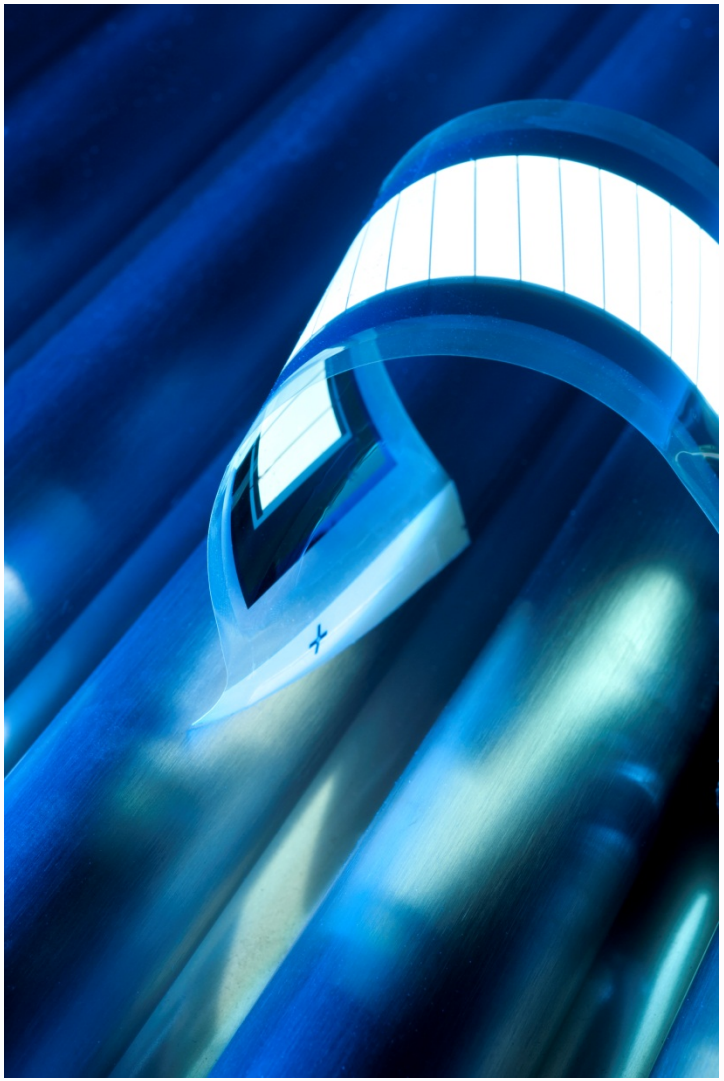
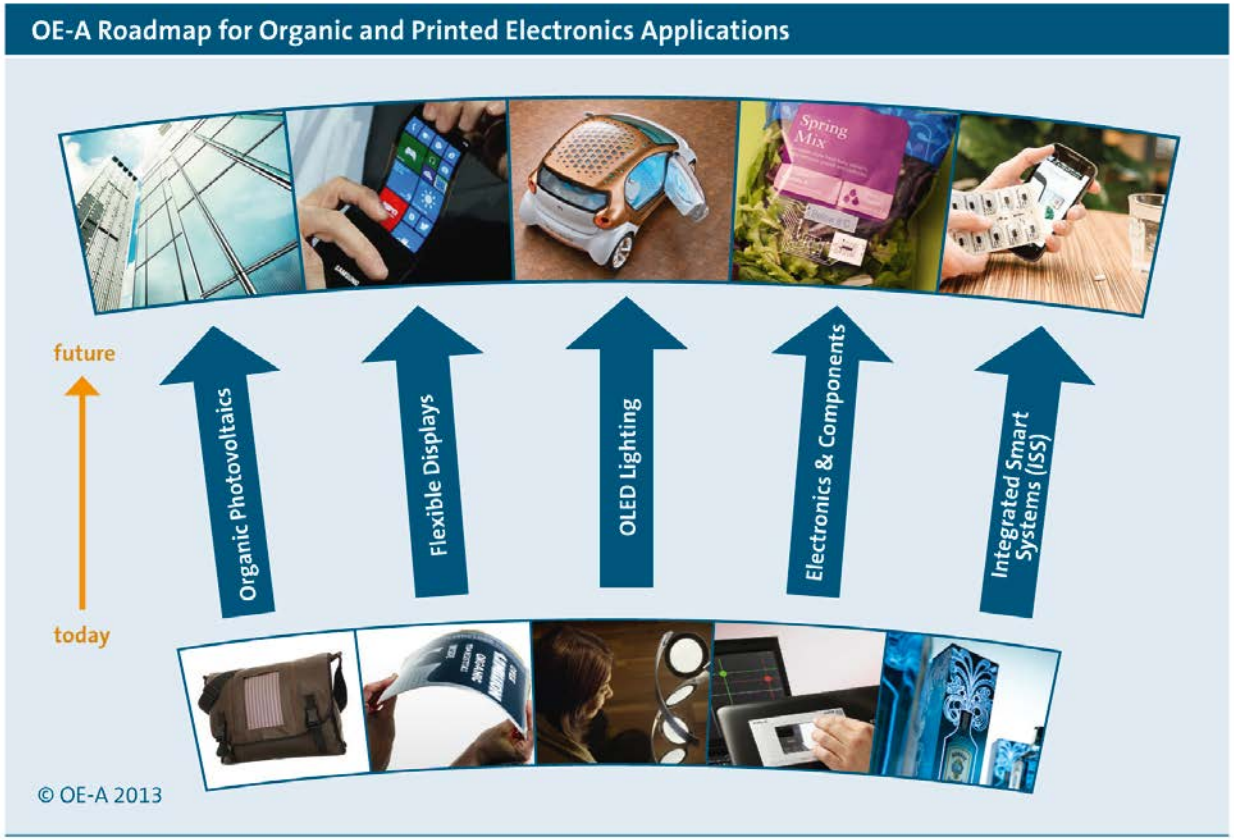


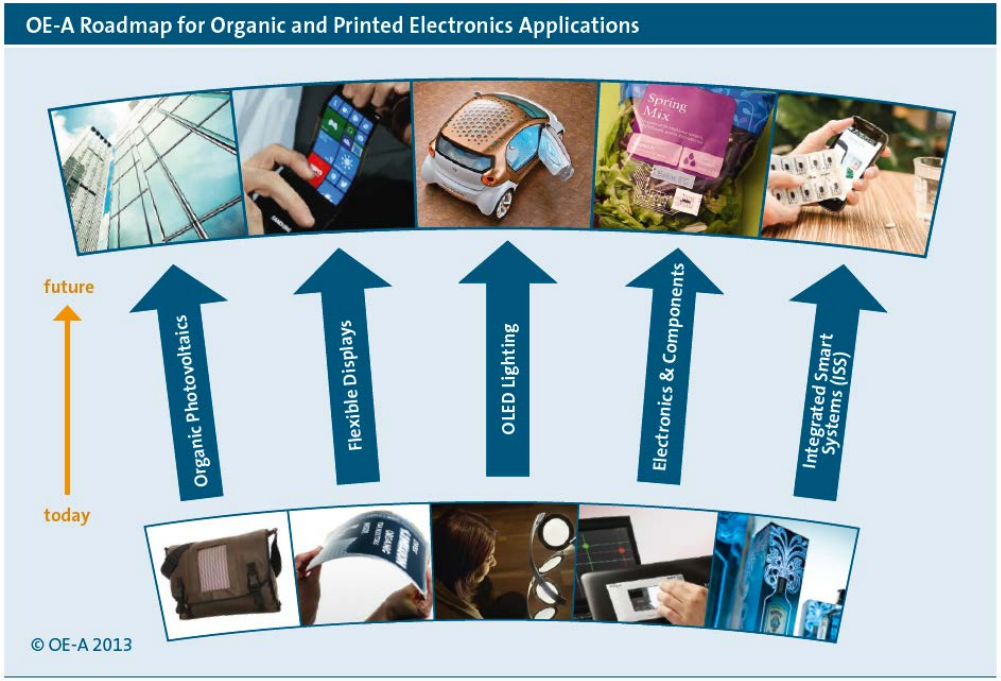
OE-A Roadmap for OE Applications



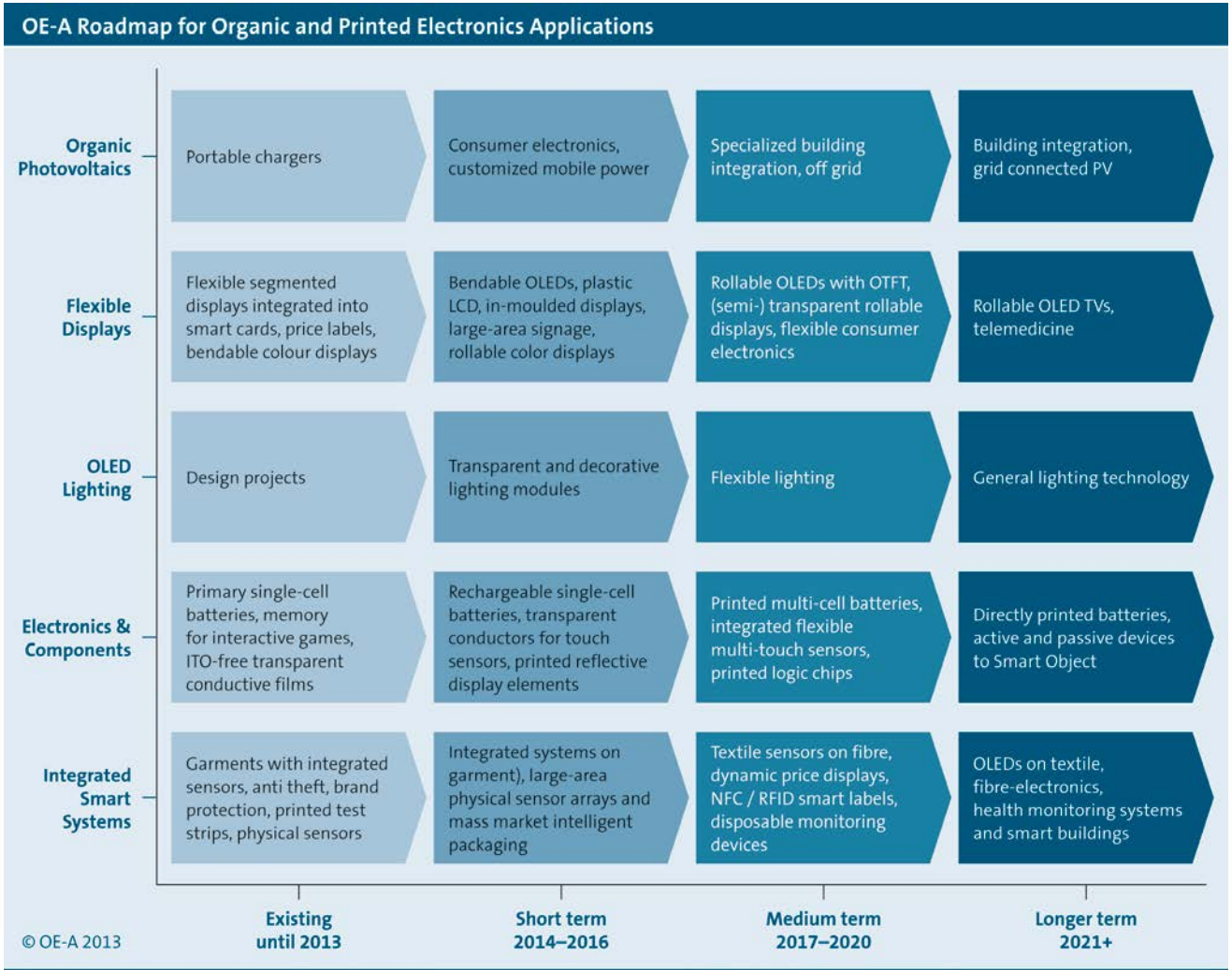
- Summary of the OE-A Roadmap is published in the OE-A brochure

OE-A Roadmap, Key Messages

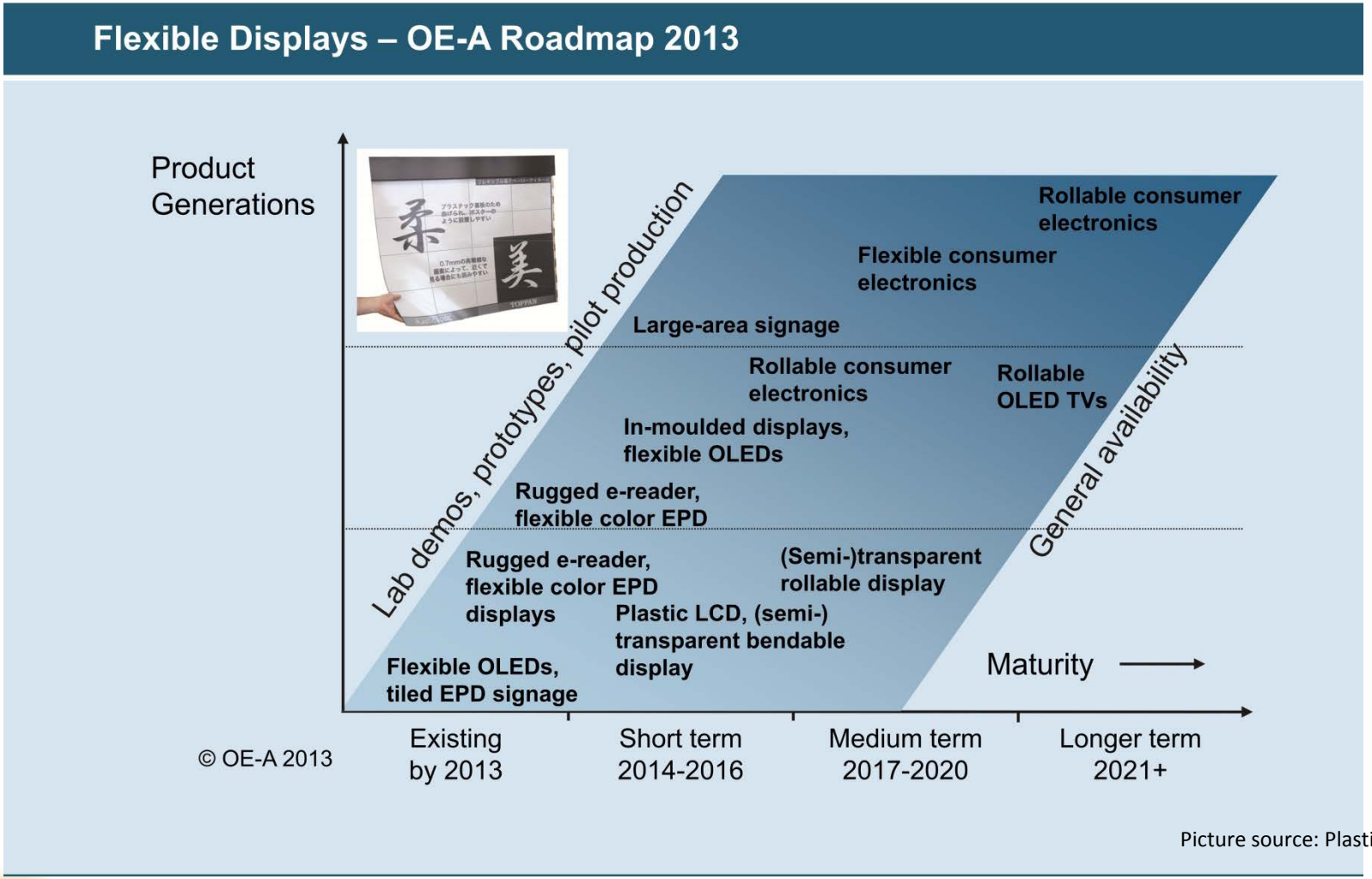
- Organic and printed electronics progresses in an "organic growth"
- Commercial products are now appearing in most of the application clusters, more products are in the pilot or test marketing phases
- Continued "organic growth" in a number of areas is more likely than a new "killer app"
- Heterogeneous integration (organic and Si) and hybrid processing will be important for new products in the short- to medium term.



OE-A Roadmap for OE Applications Forecast for the Market Entry

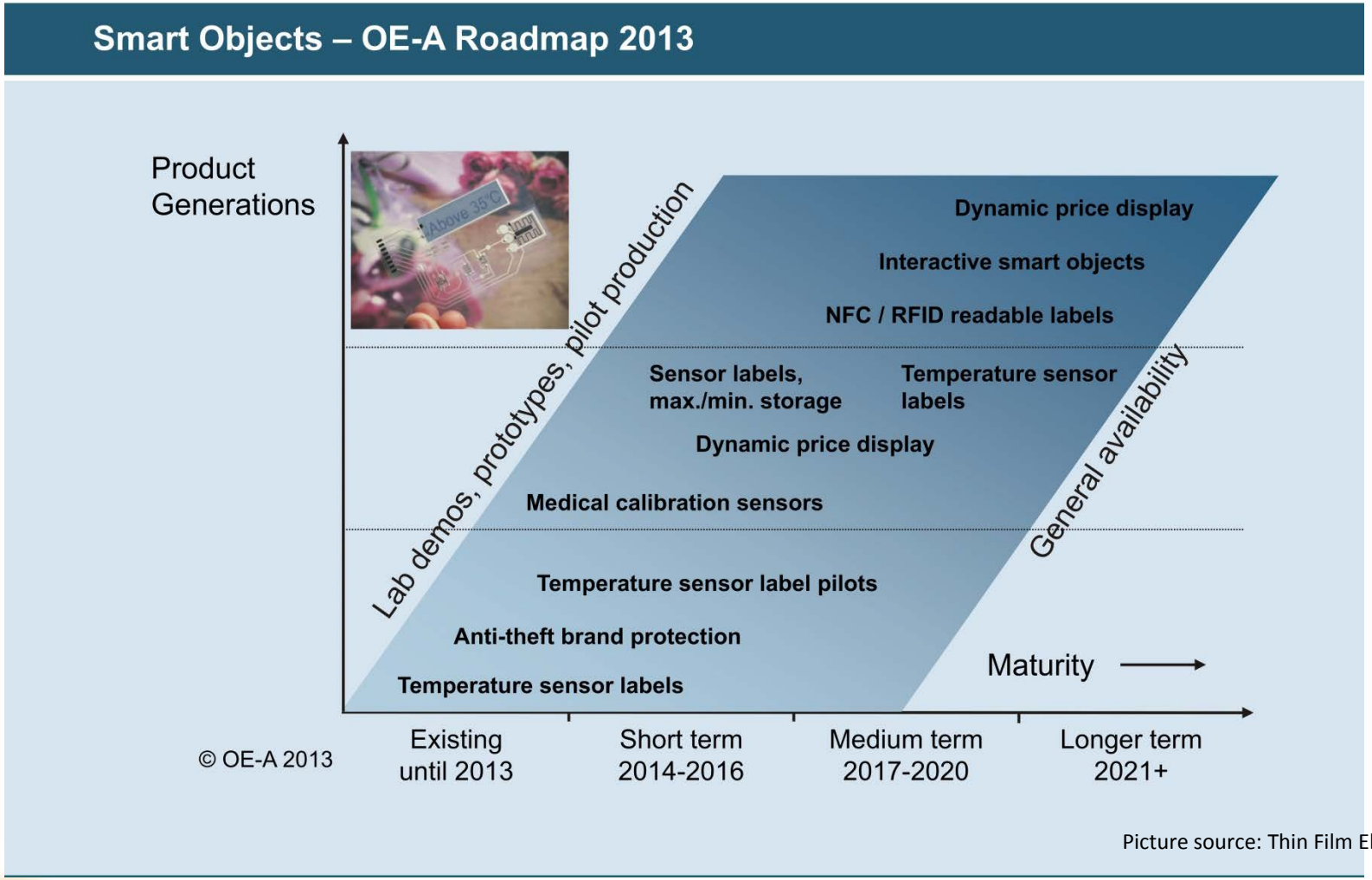


Flexible Displays – Roadmap 2013



Picture source: Plastic Logic

Smart Objects – Roadmap 2013

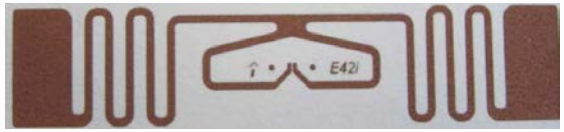


Picture source: Thin Film Electronics

Technology: Functional Materials

- Conductors:
  - Polymers
  - Metal filled pastes
  - Carbon nanotubes
  - Metallic nanoparticles
- Semiconductors:
  - Small molecules
  - Amorphous polymers
  - Semi-crystalline polymers
  - Carbon nanotubes
- Substrates
  - Paper, cardboard, film, foil, thin glass, stainless steel
- Dielectrics
  - Thermoplastic to thermosetting plastic polymers
- Encapsulation
  - Hybrid organic/inorganic barrier

- The material best suited for a specific application depends on process conditions, surface roughness, thermal expansion, barrier properties



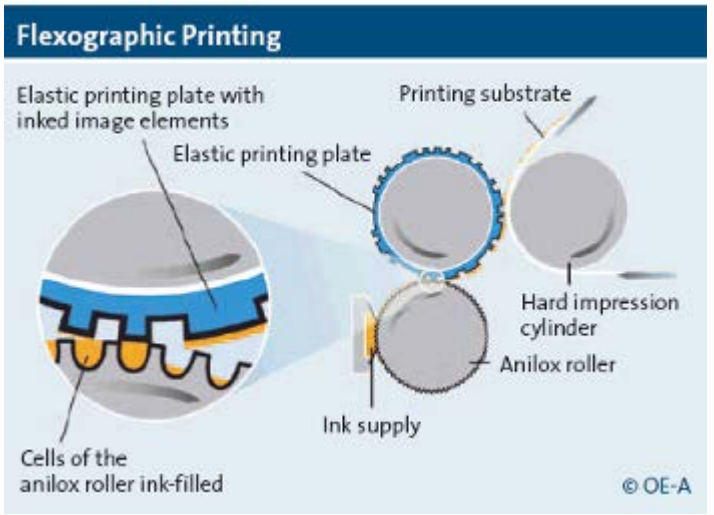
Source: Heraeus Clevios, Bayer Materialscience, NovaCentrix

Technology: Large Area Patterning Techniques

Many options

- Offset, screen, gravure, flexography, ink-jet, aerosol jet printing
- Laser ablation, large-area optical lithography, soft lithography, photo lithography, xerography, pad transfer, wetting, hot stamping, syringe deposition, micro plasma printing
- Solution coating techniques like slot-die, wire bar or curtain coating

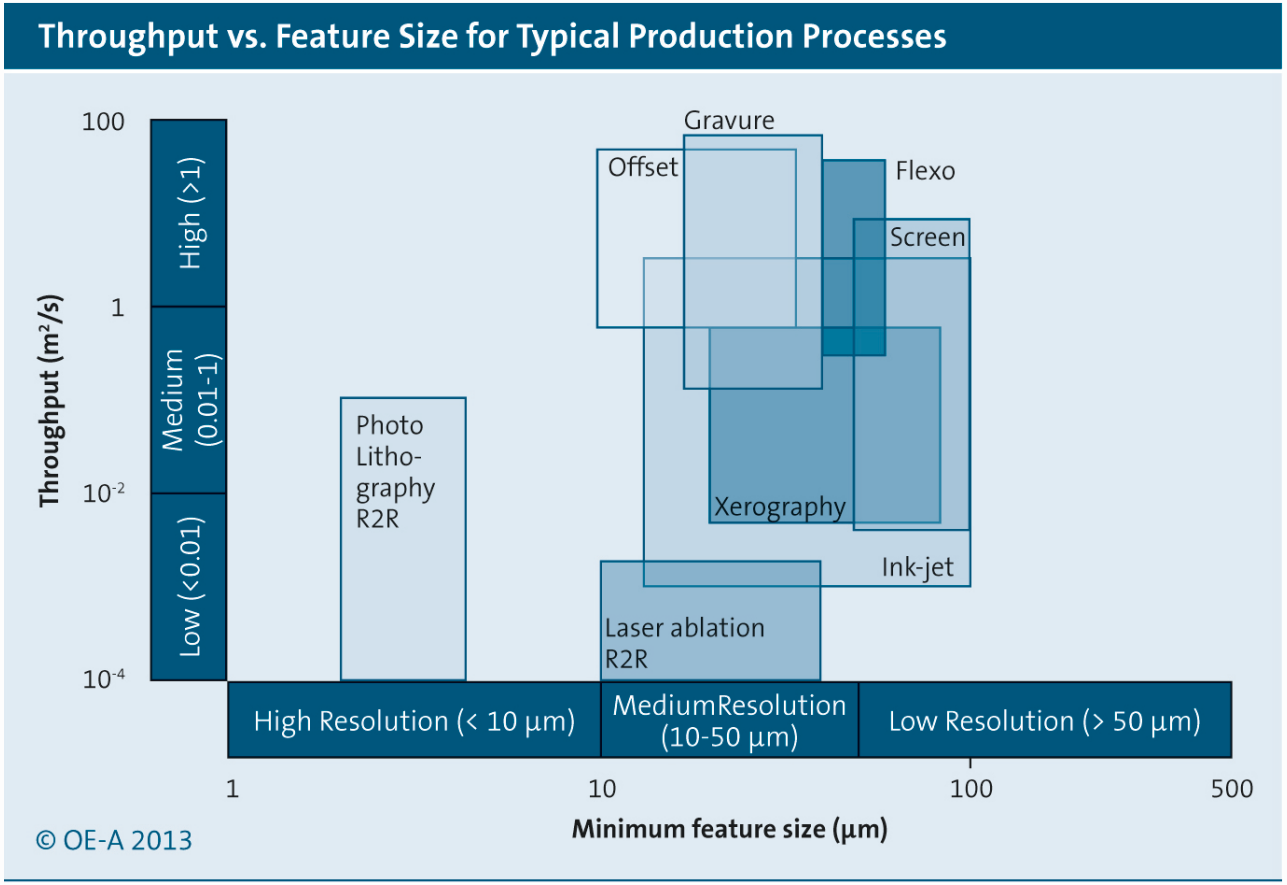
- No single standard process today
- Combination of different processes required



Source: CPI

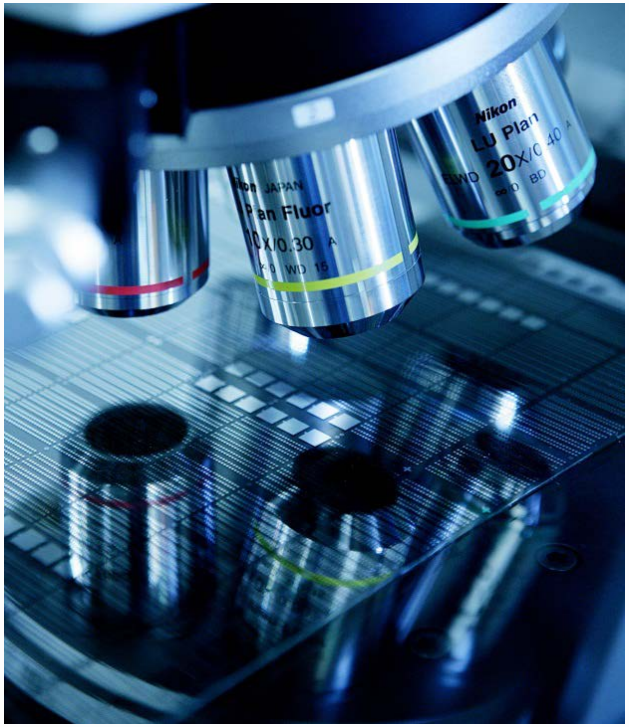
Technology: Large Area Patterning Techniques

Smallest feature size typically 20-100 µm depending on process throughput, substrate and ink properties



Technology: Short List of Key Technology Parameters

- Mobility/electrical performance (threshold voltage, on/off current)
- Resolution/registration
- Barrier properties/ environmental stability
- Flexibility/bending radius
- Fit of process parameters (speed, temperature, solvents, ambient conditions, vacuum, inert gas atmosphere)
- Yield



Source: CPI

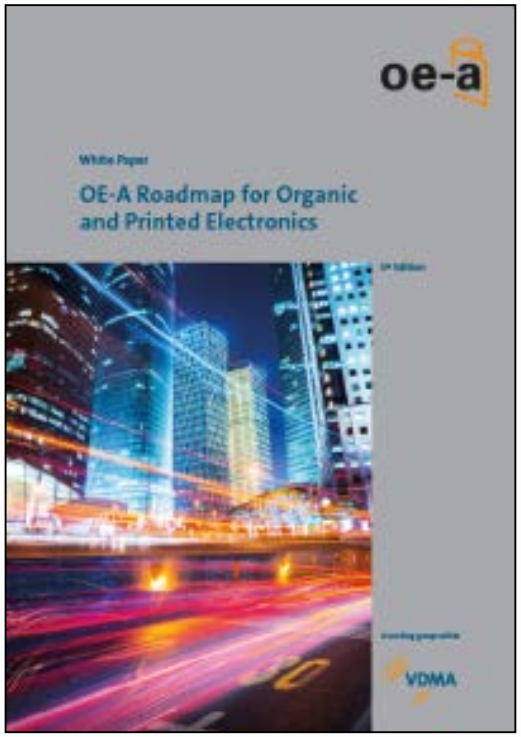
Key Challenges/Red Brick Walls

Major breakthroughs are absolutely necessary:

- Materials
  - Charge carrier mobilities of printable commercially available n- and p-type semiconductors above 5-10 cm^2/Vs would enable more complex devices
  - Improved processability
  - Improved environmental stability is needed to enable operation in robust environment
- Processes
  - Higher resolution, registration and process stability of the patterning processes required
  - Uniformity over large areas needs to be improved
  - High-throughput inline electrical characterization is necessary
- Encapsulation
  - Flexible, transparent barriers at low cost with improved barrier properties
- Standards and Regulations
  - Define new standards which reflect the specific needs of organic and printed electronics applications

OE-A Roadmap White Paper

- New White Paper "OE-A Roadmap for Organic and Printed Electronics", 5th edition now available for download!
  - Members: free access to printed and pdf version
  - Non-Members: White Paper for sale
- Editorial team: Wolfgang Clemens, Don Lupo, Sven Breitung, Klaus Hecker
- Additional info for members:
  Detailed tables available for download from new member area my.oe-a
  - Key application parameters
  - Key technology parameters
  - Materials, patterning techniques and substrates



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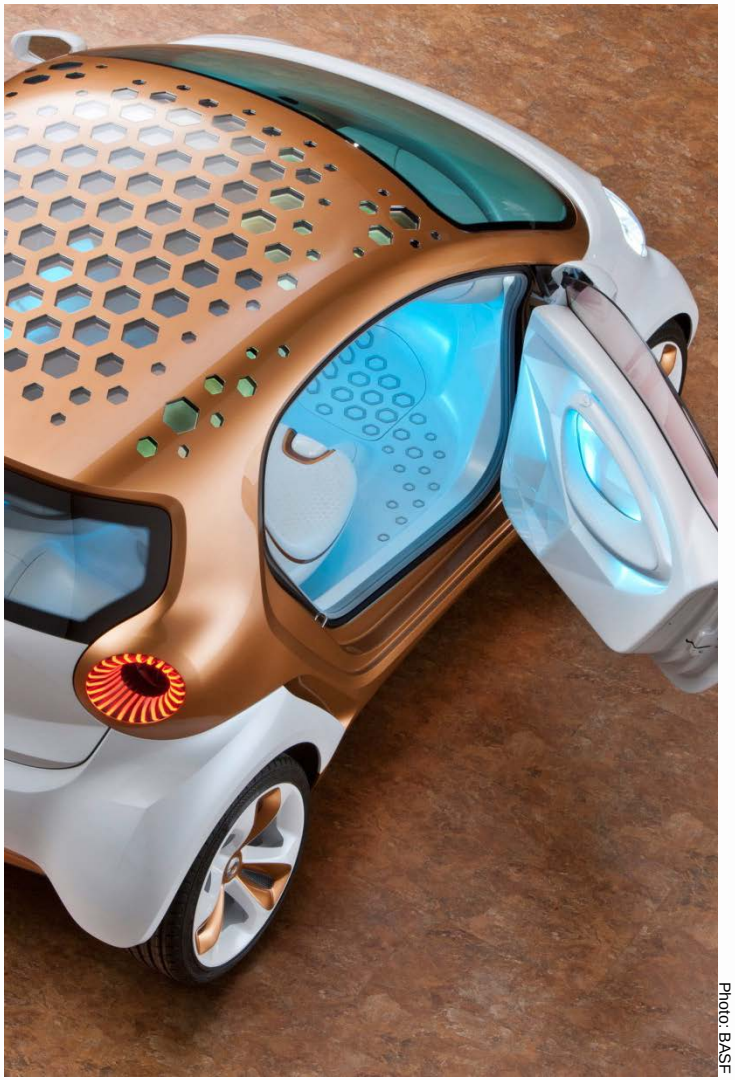
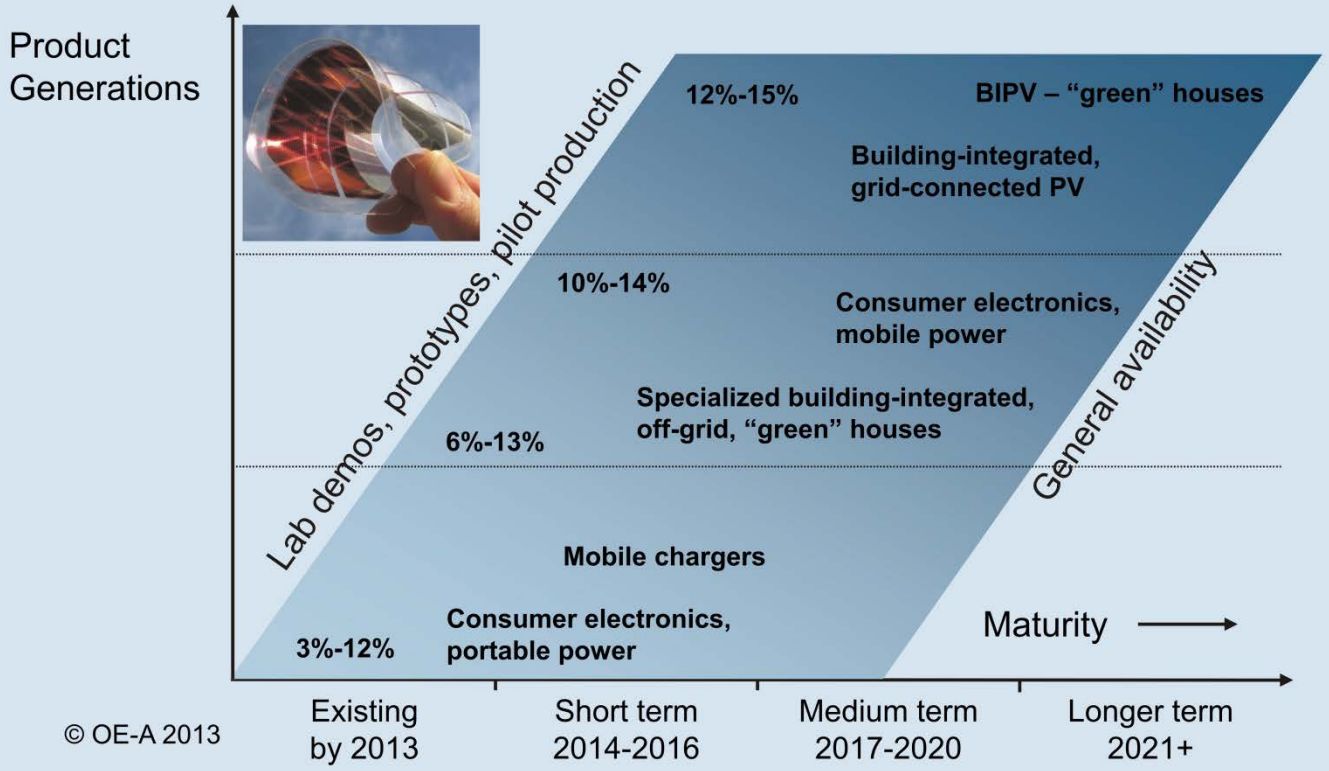


Photo: BASF

Back-Up Sub-Roadmaps

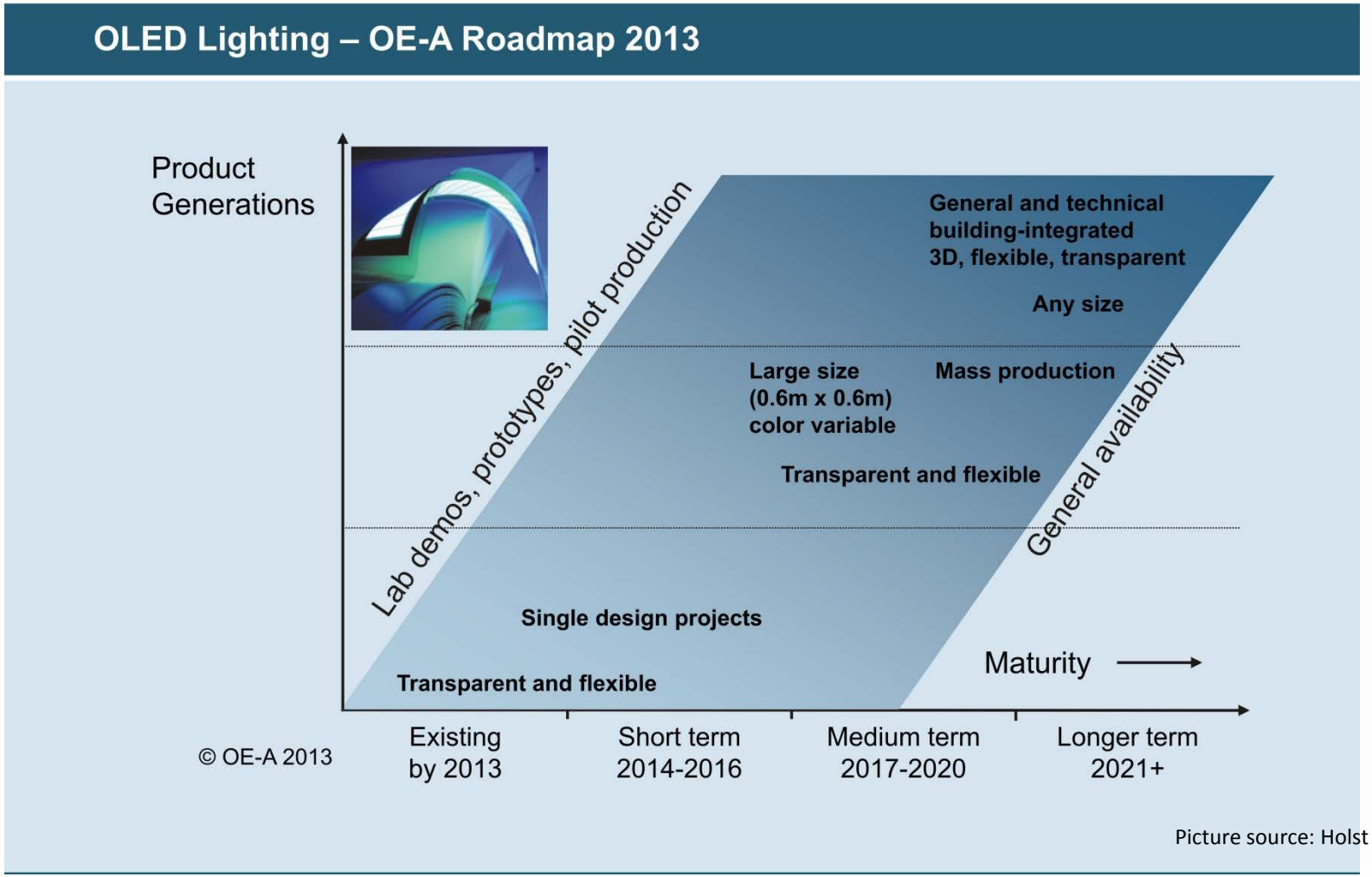
Organic Photovoltaics – Roadmap 2013

Printable, Organic Photovoltaics – OE-A Roadmap 2013



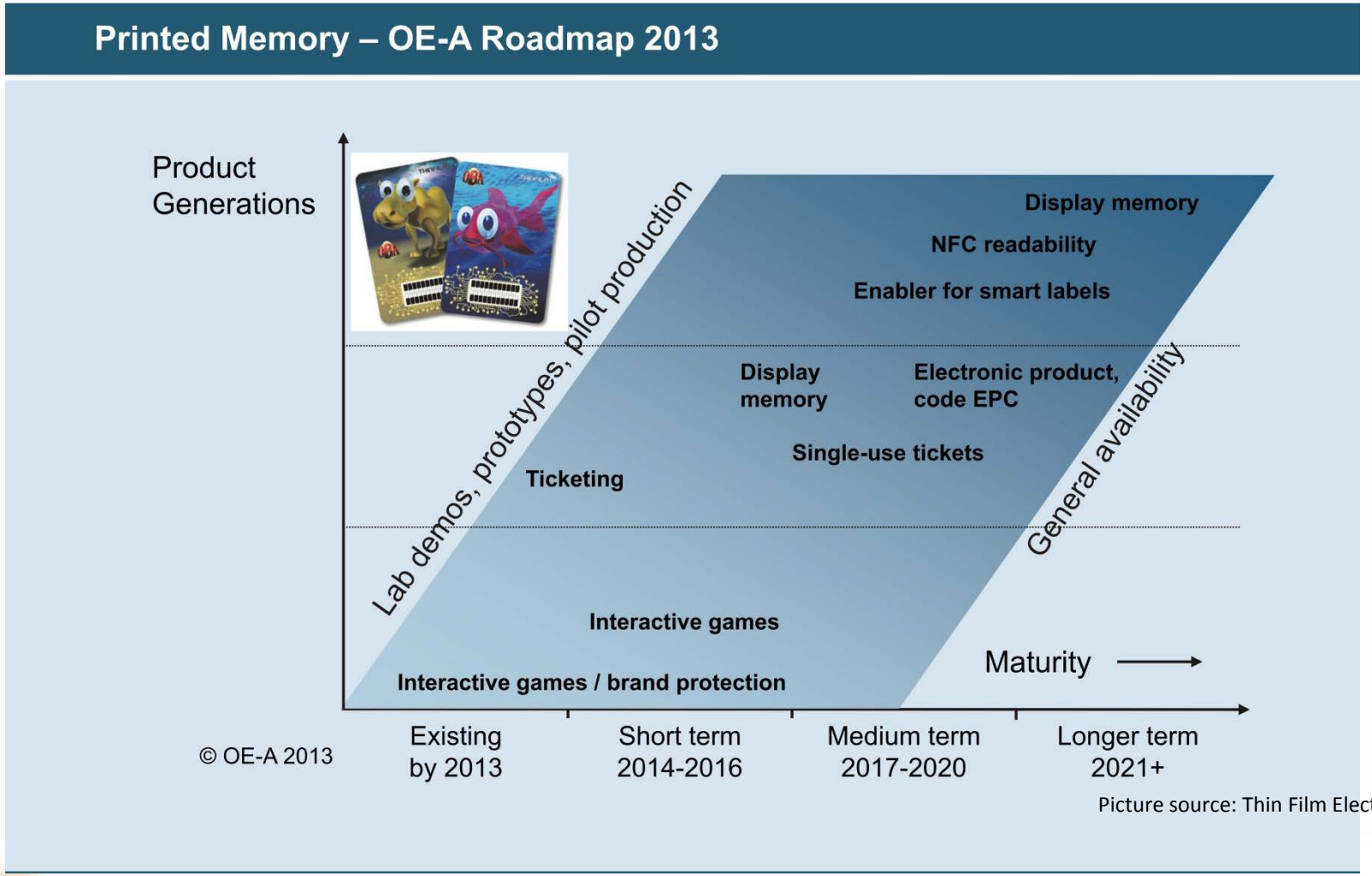
Picture source: Fraunhofer ISE

OLED Lighting – Roadmap 2013



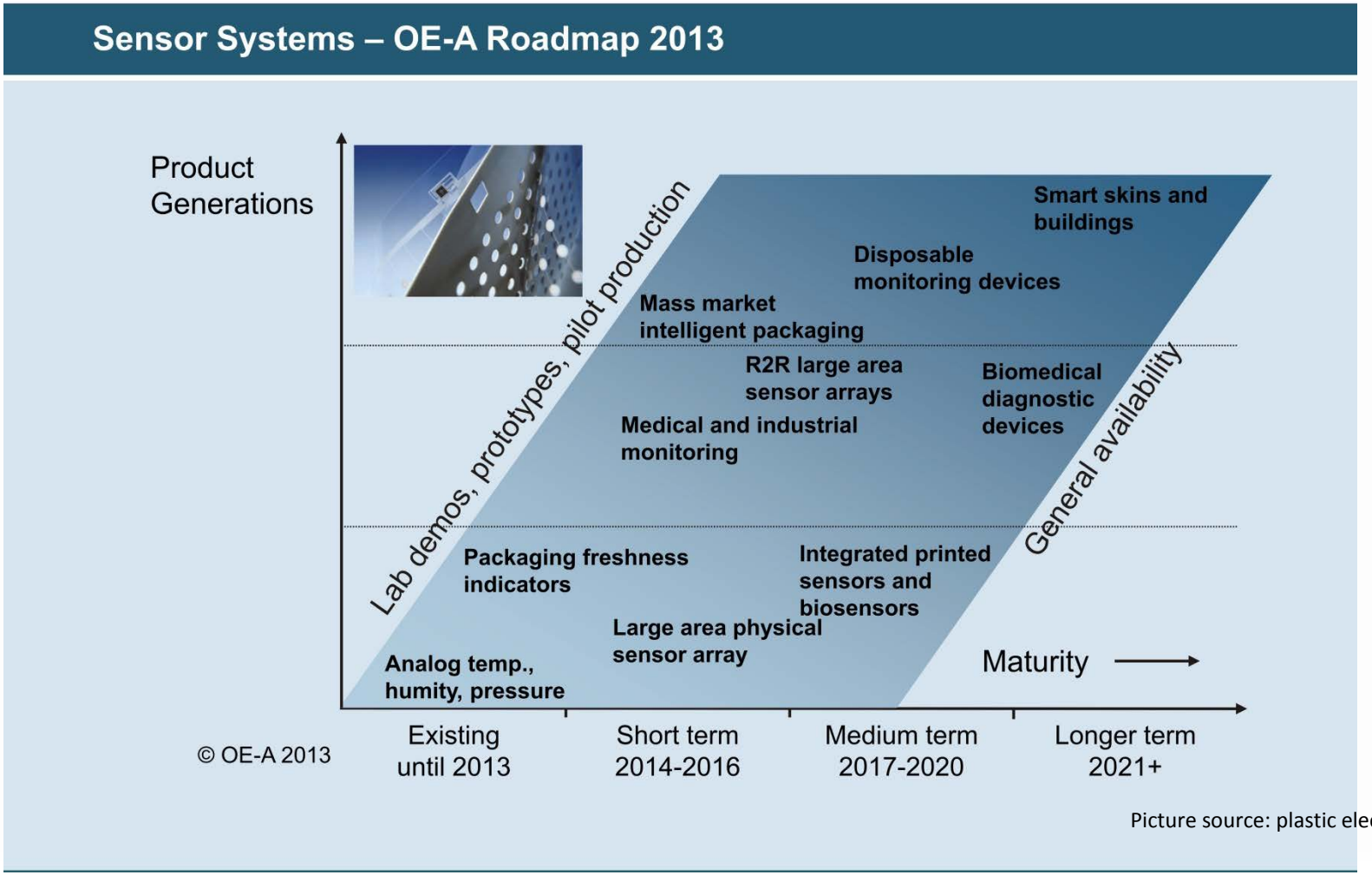
Picture source: Holst Centre

Printed Memory – Roadmap 2013



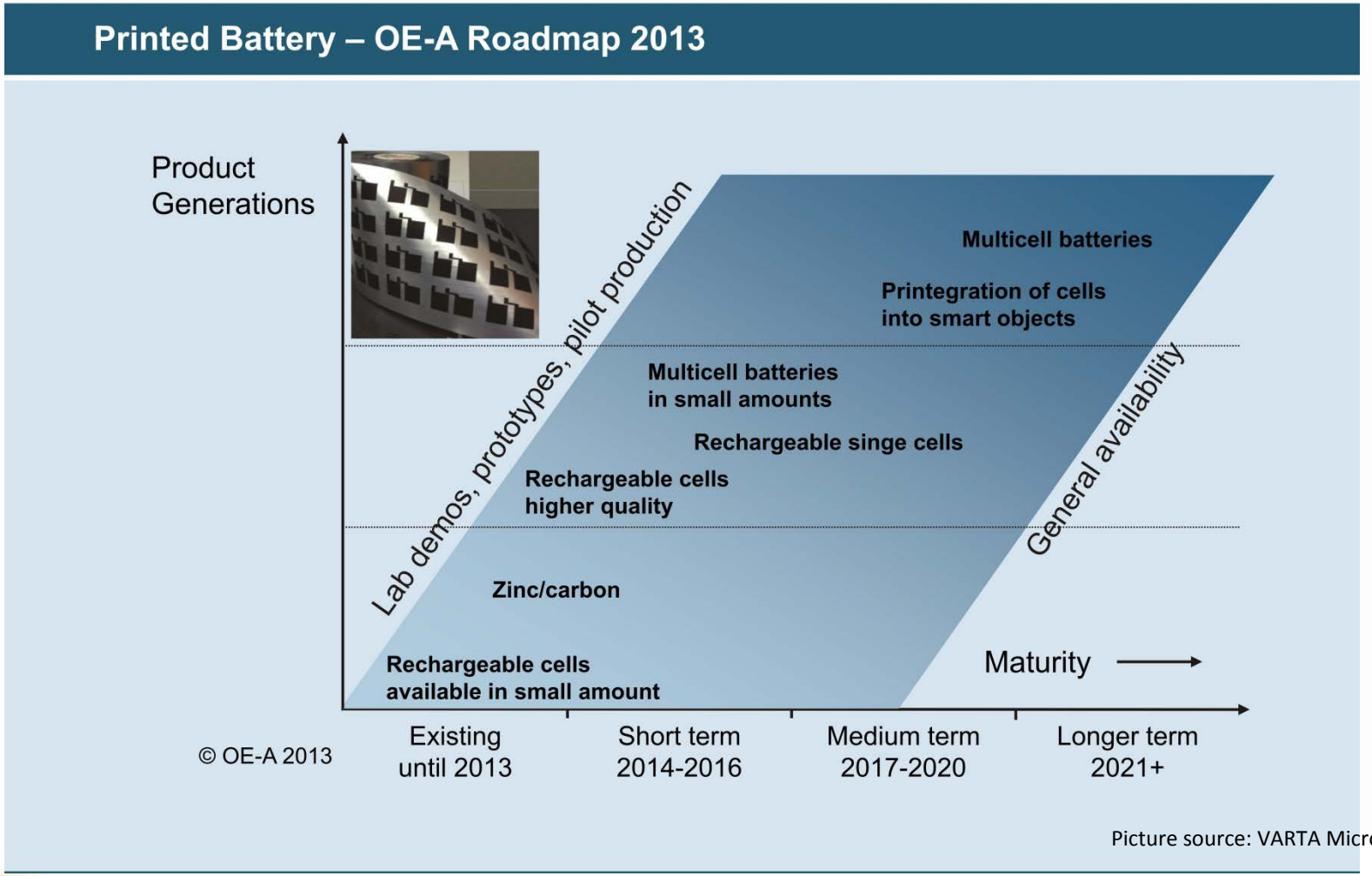
Picture source: Thin Film Electronics

Sensor Systems – Roadmap 2013



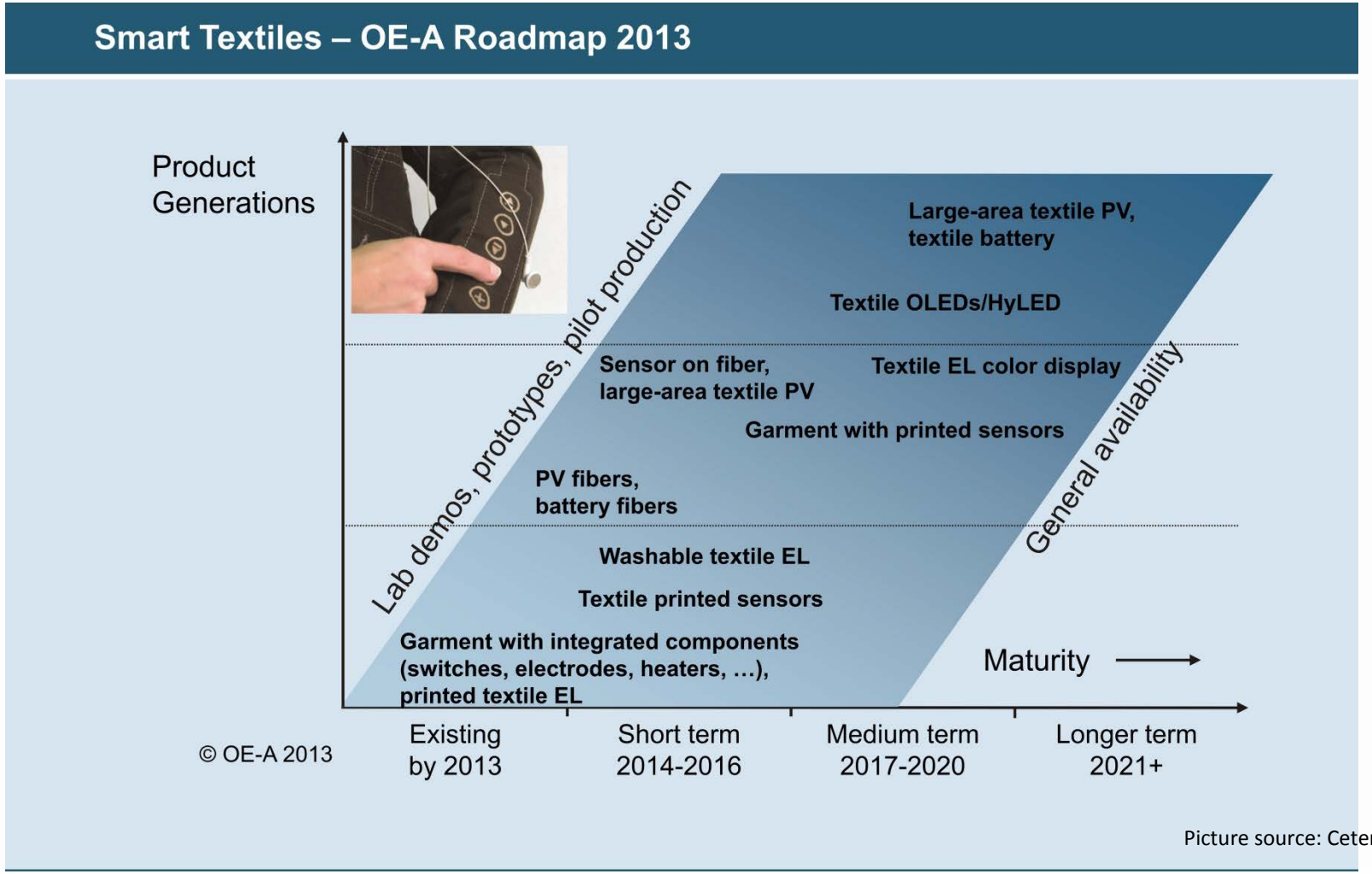
Picture source: plastic electronic

Printed Battery – Roadmap 2013



Picture source: VARTA Microbattery

Smart Textiles – Roadmap 2013



Picture source: Cetemmsa