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International Electronics Manufacturing Initiative

2013 iNEMI Environmentally Sustainable Electronics Roadmap

Bill Bader, CEO of iNEMI

Sustech 2013

August 1st, 2013

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Agenda

iNEMI Overview

Technology Roadmap

Environmentally Sustainable Electronics; Methodology, History, Success Examples

Key Environmental Challenges form the 2013 Roadmap

Conclusions and Summary

Q & A, Discussion

International Electronics Manufacturing Initiative (iNEMI)

- **Not for profit, highly efficient R&D consortia since 1994**
  - Funded by Corporate memberships - Staffed globally in US, China & Ireland
- **Membership includes 110 leading industry companies & organizations, representing a cross section of our electronics manufacturing industry & supply chain**

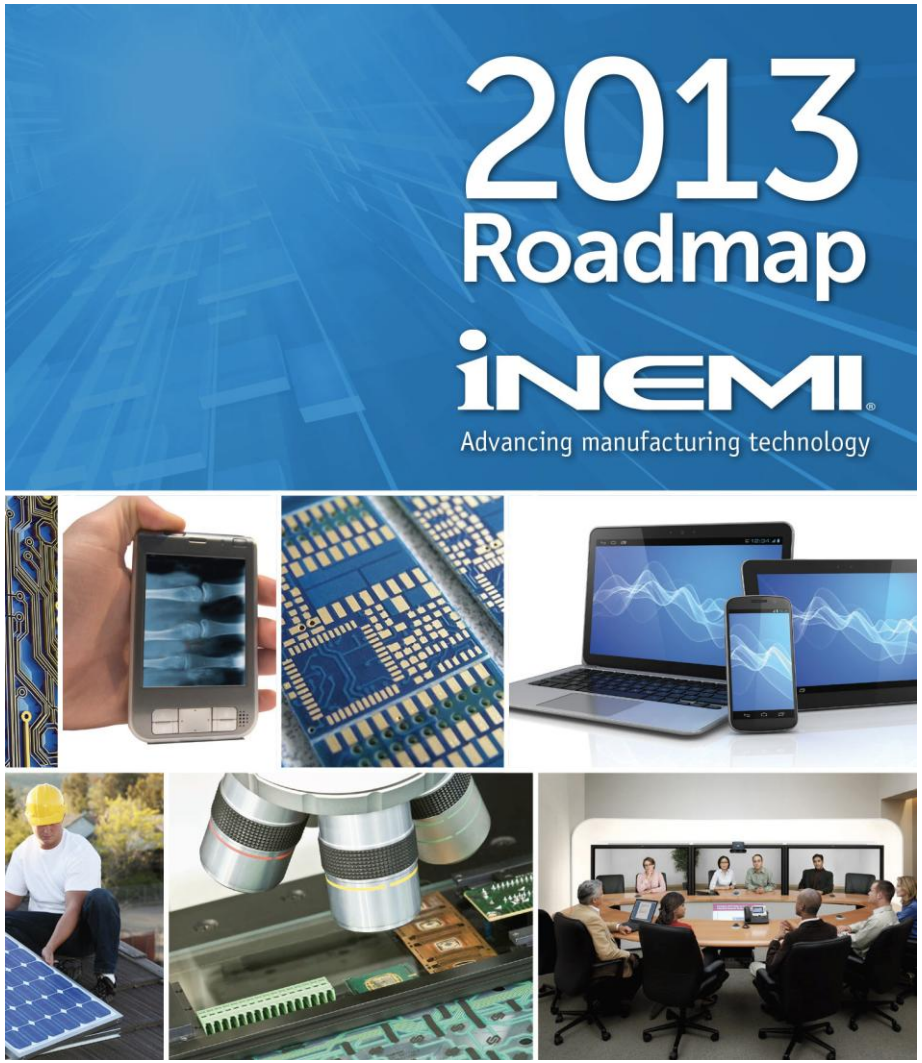
iNEMI Mission: Forecast and accelerate improvements in the Electronics Manufacturing Industry for a sustainable future.

We Accomplish This By:

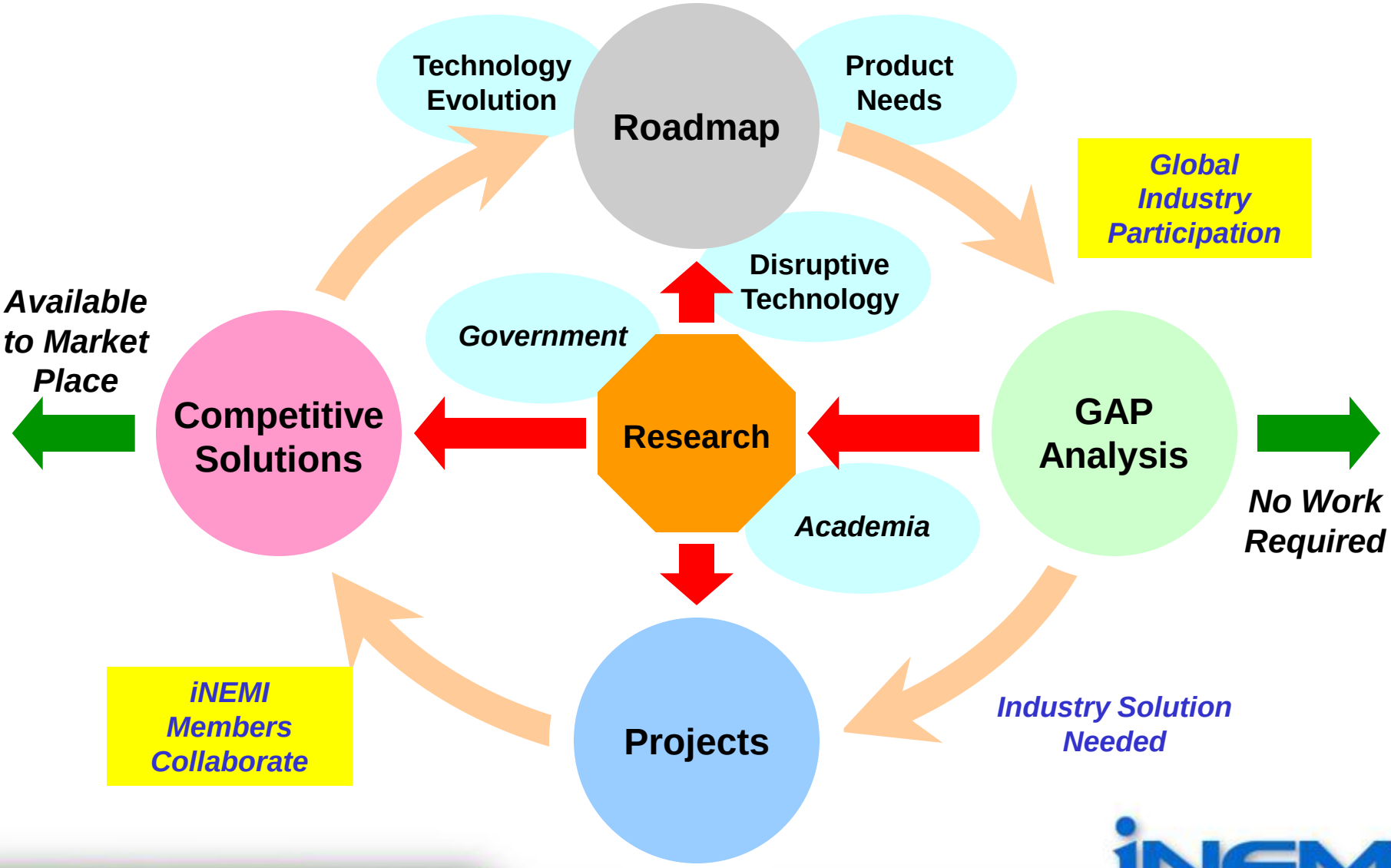
- Being the recognized leader at projecting future technology needs for the global supply chain (iNEMI Technology Roadmap).
- Guiding and leveraging the strength of the consortium's industry leading international membership.
- Driving high impact collaborative R&D Results through constantly improving methodologies.
- Defining and implementing science based sustainable solutions in high impact areas including the environment and health care.
- Influencing and leveraging key government agencies and labs (iNEMI Research Priorities Document).

- iNEMI has currently 23 collaborative R&D projects and initiatives that address key technology gaps
- Projects typically have 10-20 member companies/institutions

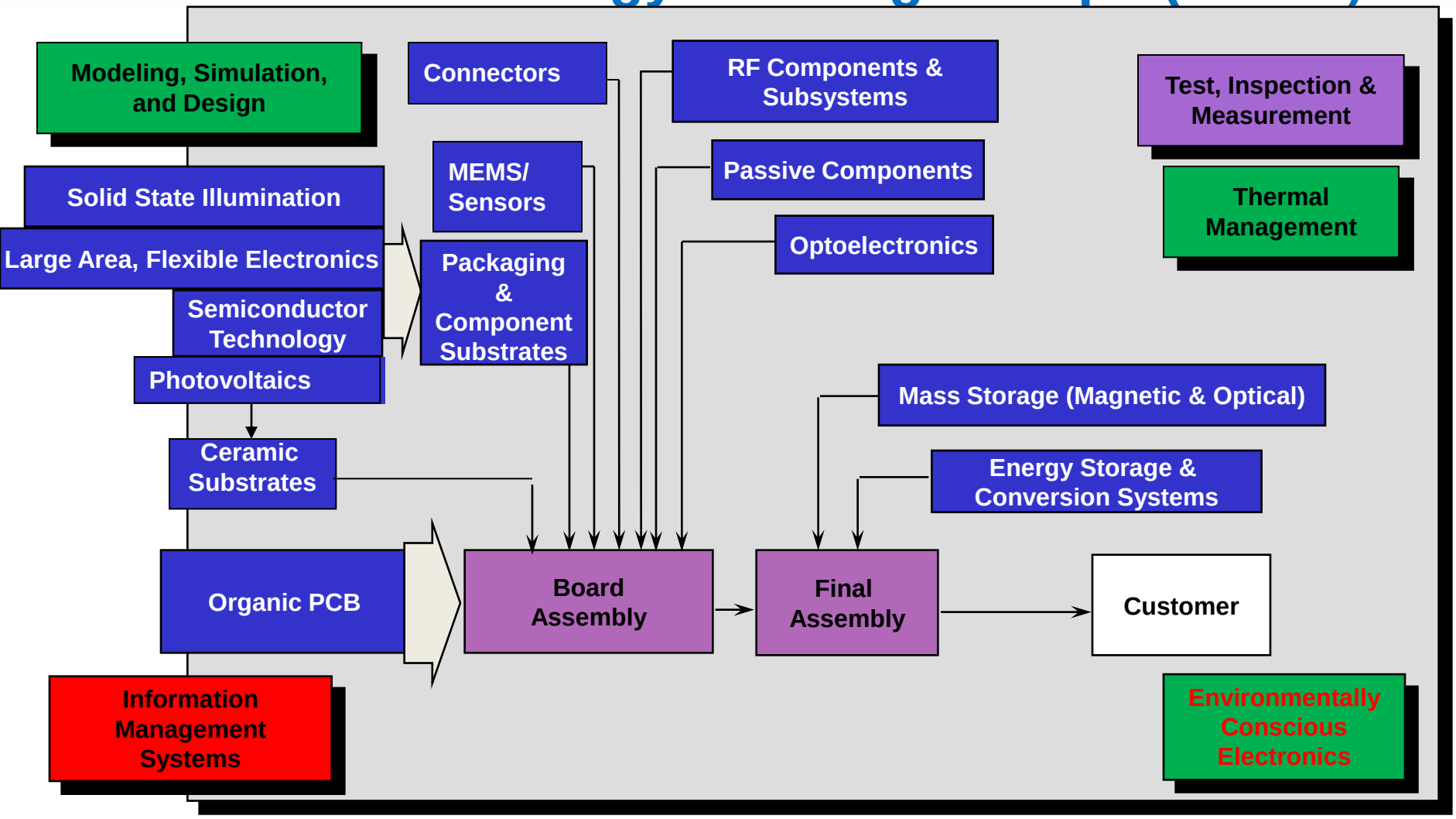
The 2013 iNEMI Roadmap; Process and Scope



Methodology



2011 Technology Working Groups (TWGs)

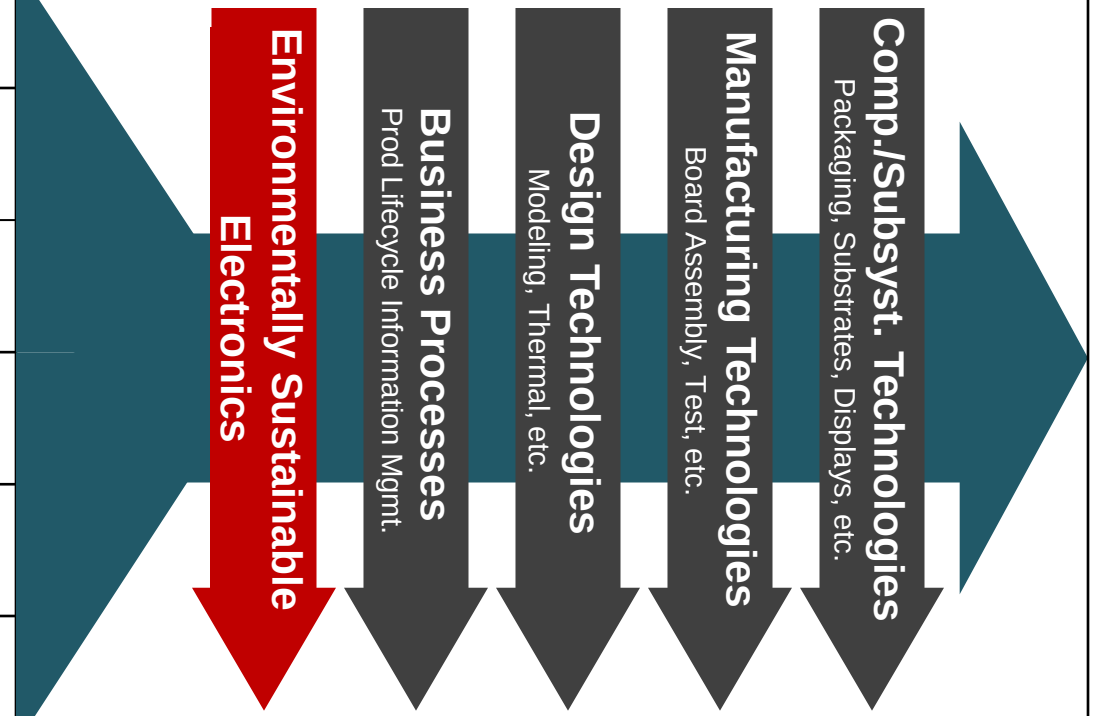


Red=Business Green=Engineering Purple=Manufacturing Blue=Component & Subsystem

Roadmap Development

Product Sector Needs vs. Technology Evolution

Product Emulator Groups	TWGs
Portable / Consumer	
Office / Large Systems	
Highend (e.g. netcom, server)	
Automotive	
Medical Products	
Defense and Aerospace	



Statistics for the 2013 Roadmap

- **> 650 participants -- Big Thanks to All Contributors!!**
- **> 350 companies/organizations**
- **18 countries from 4 continents**
- **20 Technology Working Groups (TWGs)**
- **6 Product Emulator Groups (PEGs)**
- **> 1900 pages of information**
- **Roadmaps the needs for 2013-2023**
- **Workshops held in Europe (Berlin, Germany), Asia (Hong Kong) North America (ECTC, San Diego, CA) in May 2012**
- **A Full Global Perspective**

- **Available to iNEMI members on 12/28/12 at: www.inemi.org**
- **Available to industry beginning April 4, 2013 at www.inemi.org**

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iNEMI Product Sector Forecast Growth

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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%

Note: Total includes product categories not included in iNemi segmentation

Courtesy PrismarK Partners LLC

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High Level Key Messages

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Electronics Business Situation Analysis

- **Convergence**
  - Medical-Consumer
  - Automotive-Entertainment
  - Communication-Entertainment
    - Telecom-Datacom
- **Miniaturization and Thinner; Speed of Change Escalating**
- **Quality, reliability, cost still paramount**
- **Counterfeit Products a growing issue**
- **Infrastructure (Business Model) changes:**
  - Growth of “The Cloud”
  - Fabless Semiconductor Fabrication
  - EMS and ODM roles grow; R&D Challenges
- **Rare Earth and Conflict Materials**
- **Carbon foot print & Material Data Reporting Requirements**
- **Energy Storage & Usage Growing in Importance**
  - Rapid spread of Consumer electronics
  - Solid State Lighting
  - Electric and Hydrogen Vehicles
  - Opportunities for smart grid

Situation Analysis: Technology

- **Consumers' demand for thin multifunctional products has led to increased pressure on alternative high density packaging technologies.**
  - 3D IC with TSV
  - SiP still key
    - Technology driver for small components, packaging, assembly processes and for high density substrates
  - Sensors and MEMs:
    - Exponential volume growth driven by portable products
    - Motion gesture sensors expanding use of 2D-axis & 3D-axis gyroscopes
    - Segment maturing, encouraging industry collaboration
- **Semiconductor Scaling Limit Near**
  - Definition of future requirements moving to "More than Moore"
- **Product miniaturization and speed/voltage are challenging the movement to high reliability alternative materials**

Strategic Concerns

- **Restructuring from vertically integrated OEMs to multi-firm supply chains**
  - Resulted in a disparity in R&D Needs vs. available resources
- **Industry collaboration**
  - Gain traction at University R&D centers, Industry consortia, “ad-hoc” cross-company R&D teams
- **The mechanisms for cooperation throughout the supply chain must be strengthened.**
  - Cooperation among OEMs, ODMs, EMS firms and component suppliers is needed to focus on the right technology and to find a way to deploy it in a timely manner
- **Collaboration is iNEMI’ s Strength; We play an important role**

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iNEMI Environmental Focus

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iNEMI Actions in Environmental Area

- **The Environmental Leadership Steering Committee in place to set strategic direction**

Bill Bader – iNEMI – Chair
Marc Benowitz – BOD Member
Jackie Adams
Todd Brady
Mary Liz Burns
Carol Handwerker
Joe Johnson
Nils Nissen
Scott O'Connell
Tom Okrasinski
Patrice Rollet
Tamim Sidiki
Joyce Taylor
Rob Taylor

iNEMI History & Actions in Environmental Area

- **Roadmap of Environmental Conscious Electronics (since 1996)**
- **Established the Environmental Leadership Steering Committee to set strategic direction & priorities:**
  - **Issued iNEMI position papers on Product Carbon Foot printing and Definition of Low Halogen**
  - **Issued white paper on Timeline for Conversion of Notebook and desktops to HFR-Free and PVC free**
  - **Issued White Paper on Environmental Material Data Management & Reporting in Q4 2012**
  - **Issued White Paper on PVC Alternatives in Q4 2012**
- **Leading Projects on**
  - **Characterizing and improving Pb-free reliability - since 2000**
  - **Characterizing PVC alternatives & HFR-free high reliability - since 2009**
  - **Developing LCA tools for ICT products since 2010 – Two active well-led teams**
- **Defining Environmental Research Priorities**
  - **Six environmental research proposals webinars held in 2012; 2 YTD in 2013**
- **Organizing workshops**
  - **Electronics Goes Green 2012**

A Winning Example of Joint iNEMI Research Initiated

NSF Integrated Education and Research Traineeship Program

IGERT: Global Traineeship in Sustainable Electronics

Purdue University and Tuskegee University in close collaboration with Global Electronics Industry - iNEMI plus 5 members - and
International Academic Partners - Fraunhofer IZM - Berlin, Shanghai Jiao Tong University, Tsinghua University – Beijing, Indian Institute of Management – Udaipur, Universidad EAFIT – Medellin Columbia

Vision

Create a new integrative, collaborative model for graduate research and education needed to enable *meaningful and measurable improvements in the global sustainability of electronics*.

Funded by NSF in June 2012
$3.2M for 28 two-year fellowships over 5 years
External Advisory Board and opportunities for collaboration with industry, NGOs, research institutions

NSF Integrated Education and Research Traineeship Program
IGERT: Global Traineeship in Sustainable Electronics

Three Research Thrusts

1. Polymers from Nature for Construction & Disassembly
   - **Natural Nanocomposites for Structural Applications in Casings and Boards**,
   - **Bio-based Lignin and Soy-based Resins for Circuit Board Construction**
   - **Biomimetic Marine-Derived Bioadhesives for Device Construction & Disassembly**
   - **Green Replacements for Brominated Flame Retardants**
2. Sustainable Product Design and Manufacturing
   - **Novel LCA Approach for Electronic Products**
   - **Electronic Product Manufacturing Process Characterization and Improvement**
   - **LCA-based Design of Electronics**
   - **Recycling and Reuse of Electronic Devices**
3. System and Supply Chain Issues
   - **Integrating Sustainability Indicators across the Supply Chain**
   - **Corporate Sustainability Behavior – Stakeholder Perception – Corporate Valuation**
   - **Consumer Behavior**
   - **System-wide Effects of Laws and Regulations**

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Learning & Result Examples of 2012 Completed Projects

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HFR Free PCB Electrical and Material Performance & Supply Chain Readiness

- **Eighteen company project of key laminators, OEM's, ODM's and Test Service providers**
- **Executed a comprehensive test suite on multiple materials from multiple suppliers, at multiple test facilities**
- **The test suite methodology developed enabled direct comparison of desired laminate properties**
- **Testing results are conclusive that the industry and the laminate providers are ready to make the transition to HFR Free materials for notebook and desktop applications**
- **Full spec sheets developed for usage at outgoing testing at laminate providers**
  - **Commitment received from all suppliers that outgoing laminate materials would be tested to conform with the iNEMI project team specifications**
- **Evaluation of industry capacity performed to ensure volume ramp readiness was in place.**

ECO Impact Evaluator for ICT Equipment

- **Simplified Building Block Tool Developed For Full Life Cycle Analysis of Product Carbon Footprint**
  - **Data bases assembled and tested**
  - **Algorithm's for calculating impact of individual components**
  - **Full Life Cycle tool set for complete ICT boards and systems**
- **Model was tested and verified by multiple iNEMI members on multiple products.**
  - **Within 5% accuracy of complex commercial tools**
- **Discussions underway to put in place a long term sustainable ownership model**

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Environmentally Sustainable Electronics

Chairs:

Jackie Adams, IBM

Stephen Tisdale, Intel

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ESE Table of Contents

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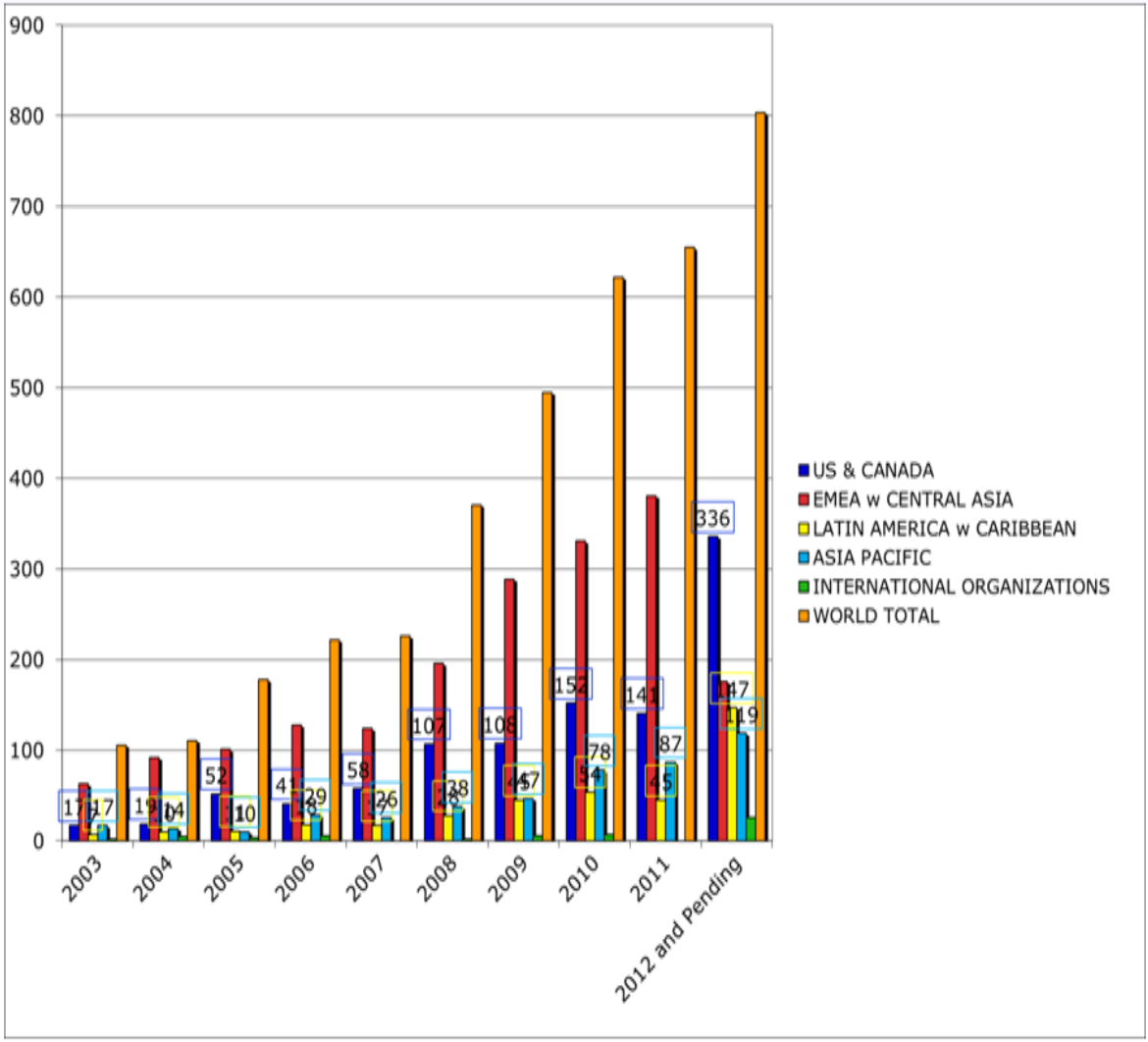
Environmentally Conscious Electronics (ESE) Road Map Overview

- To produce environmentally conscious electronics the ESE TIG must continue to keep pace with:
  - Emerging material restrictions
  - End-of life requirements
  - Energy efficiency requirements
  - Holistic design requirements
  - Sustainable business practices
- To achieve these goals the ESE TIG has been divided into 5 groups:
  - Materials
  - Recycling
  - Energy
  - Design
  - Sustainability

What Has Changed Since 2011?

- **Global environmental regulations and standards continue developing at a rapid pace, particularly Energy & Waste**
- **"Old" major regulations are being revised (EU RoHS, EU WEEE, etc)**
- **Emerging sustainability issues – conflict minerals, rare earth metals, etc**
- **Continued opportunities for industry to develop collaborative solutions to meet future needs and reduce costs/complexity**



Environmentally Conscious Electronics (ESE) Road Map Overview

- Current Projects/Initiatives under or cross cutting to the ESE TIG
  - Projects
    - Pb-Free Rework Optimization
    - High-Reliability RoHS Task Force
    - Component and Board Finish Reliability*
    - Eco-Impact Evaluator Project
    - Rare Earth Metals
  - Initiatives
    - Create a quantifiable set of metrics and potentially a tool for measuring a products true recyclability and reuse. Eco design for recycling/sustainability including toxicity assessment and critical usage/application.
    - Develop a stakeholder aligned methodology/stepwise approach to develop and assess new or alternative materials.
    - Identify and communicate/share best known practices for recycling, for metals recovery, and for resource efficiency at EOL processing.

ESE Summary

- **2013 Key Issues**
  - Growing issues that may impact other Technology Working Groups
    - Rare earth and conflict metals criticality
      - Reporting requirements on Conflict Minerals spelled out in Dodd-Frank Act
      - iNEMI team formed and defining critical actions/priorities on Rare Earth
    - Rapidly expanding list of restricted materials
    - Standards for carbon foot-printing/life cycle analysis data evolving
  - Highlighted issues that are cross cutting in the Roadmap
    - Energy efficiency standards being defined
    - Transition to lead free and low halogen in previously exempt sectors
    - Additional restricted materials
    - Standards for product data management
    - Eco-design standards
    - Automotive growth in electronics per vehicle is rapid.

Summary

- ESE TIG is divided into 5 areas, including Sustainability
- New proposed 2013 ECE gaps identified to-date:
  - Develop methodology for evaluation of alternative materials, emphasis on polymers and plasticizers
  - Technical qualification of HFR-free high-end connectors
  - Commercialization/viability of post-consumer recycled plastics
  - Address emerging materials issues: nanomaterials, rare earth metals
  - Identify water quality/scarcity issues
  - Increase visibility of global product energy efficiency regulations/standards (developed global matrix)
- Full Technical Plan (Gaps 1-5 Years) and Research Priorities (Gaps 5-10 years) to be published in September
- We encourage iNEMI member and non member participation

Concluding Thoughts

- **New global environmental requirements continue to multiply – faster than industry can effectively respond**
  - Opportunities to work alignment need to be captured and driven
- **Industry needs to be more proactive in developing solutions that:**
  - Are based on science and engineering, delivering value to customers
  - Are available in advance of new regulations
  - Can influence future regulations and stakeholder groups for more sustainable results
- **Sustainability will be a major undertaking for industry as well as society**
- **Electronic solutions can help to empower people to live a more sustainable lifestyle**
- **iNEMI and its members are playing a significant role in preparing industry for these future needs**

2013 Roadmap Pricing
(available April 4, 2013)

Full roadmap (USB drive)	$3000*
Single chapter (PDF download)	$ 500

Special pricing for research institutes, universities, gov't agencies & non-profits

Full roadmap	$ 500*
Chapter	$ 100

** + $100 shipping outside North America*

Summary

- **INEMI has a strong history of driving environmental improvements globally**
- **Excellent new projects and focus as we move forward in 2013**

Get Involved!!

Thank You

Merci Gracias Grazie Danke Schon Effaristo
Dank u Obrigado Go raibh Maith agat.....

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