Where Power Electronics make a real difference

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EPSRC Centre for Power Electronics – Annual Conference, 01 July 2014
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Presentation Objectives

- Consider the state of Power Electronics globally and more specifically in the UK
- Review progress against the objectives of the Power Electronics Strategy
- Highlight issues and opportunities

Context – Creating Jobs and GDP for UK plc

2020
100k Jobs £100bn
Power Semiconductor Market

Volume = 7% CAGR + Price

Pessimistic!!!
Power Electronics - A Global Market

- £135 billion direct market with 10% CAGR
- The market is Global and Competitive
- Multi-national companies with Global design and manufacturing locations
- Power electronics is recognised as a strategic asset underpinning multiple industry sectors

“Power Electronics could make everything from cell phones to industrial motors to electric cars, smaller, faster, cheaper. And the country that figures out how to do this first, and companies that figure out how to do this best, are the ones that are going to attract the jobs that come with it.”

Obama
Power Electronics – A UK Strength

- 78,000 engineers directly employed in Power Electronics
- A key Power Electronics Manufacturer
  - >£4bn of Power Electronics product
  - >£40bn of Power Electronics enabled Systems
  - >90% exported
- An international reputation for Design
  - Design for Global manufacture
- A strong SME base
  - Driving Innovation & key component supply
- Established and good routes to market
Power Electronics - A UK Strength

- The UK is competitive, punching above it’s weight” in key **Global** markets *including* in the “systems” area:
  - Aerospace
  - Industrial Drives / Marine Drives / Renewable Energy Converters
  - Automotive
  - HVDC

- The UK is also a major designer and manufacturer of Power Semiconductor devices
Power Electronics is a UK Success Story

World class companies across a number of market sectors

+ Innovative SME’s delivering new approaches and technologies to the market
Power Electronics - An Enabling Technology

Transport

Domestic & Consumer

Industrial

Energy

Commercial
High Power Semiconductor Production

Press Pack Bipolar Discretes

- Power bipolar devices to 11,000A & 8,500V
- Thyristors, GTOs and diodes for high-power applications (>100kW) for electric grid, rail transport, marine drives, industrial drives and PSU
- 4”, 5” and 6” wafers
- Capacity 100,000 wafers 4” equivalent per annum
- Main production 2.2kV – 8.5kV 500A-5000A

IGBT & FRD

- Power IGBT and diode modules to 3,600A & 6,500V
- Specialising in the high voltage power market: e.g. industrial drives, renewable energy, marine drives, aircraft, electric vehicle and rail transport. & next generation T&D
- 6” wafers
- 50,000 6” IGBT wafers per annum capacity meets demand for 100k high power modules
- Main production > 3.3kV 150A – 1500A

Copyright : 2014 Dynex Semiconductor Ltd
Low Power Semiconductor Devices

Manufacturer A:
- 12 million die per week in the UK

Manufacturer B:

Manufacturer C:

Manufacturer D:
Power Electronics is a UK Success Story

Internationally recognised universities educating the next generations of power electronic engineers and expanding the knowledge base through research

University of Bristol
University of Nottingham
Newcastle University
University of Cambridge
Manchester 1824
Cranfield University
University of Sheffield
The University of Warwick
University of Liverpool
University of Glasgow
Imperial College London
The University of Edinburgh
The Future for Power Electronics is VERY Bright
Conventional Aircraft Technologies

Total Electrical Rating ~175kVA
More Electric Aircraft Concept

Total Electrical Rating ~1.4MVA
Energy
(Transmission & Distribution)
DECCs UK Energy Flow Chart 2011

- Gas
- Electricity – 18% final consumption
- Petroleum
R & D Spend on Energy in UK

- Cross-cutting
- Power and storage
- Hydrogen and fuel cells
- Nuclear
- Renewable energy
- Fossil fuels
- Energy efficiency
A mature sector with a weak innovation culture (and capability)

The lights really could go out!!
- North of Scotland grid collapsed in April
- System capacity is severely limited
- Renewables causing severe system problems
  - Protection and distribution capacity
- EV loading
  - Disaster waiting to happen..........
Renewables

<table>
<thead>
<tr>
<th>Renewable electricity in planning</th>
<th>MW Capacity</th>
<th>% Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating</td>
<td>14,396</td>
<td>28%</td>
</tr>
<tr>
<td>Under construction</td>
<td>3,755</td>
<td>7%</td>
</tr>
<tr>
<td>Awaiting construction</td>
<td>13,969</td>
<td>27%</td>
</tr>
<tr>
<td>Submitted</td>
<td>20,229</td>
<td>39%</td>
</tr>
<tr>
<td>Total</td>
<td>52,349</td>
<td></td>
</tr>
</tbody>
</table>

Source: REStats from DECC. Note excludes FITs projects which do not require planning consent, approx another 1600 MW

- Distribution system can’t cope – protection & location
- Intermittent supply brings ENERGY STORAGE into focus
Energy Storage: “Holy Grail” for Electric Power

Grid Storage Market only

$10.4 B

$200 M

2012

2017

Energy Storage Market

$220 billion by 2021

Rechargeable Batteries will dominate (98%) the energy Storage market and Lithium is the fastest growing segment

PikeResearch

A PART OF NAVIGANT

Alliance Bernstein

luxresearch

electrovaya
Automotive
Hugh Opportunities but can UK plc deliver?
“The Power Electronics Community lacks cohesion and representation”
6 Strands of Activity
(mapping to BISS report Challenges)

1. Skills
2. Build the Community
3. Supporting Academia
4. Market-driven Innovation
5. Investment
6. International investment
Position Papers

(Strategy & Tactics)

维持和激发英国的电力电子制造

电力电子UK认识到电力电子在英国的重要性，并致力于提升英国在电力电子领域的地位。我们专注于以下方面：

1. **维持和增强英国的电力电子制造能力**
   - **目的**：创建机会和知识共享平台，吸引和保留制造业精英。
   - **方法**：与大学、EESD和研究机构合作，提供实习机会。
   - **重要性**：电力电子在可持续能源和可再生能源技术中发挥关键作用。

2. **工业投资**
   - **目标**：吸引重大投资，促进创新和就业。
   - **方法**：举办技术研讨会和论坛，吸引投资者。

3. **建立电力电子社区**
   - **目的**：创建一个强大的、包容的电力电子社区。
   - **方法**：举办年度会议和网络活动。

**背景**
电力电子在可持续和可再生能源领域扮演着重要角色。提高英国在这些领域的竞争力是关键。我们需要投资于技术和人才开发。

**目标**
- **提高**：通过创新和合作，提升英国在电力电子领域的地位。
- **发展**：建立一个强大、包容的电力电子社区。

**方法**
- **合作**：与政府、研究机构和行业组织建立合作伙伴关系。
- **培训**：提供培训和教育机会，吸引新人才。

**案例研究**
- **EESD**
  - 电力电子教育和技能发展组织。

**联系方式**
- EESD办公室：01234 567890
- 邮件：info@eesd.org

**支持**
- **投资**：政府和企业需增加对电力电子研发的投资。
- **教育**：加强电力电子在教育中的地位。

**合作伙伴**
- **大学**
  - 提供研究和教学支持。
- **行业**
  - 提供实际应用和市场机会。

**结论**
通过上述努力，我们相信英国电力电子行业将实现可持续发展。

**日期**：2023/04/23

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To ensure a good supply of talented Power Electronics engineers

Is there a problem?
UK Students accepting UK Degree Places

- 41%

12.9% fewer 15-19 year olds in 2018 than there were in 2008
Accepted Students onto UK Degree Courses

- Mechanical
- Electrical & Electronic
- Civil
Accepted Students onto UK Degree Courses – “English, UK domiciled”

Power Electronics needs 1800 graduates / year by 2020
To ensure a good supply of talented Power Electronics engineers

1. Quantified the skills gap (mix ongoing)

2. Assist in unifying “schools” actions
   - BIS-EngUK, RAEng, IET, IMechE. “Tomorrow’s Engineer”
   - Support Alternative routes to Professional Registration

3. Universities
   - Support UG Programmes
     • Curriculum Support
     • Sponsorship incl E3 Academy & UKESF
   - EPSRC Power Electronics Ctr + Doctoral Funding

4. Support CPD & networking activities
   - IET PEMD Community ++++++ (to embrace all supplier activities (NMI, KTN, IEEE, Mag Soc…….)
Building The Community

Identify Community Benefits
- Sector networks
- Sector finance initiatives
- Representation to Gov
- Access to Finance & Funding
- .......

Attract Stakeholders
- Gov, NGO, TA, Regional
- By Sector
  - Automotive
  - Aerospace
  - Energy/Renewables
  - Transport (Rail & Marine)
  - Built Environment
  - .........

Events & Representation
- PowerelectronicUK branded
- Sectoral Specific
  - IET PEMD (Community
  - ......

Energise Community
- Marketing Materials
- News channels
- Events
- .........
International Investment

1. Prepare a power electronics sector promotional data pack / e-brochure, for inward investment / UK promotion investment

2. Work with UKTI to seek out suitable overseas promotion opportunities

3. Attracting new skills - Improve the visa opportunities for overseas students to study and undertake post study work
An Observation
Power Electronics

- It is a Cross Sector enabling technology, critical to efficient electrical energy conversion and regulation

- It is a fragmented community and so the breadth of its impact on UK plc, future opportunities and the problems it faces are hidden
Silo’s limit innovation

- Cross Sector Visibility has decreased – Specialist Conferences, Journals & Forums restrict view
- Power Electronics is “mature” - High Reliability has been achieved in many very demanding applications yet is seen as “high risk” in others
- Systems issues (eg EMC) can vary between sectors but the Physics can’t!
- Vocabulary can be an issue

(Company – Company partnerships w/o university link unusual)
To finish on some positive news
Since publishing the Power Electronics Strategy - Oct 2011

- The community has focus and direction
- EPSRC committed £44M incl establishing National Power Electronics Centre
- TSB committed £19M
- Power Electronics Capability Directory
- Technology Roadmaps developed
- Moved to co-ordinate Skills activities
- Some SME Supply Chain Issues being worked on
- IET PEMD Community in formation
- The needs and opportunities of Power Electronics are being voiced and heard
Thank you for your attention