The Graphene Council

Research, Development, Application

2016 Global Graphene Survey Results

What is the current and future state of the graphene industry?

Presented by:

Terrance Barkan CAE, Executive Director

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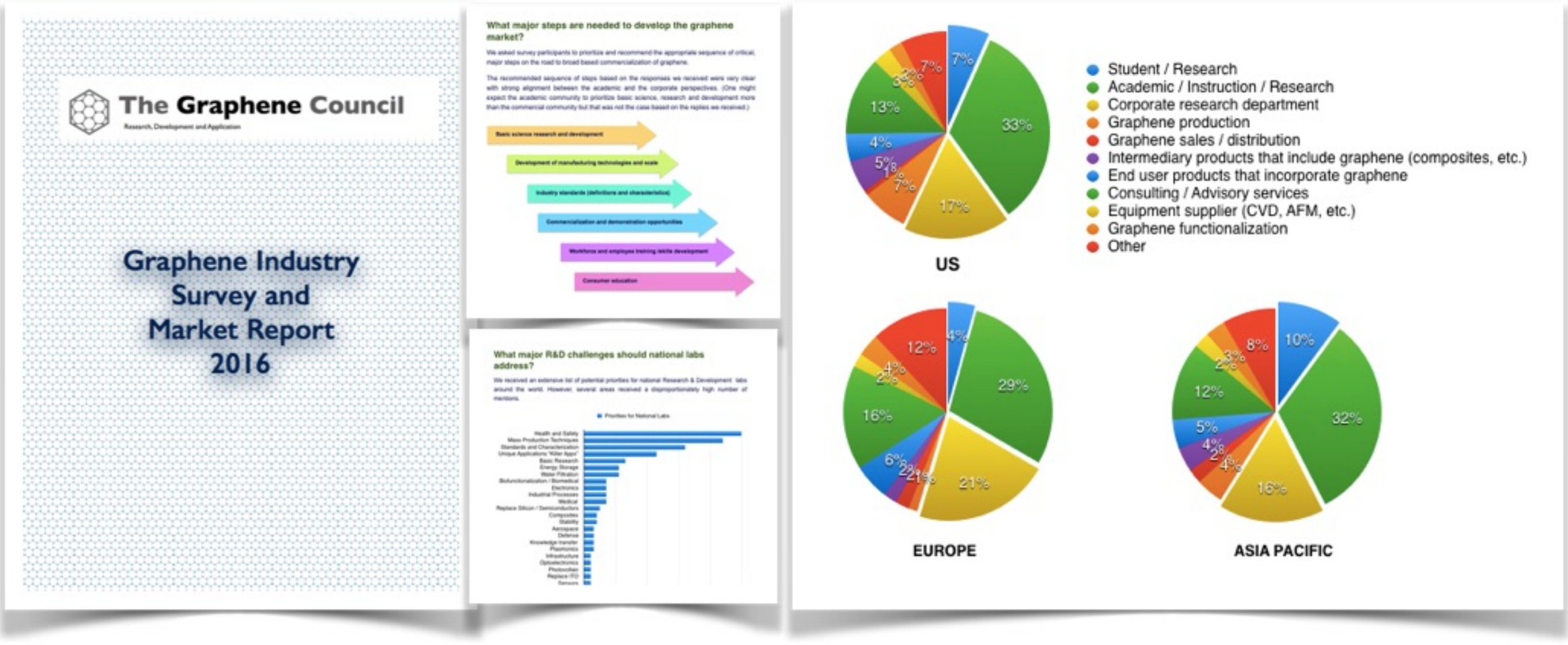
2016 Global Graphene Survey



bit.ly/2016GrapheneReport

Bulk Graphene Market Report - Survey Results

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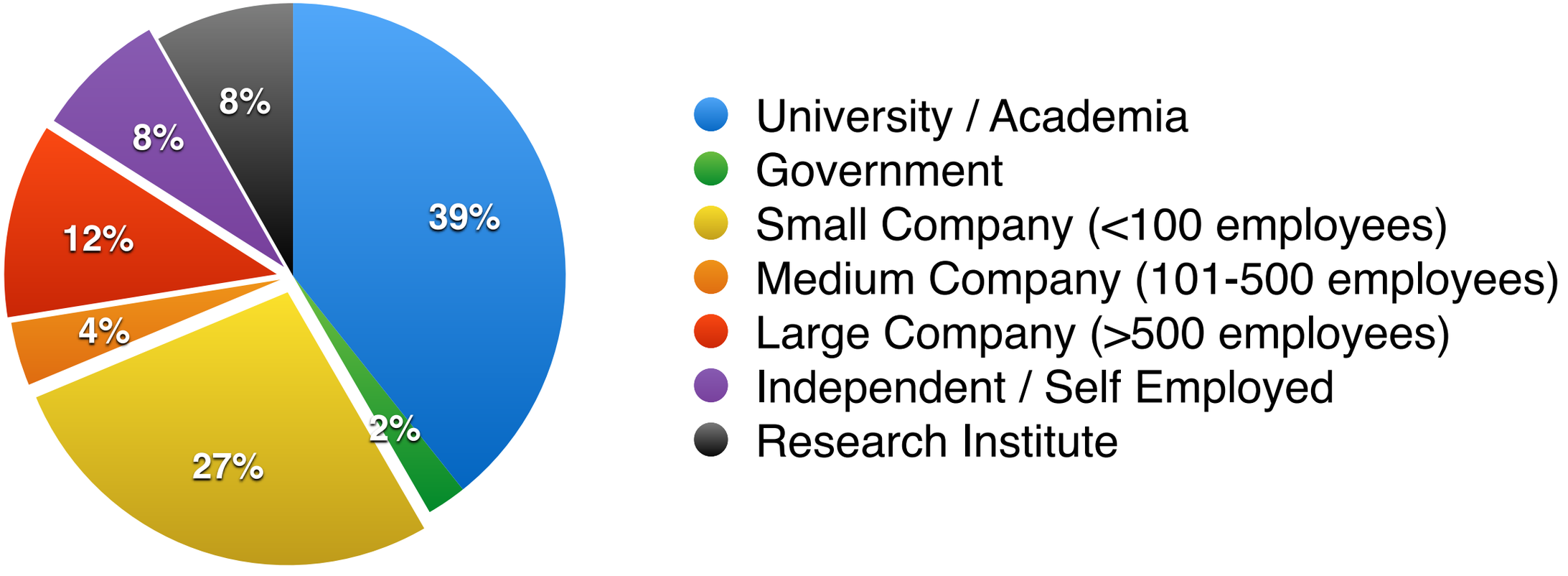
2016 Global Graphene Industry Survey and Report

More than 440 replies from graphene experts and stakeholders in 57 countries, the results analyzed and distilled into a compact 35 page report.

We asked the people that know and understand graphene the most; scientists, researchers, producers, academics, distributers and end-users



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The Market for Graphene

- Main challenges include the absence of any standards.
- Producers are calling material that contains many different forms of carbon “graphene”.
- Confusion in the nomenclature even for materials that is of same or similar characteristics
- Inconsistency in the production of materials
- Lack of a standard to assure buyers of quality and performance characteristics

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Which industries will graphene change?

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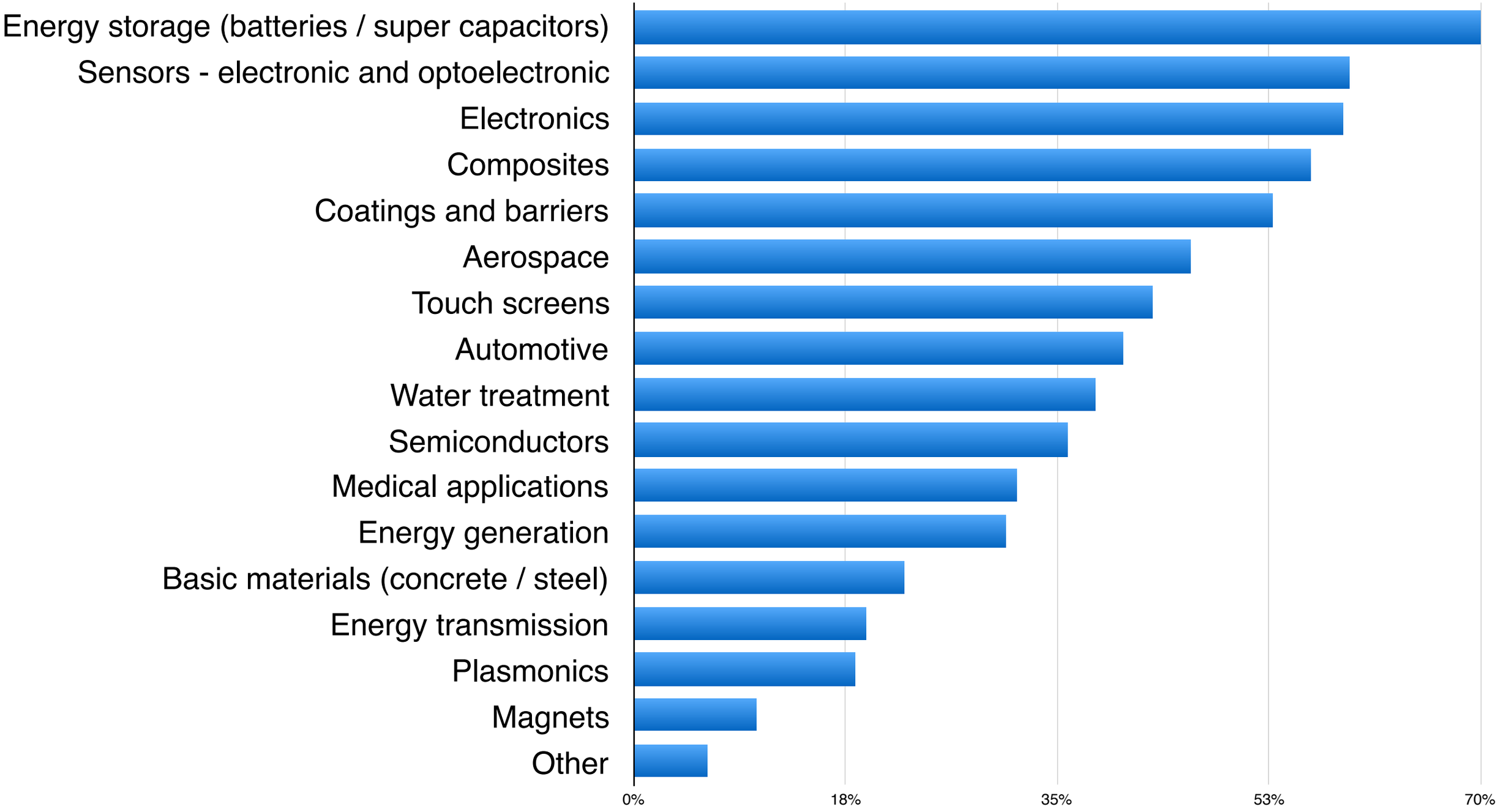
Which Industries will Graphene Change?



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When will graphene become a sustainable, commercial market?

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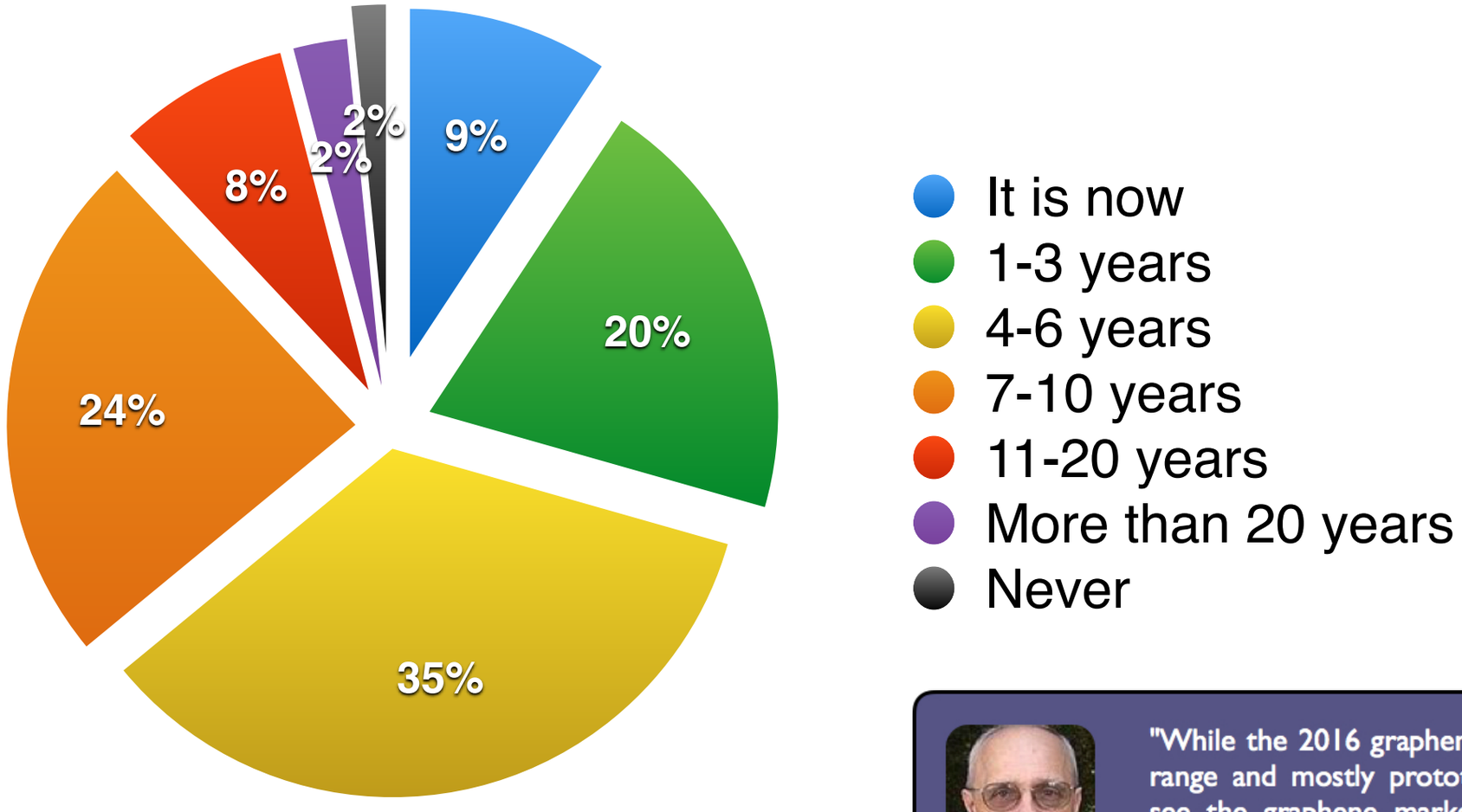
When will graphene will be a sustainable commercial market?



Bo Varga
Managing Director
Silicon Valley
Nano Ventures

"While the 2016 graphene market is in the ten to twenty million range and mostly prototyping and lab research applications, we see the graphene market becoming significant (to the level of several hundred million dollars per year) within the next 4-6 years.

In our experience, the transition from lab results to early revenue is the most difficult stage to achieve and to fund. Most private funding is either inadequate (seed) or focused on later stage (with proven recurring revenue) where either customers or markets enable a reasonable projection of future prospects."

What are the major barriers?

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What are the major barriers to market development?

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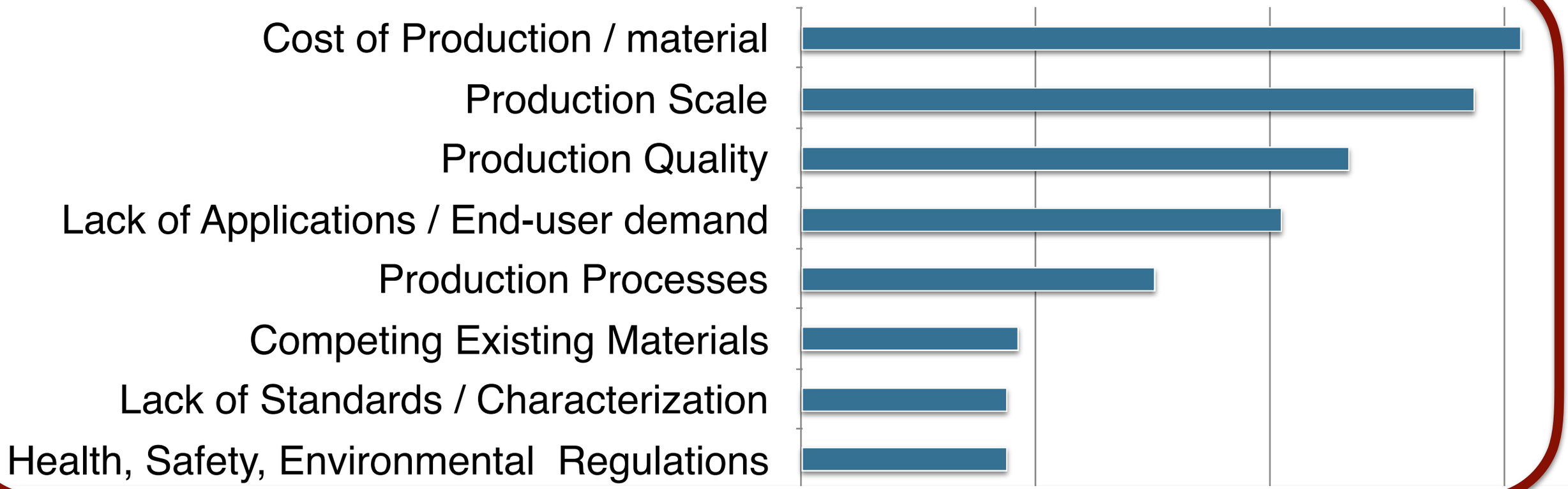
What are the major barriers to market development?



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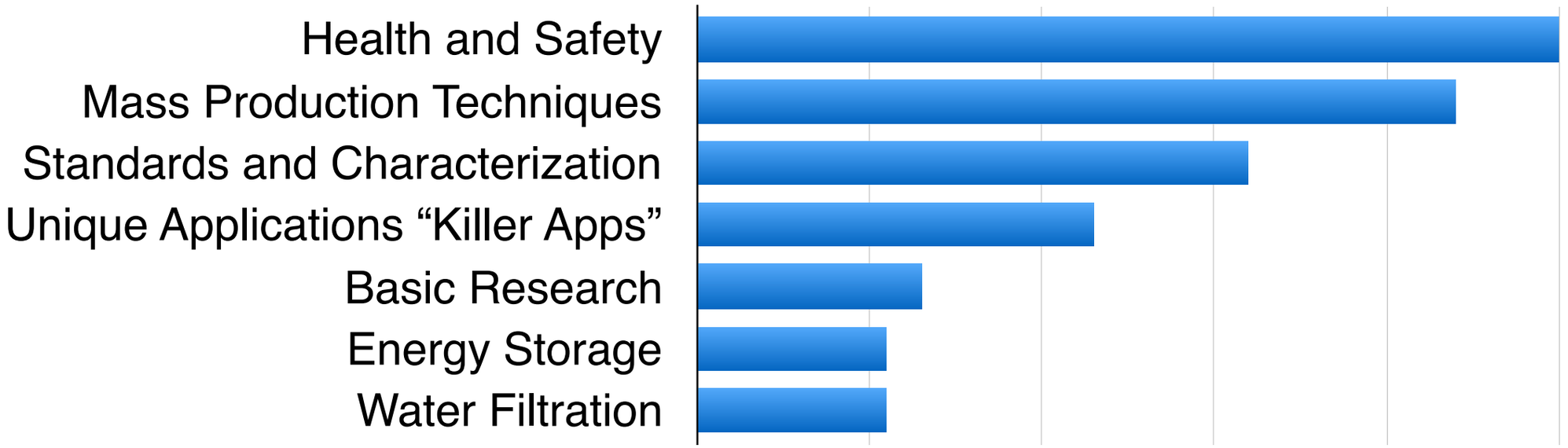
Priorities for National Labs



Angela Hight Walker
Senior Scientist
NIST

“We are certain that the development, validation and adoption of characterization protocols will lead to consensus-based international documentary standards for graphene including nomenclature and measurement as well as realistic and uniform product specifications between buyer and seller for graphene-based products.”

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Standards Developments

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Multiple bodies are working on standards for graphene

GRAPHENE FLAGSHIP

ISO International Organization for Standardization

cen EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

IEC INTERNATIONAL ELECTROTECHNICAL COMMISSION

NPL National Physical Laboratory

ANSI American National Standards Institute

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Current work in progress

Nanotechnologies — Vocabulary — Part 13:
Graphene and related two-dimensional (2D) materials

Symbols and abbreviated terms

1L	monolayer/single-layer
1LG	monolayer/single-layer graphene
2D	two-dimensional
2L	bilayer
2LG	bilayer graphene
3L	trilayer
3LG	trilayer graphene
CVD	chemical vapour deposition
FL	few-layer
FLG	few-layer graphene
GNP	graphene nanoplatelets
hBN	hexagonal boron nitride

When does “graphene” stop being “graphene”?

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Terms related to the materials
3.1 General terms associated with 2D materials

2D heterostructure	3.3.1
2D in-plane heterostructure	3.3.3
2D vertical heterostructure	3.3.2
AB stacking	6.1.10
ABC stacking	6.1.11
alcohol precursor growth	4.1.8
angle resolved photoemission spectroscopy	5.3.5
anodic bonding	4.1.10
anomalous quantum Hall effect	6.3.2
atomic force microscopy	5.1.2
atomic layer deposition	4.1.19
Auger electron spectroscopy	5.2.1
Bernal stacking	6.1.10
bilayer graphene	3.2.6
bottom-up precursor growth	4.2.4
buffer layer	6.1.16
carbon nanotube unzipping	4.2.1
chemical doping	6.2.4
chemical synthesis	4.1.7
chemical vapour deposition	4.1.1
defect	6.1.1
dislocation defect	6.1.9
domain size	6.1.14
doping	6.2.3
electrochemical doping	6.2.5
electrochemical exfoliation	4.1.14
electron beam lithographic patterning	4.2.5
electron energy loss spectroscopy	5.2.3

Need for consistent definitions to instill transparency and confidence in the marketplace

Conclusions

Conclusions

- Rapid progress is being made on the establishment of a sustainable and viable commercial market for graphene.
- The technical problems identified are fairly well known and are being actively addressed by hundreds of companies, universities and research departments world-wide.

Conclusions

- There is a strong alignment of perceptions of the graphene market (current and projected) between global stakeholders (whether between academic and commercial sectors or between graphene specialists in Europe, the U.S or Asia).

- Real progress is being made regarding the establishments of commercial standards for graphene and closely related materials.

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Questions? Feel free to contact me:

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