

# EUREKA Cluster

## “Graphene & 2D Materials”



**Antonio Correia**  
Phantoms Foundation (Spain)



# EUREKA Cluster

## Graphene and 2D Materials

↳ Emerging / Disruptive Technology

↳ Potential to create a completely new industry

↳ Place Europe at the forefront of a new revolution / economy



**GRAPHEN**   
EUREKA cluster



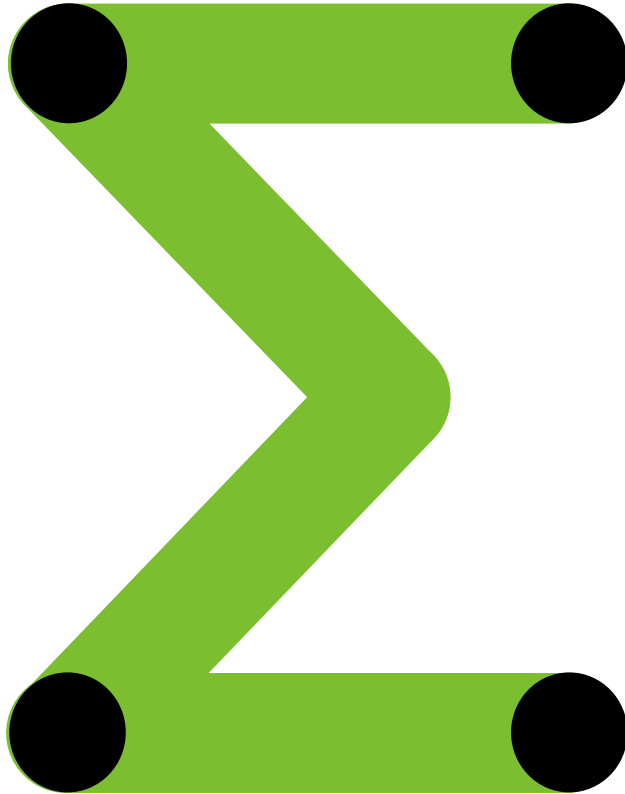


# Content

- EUREKA & Clusters
- Graphene & 2D Materials – Current Scenario
- Implementation Plan
- Expressions of Interest (EoI) (Industry involvement, Strategy, etc.)
- Cluster Form Signatures
- Strategic Research Agenda (SRA)
- Summary

# 1 EUREKA

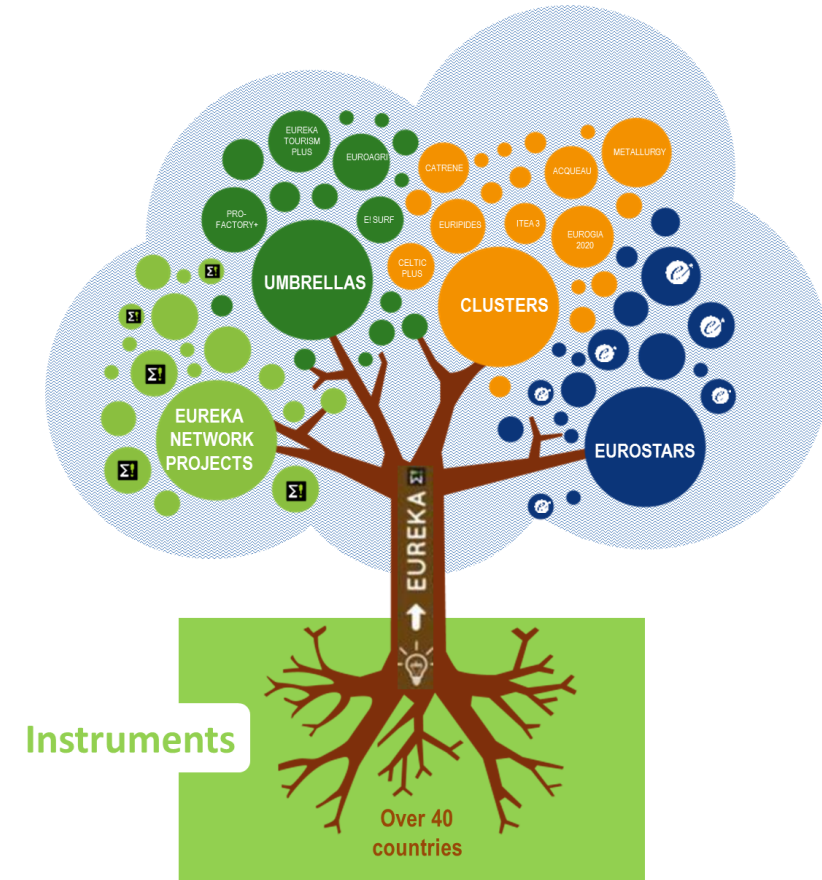
Leading **platform**  
for international  
cooperation



Intergovernmental  
**network**

Supporting  
**market-oriented R&D**  
projects

Facilitating  
**access to finance**



# 1 EUREKA Clusters



## Industry led initiatives

- Medium term
- Strategically significant
- Coordination with National Funding bodies



## Large number of participants

- Major European industries.
- Sector's main actors.
- Large SME participation (30–50%) of partners.
- Research organisations and academia.



## Fostering European competitiveness

- Develop generic technologies and standards
- Address economic and societal challenges.
- The whole value chain.



## Procedures Eureka

- The cluster itself carries out the technical evaluation.
- Decentralised funding (each country).

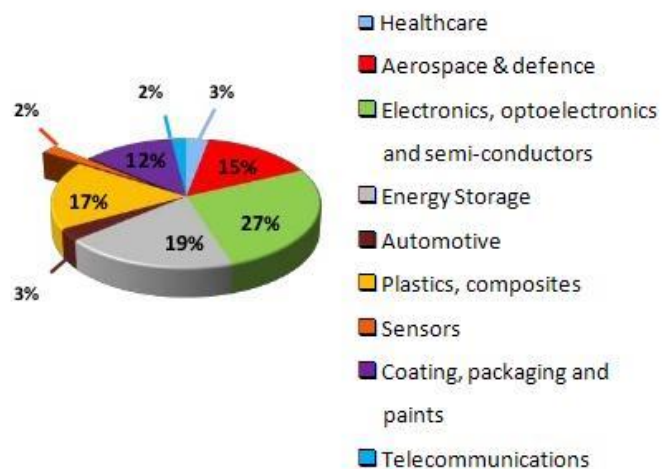
# EUREKA Clusters - advantages

- The cluster itself **decides the strategic agenda** in the international scope of a certain sector.
- It gives to its members a **technological boosting** position in their field.
- It provides **national funding** to the projects.
- It takes advantage of **sinergies between clusters** and other programs.
- It offers a **cooperative ecosystem** to encourage project and business generation.
- It provides an access to technology and markets **beyond Europe**.

# 2 Graphene – current scenario

## GRAPHENE AND OTHER RELATED 2D MATERIALS EXTRAORDINARY PROPERTIES

Electrical and thermal conductivity; strength; biocompatibility; chemical stability; etc.



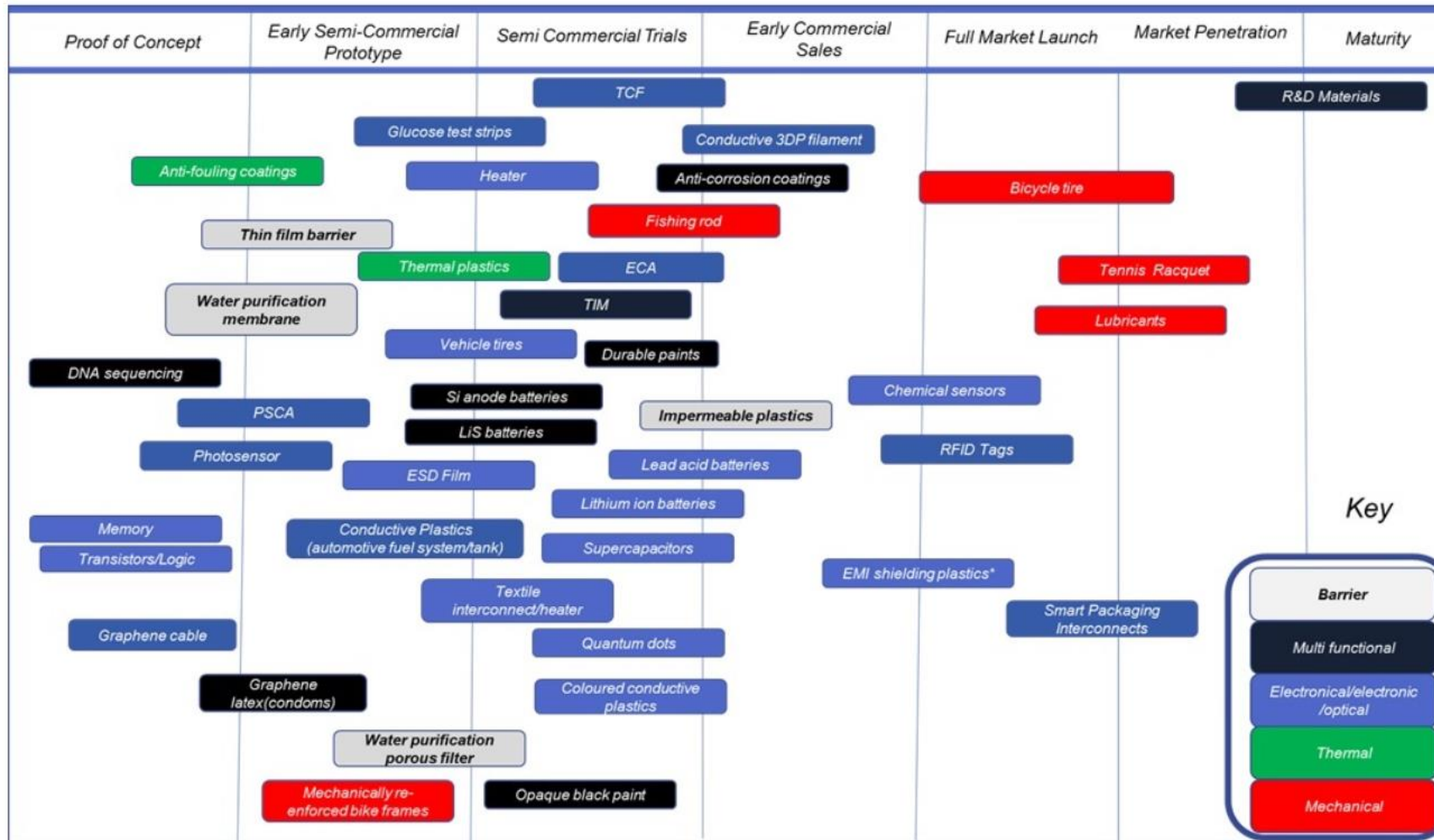
Source: Nanoscale, 2015, 7, 4598-4810



# 2 Graphene – current scenario

## Graphene application pipeline

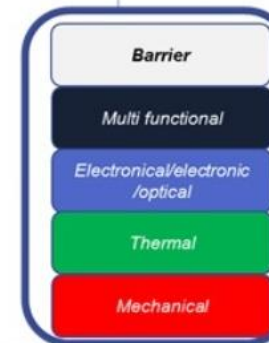
IDTechEx Research



Applications pipeline showing the market readiness of each graphene application

Source: IDTechEx (2017) Report Graphene, 2D Materials and Carbon Nanotubes: Markets, Technologies and Opportunities 2017-2027

Key





# 2 Graphene – current scenario

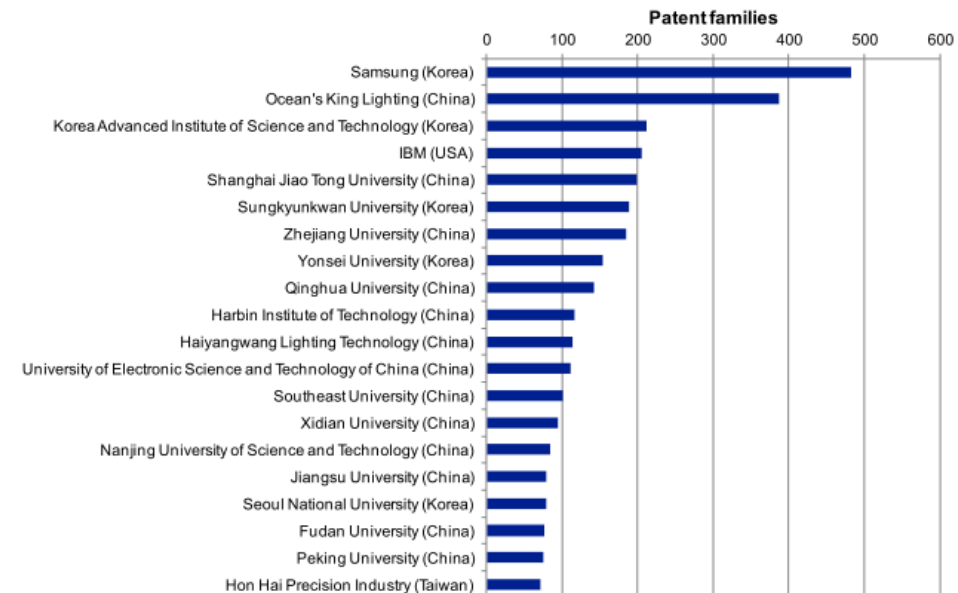
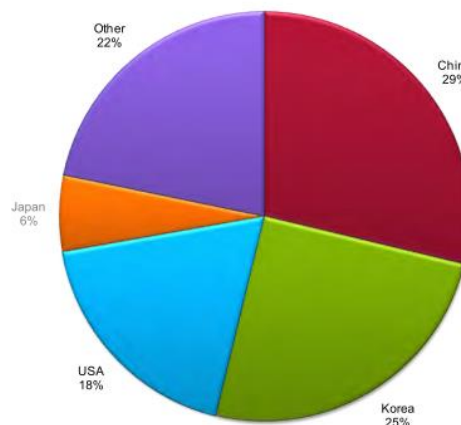
## INDUSTRIAL & TECHNOLOGICAL CHALLENGES

Mass production of high quality graphene

- i. Scaling up
- ii. Industrial applications

## IP SCENARIO

- i. Patenting in graphene has risen rapidly in recent years. Leading of South Korea entities.
- ii. Chinese influence since 2013 has continued to grow



## RESEARCH IN THE EU



**GRAPHENE FLAGSHIP**

Top 5 organisations contributing to the 2D materials patent landscape

Source: Google scholar, Date: 24/03/17

Rank	Top 5 organisations	Country	%
1	Samsung Electronics Co. Ltd	South Korea	4.6%
2	International Business Machines Corporation (IBM)	USA	2.8%
3	Hitachi Chemical Co.	Japan	2%
4	Taiwan Semiconductor Manufacturing Company Ltd	Taiwan	1.8%
5	SJE Steel Corporation	South Korea	1.6%



**Graphene**

The worldwide patent landscape in 2015

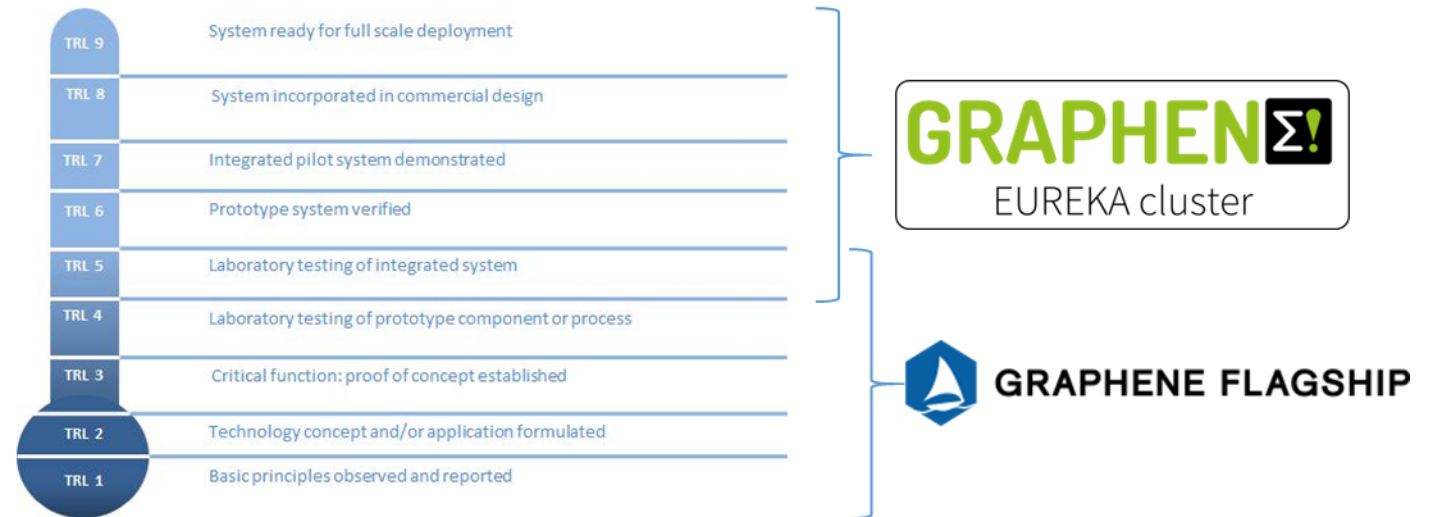


## 2 Graphene – current scenario

### • Graphene – Why?

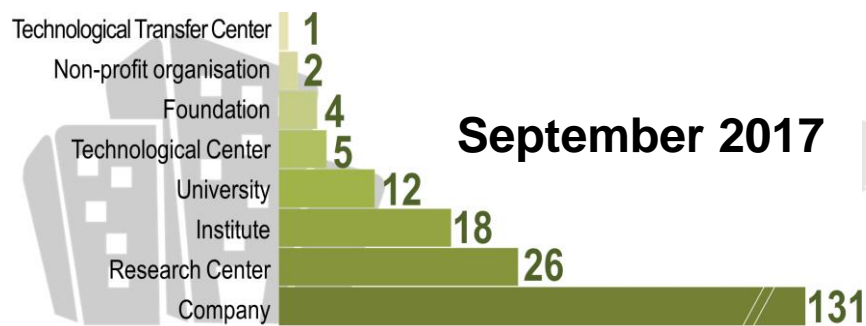
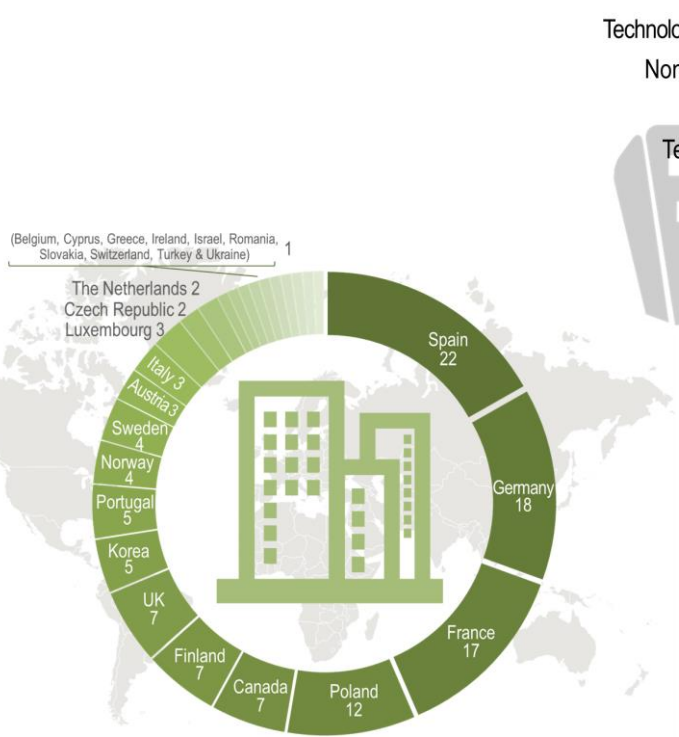
- ✓ To fill the gap between academic research and market.
- ✓ To develop new industrial applications and to boost the existing.
- ✓ To standardize the «big family» of graphene and related materials.

### Technology Readiness Level

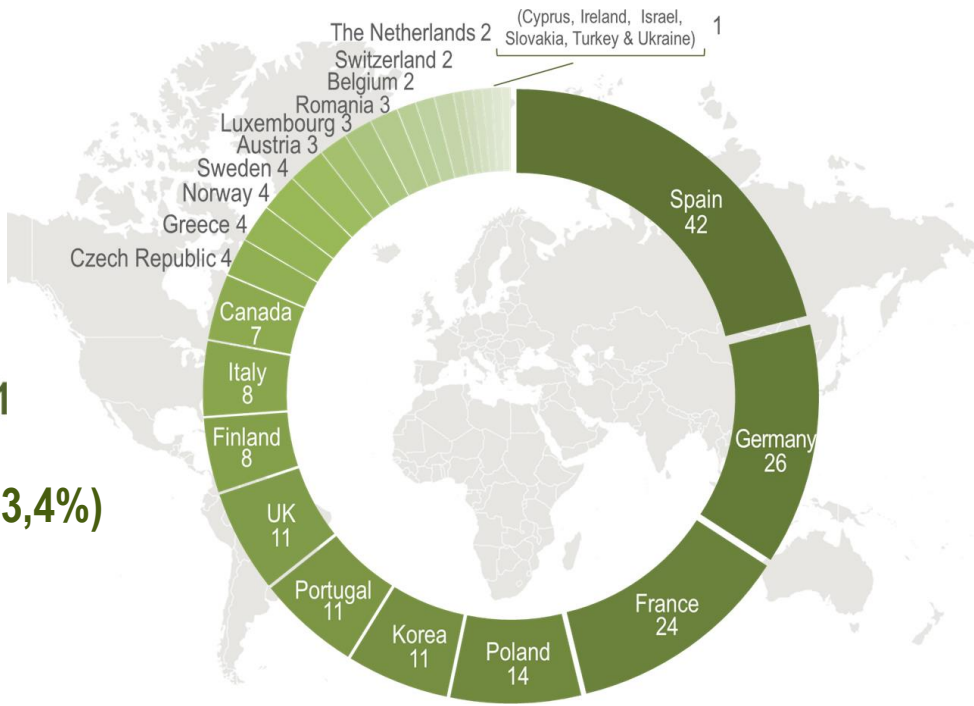
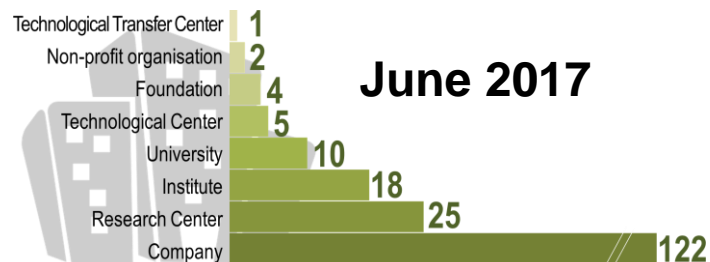


# 4 Expressions of Interest (Eols)

243 Eols received (February 2018)

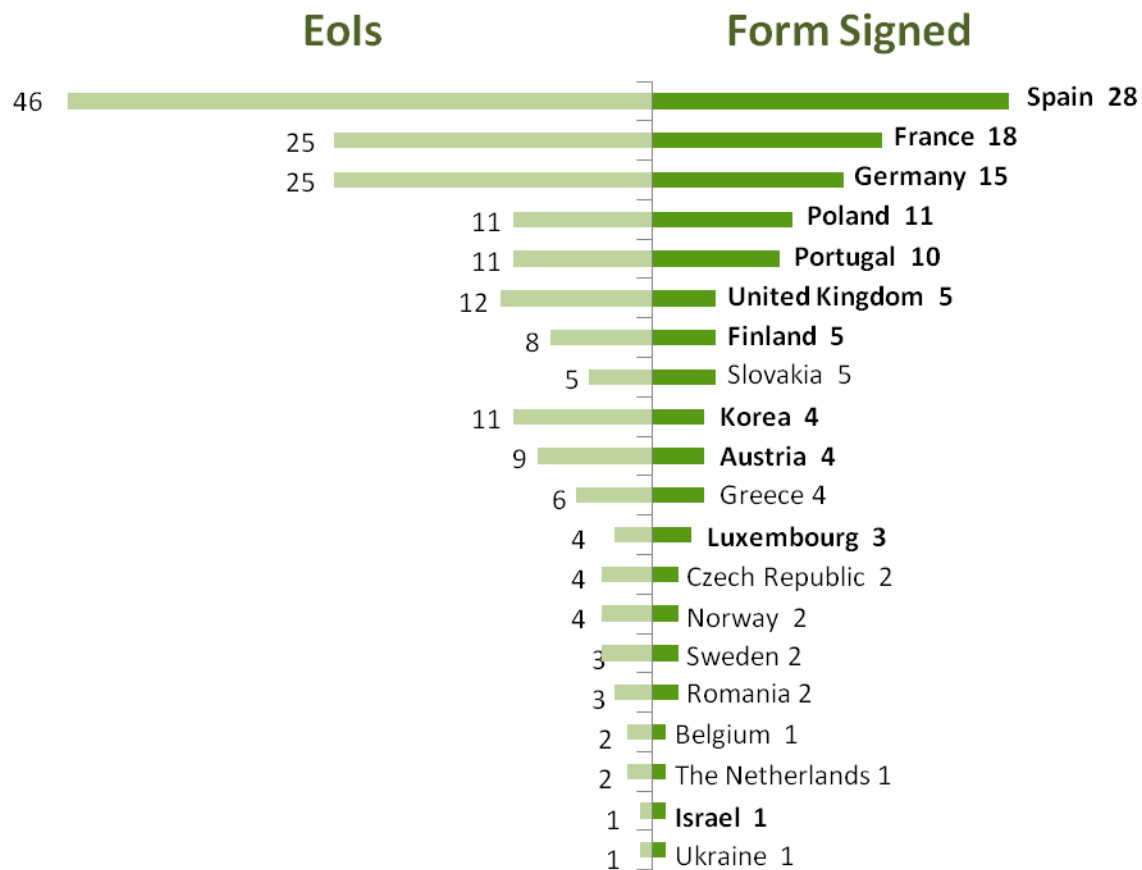


 **154 Companies (63,4%)**



# 3 Application forms signed

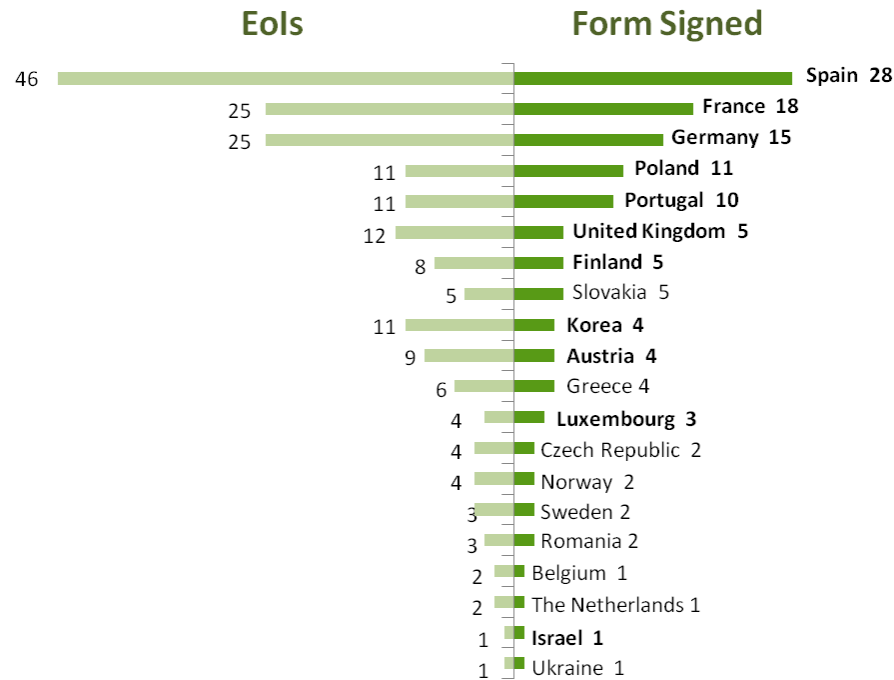
146 signed application forms received (February 2018)



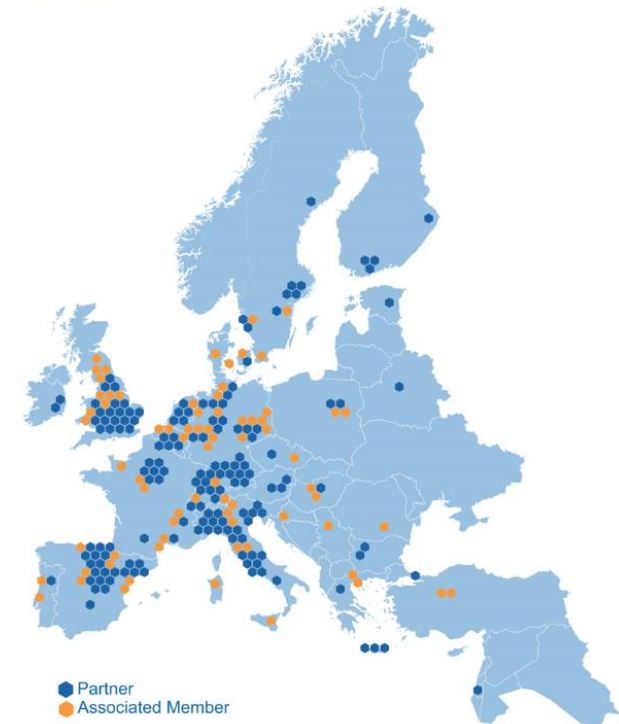
 **89 Companies (60,9 %)**

# 3 Application forms signed

146 signed application forms received (February 2018)



 **89 Companies (60,9 %)**



156 academic & industrial partners (2017)

## 4

# Expressions of Interest (Eols)

## Supporting countries

*Spain / Turkey / Israel / Luxembourg / Korea (Associated) / Chile (Associated)*

## Countries in the pipeline

Strategy defined to finalise the country support (in contact with NPC & HLR)

*Poland / Portugal / France*

Strategy to be defined to finalise the country support (in contact with NPC & HLR)

*Finland / UK / Czech Republic / Germany*

Finland (8)

Name	Type	Contact person
<b>Aalto University</b>	University	Harri Lipsanen
<b>Beneq</b>	Company	Mikko Söderlund
<b>Canatu</b>	Company	Ilkka Varjos
<b>Diac</b>	Company	Sanna Tervakangas
<b>Emberion Oy</b>	Company	Tapani Ryhanen
<b>Picodeon</b>	Company	Jari Liimatainen
<b>Picosun</b>	Company	
<b>VTT</b>	Company	Jouni Ahopelto

Statement drafted by the Finnish institutions sent to Tekes!



# 4 Expressions of Interest (Eols)

## Poland (14)

Name	Type	Contact person
2Dpro Sp. z o.o.	Company	
AGP Sp. z o.o.	Company	
Akademia Kamienia Sp. z o.o. Sp. K.A.	Company	
Golden Stone Sp. z o.o. Sp.K.	Company	
Graphene Solution	Company	
Grupa Azoty	Company	
GUMET Sz. Geneja Sp. j	Company	
Institute of Electronic Materials Technology	Institute	Włodzimierz Strupiński
Instytut Elektrotechniki - Electrotechnical Institute	Institute	Dominika GAWORSKA
ML System	Company	
Nano Carbon Sp. z o.o.	Company	
NanoMTG	Company	
Seco Warwick SA	Company	
Zakład Narzędzi Diamentowych i Spiekanych	Company	

Letters of support requested to companies to be sent to NBCR!

## Portugal (11)

Name	Type	Contact person
C2C-NewCap	Company	André Mão de Ferro
CBIOS	Institute	Pedro Fonte
CICECO	Institute	Andrei Kholkin
GLEXYZ Group	Company	André Godinho Luz
Graphenest - Advanced Nanotechnology	Company	Vitor Abrantes
inanoEnergy	Company	Joao Ventura
INNOVCAT	Company	Cristina Freire
INL	Research Institute	Lars Montelius
Instituto Superior Técnico (IST)	Institute	Eduardo V. Castro
REQUIMTE	Research Institute	Cristina Freire
TEMA	Research Center	Paula Marques

Large companies in the pipeline!

# 4 Expressions of Interest (Eols)

France (24)

Name	Type	Contact person
Annealsys	Company	Jean-Manuel Decams
ArcelorMittal France	Company	Cyrielle Roquelet
ARMOR	Company	Pierre Guichard
C2N - UPSud	University	Giancarlo Faini
Canoe	Technological Center	Patrice Gaillard, Christophe Magro
Carbon Waters	Company	Alban Chesneau
CEA- Nanoscience Transversal Program	Research Center	Jean-Christophe Gabriel
CEA-Leti	Research Center	Etienne Quesnel
Center for Technology Transfers in Ceramics (Limoges)	Technological Transfer Center	Gregory Etchegoyen Malgorzata Piechowiak
Corning Incorporated - Fontainebleau Research Center	Company	Michel Prassas & Robert B. Lee (NY-USA)
CRHEA - CNRS	Research Center	Adrien Michon

Large companies incorporated in August: Thales / ArcelorMittal France

Large companies in the pipeline such as L'Oreal, Total, etc.!

Name	Type	Contact person
Engie CRIGEN	Company	Lauren Baraton / Louis Gorintin
GrapHeat Solutions	Company	V. Bouchiat
Graphene Production	Company	Julien Petrizelli
HORIBA France	Company	Marc Chaigneau
LNE	Company	Felicien Schopfer Pascal Boulanger Martine Mayne
NAWATEchnologies	Company	
NOVASIC	Company	Marcin Zielinski
ONERA	Research Center	Olivier Le Traon
Polymem	Company	Olivier Lorain
RESCOLL - Société de Recherche	Company	Jeremy Di Tomaso
SOITEC	Company	Bruno Ghyselen
STELIA composites	Company	Philippe Joly
THALES R&T	Company	Paolo Bondavalli

# 4 Expressions of Interest (Eols)

## Emerging Technology

### French ecosystem

#### Emerging / Disruptive Technology

- i.SMEs → → → → → → → Innovation
- ii.Large companies → → → → → Market drivers



#### LARGE COMPANIES

ENGIE (Energy)  
HORIBA France (Standardization)  
Corning (Functional coatings)  
ArcelorMittal (Materials)  
THALES R&T (Materials)

#### RESEARCH CENTERS AND UNIVERSITIES

ONERA  
CEA  
CANOE Platform  
CRHEA – CNRS  
C2N - UPSud

#### SMEs

Annealsys (Production)  
Armor (Integration)  
Nawatechnologies (Integration)  
Rescoll (Integration)  
Carbon waters (Production)  
GraphHeat (Production)  
Graphene Production (Production)

LNE (Standardization)  
NovaSiC (Production)  
Polymem SA (Biosensors & Health)  
Stelia composites (Aerospace / Integration)  
Airbus subsidiary  
SOITEC (Integration)



All the value chain represented

France (24)

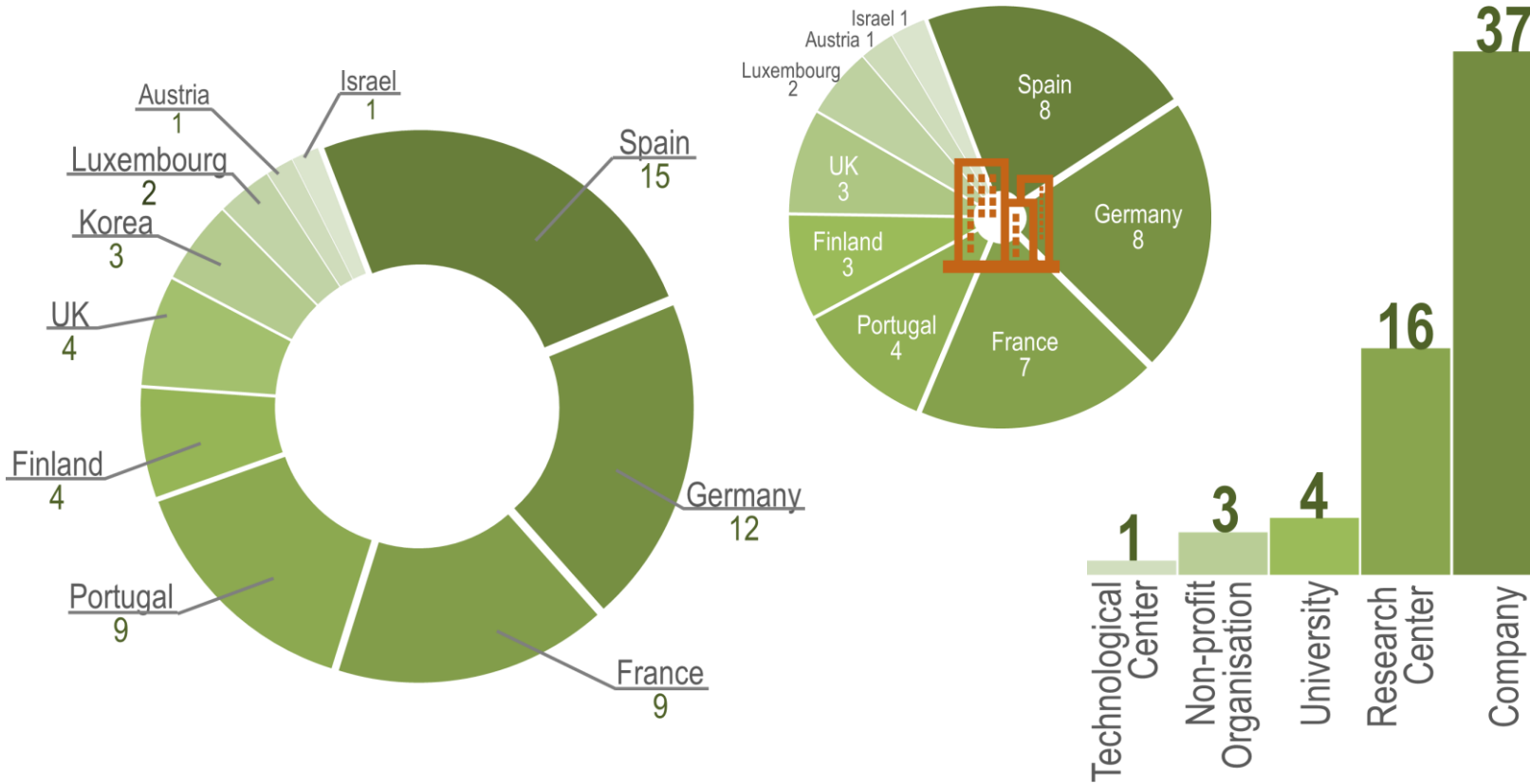
#### EUREKA Cluster

Integration (graphene and 2D ecosystem)



# 5

# Cluster Form Signatures



**Filling in of the yellow boxes is not mandatory when requesting the "Applicant Label". At the end of the definition phase, the yellow boxes must be completed in order to get the Definite EUREKA Label.**

**1. GENERAL INFORMATION**

1.1 Acronym: GRAPHENE

1.2 Title: Graphene & 2D Materials

1.3 Summary: EUREKA Group "Graphene & 2D Materials" is an initiative aimed to shorten the arrival times of graphene-based technological products to society, by creating a network of R&D&I institutions and enterprises and companies which will work in a cooperative and also competitive framework to obtain innovative products, supported by governmental entities of the member countries. All these actions will contribute to increase the EU leadership in the graphene fields as well as to boost the economical growth and jobs creation.

1.4 Main EUREKA Technological Area: Chemistry, Physical and Exact Sciences

1.5 Estimated Budget (Total costs of projects planned) and Duration

	Budget (Mio €)	Duration (months)
Definition Phase (max. 18 months)		
Implementation Phase		
<b>Total</b>	<b>0.00</b>	<b>0</b>

1.6 Start date: \_\_\_\_\_ End date: \_\_\_\_\_

1.7 Main Country

Country	Contribution (%)

Page 1 of 12

146 signed cluster application forms already received & around 16 in the pipeline (162 confirmed ~ 90%)

# 6 Strategic Research Agenda (SRA)

## Contributors – Strategic Research Agenda



Laurent Baraton (ENGIE, France)

Francesco Bonaccorso (IIT / Bedimensional, Italy)

Chester Burt (Grafoid Inc., Canada)

Iñigo Charola (Graphenea, Spain)

Antonio Correia (Phantoms Foundation, Spain) / Coordinator

Norbert Fabricius (KIT / ISC, Germany)

Xinliang Feng (Technical Univ. Dresden, Germany)

Jose Antonio Garrido (ICN2, Spain)

Julio Gomez (Avanzare, Spain)

Denis Guilhot (ICFO, Spain)

Frank Koppens (ICFO, Spain)

Arben Merkoçi (ICN2, Spain)

Stephan Roche (ICN2, Spain)

Włodzimierz Strupiński (ITME, Poland)

+ Etienne Quesnel (CEA, France)  
+ Felicien Schopfer (LNE, France)

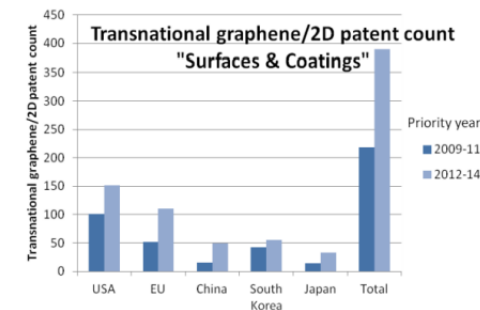


Figure 1: Europe is still a mayor player of innovation in the field of coatings, with a strong and stable market of producers and end users.

### Vision

For many years, industry and the public society have been waiting for a killer application for graphene, but as with previous "hype topics" (like CNTs) it is unlikely to be seen soon, if at all. However, coatings are not only thin film on rigid surfaces and the markets for wearables and light-weight, flexible, stretchable devices and sensors are growing rapidly. The market size for multifunctional smart coatings and surfaces is expected to exceed \$1.4 billion by 2021 and a big chance of growth is especially attributed to coatings that have multi-functionality, e.g. protection and hydrophobicity, conductivity or others. Such multifunctional coatings can also justify a higher investment price for end-users, if the additional investment pays off due to reduced maintenance or operating costs.

The opportunity of diverse markets is at the same time a threat for a new technology like graphene, in particular when the preparation techniques are differing from common technologies or product qualities are differing from batch to batch.

Therefore, next to the development of applications our activities must focus towards the growth of stable supply chains. Graphene has already entered into the market in some small-scale applications and with maturing scalable and stable production, functionalization and processing technologies, it will become more and more of a commodity product or additive in improved products in different sectors.

# 6 Strategic Research Agenda (SRA)

## Roadmap

---

### Priority R&D Areas

- Priority area 1 – Standardization
- Priority area 2 – Production & Scalability
- Priority area 3 – Composites
- Priority area 4 – Energy
- Priority area 5 – Biosensors & Health
- Priority area 6 – Optoelectronic and Electronic Devices
- Priority area 7 – Functional Coatings





# 6 Strategic Research Agenda (SRA)

**91 Extended Eol received / 58 companies (as of September 13, 2017)**

Input for the Strategic Research Agenda (SRA) for a catalogue of possible projects to be funded under the Cluster within its priority areas.

- Short description of the entity
- Main research areas of interest in 2D materials (research, applications, etc.)
- Market needs
- Objectives & challenges of the institution within the cluster

# 6 Strategic Research Agenda (SRA)

## ENGIE

### Short description of the entity

As a major energy player ENGIE develops its businesses (power, natural energy and energy services) around a model based on responsible growth to take up today's major energy and environmental challenges: meeting energy needs, ensuring the security of supply, fighting against climate change and maximizing the use of resources.

ENGIE is the first independent power producer (IPP) in the world with a 115.3 GW of installed power-production capacity containing 16.5% of renewable energy. The group provides individuals, cities and businesses with highly efficient and innovative solutions largely based on its expertise in four sectors: renewable energy, energy efficiency, liquefied natural gas and digital technology. As shown in figure below, the Group is operating business all along the value chain of energy.



Figure 1: Engie businesses across the energy value chain

### Main research areas of interest in 2D materials

As an end-user of technological products in the different businesses it operates, ENGIE has a large range of research interests in 2D materials. To name a few :

- Composite materials
- Catalysis
- Electrochemistry
- Energy storage
- Microelectronics
- Optronics

## Emberion Oy

### Short description of the entity

**Emberion Oy** (ID: 2766503-7) is a small size enterprise (SME) registered under the law of Finland with its 100% owned UK subsidiary Emberion Limited (UK company number: 10255178). Emberion Oy was registered on June 23, 2016. Emberion Limited was registered on June 28, 2016. The company is based on private equity investments.

Emberion is targeting to disrupt the markets of X-ray detectors and night vision imagers with technologies that are superior in performance but also cost efficient to manufacture. Emberion's primary business model is semi-fabrics manufacturing of graphene electronics and photonics. Emberion is working in a customer-driven operational mode.

### Main research areas of interest in 2D materials

Emberion's business idea is to develop and produce graphene photonics and electronics. Emberion's unique, high performance infrared photodetectors and thermal sensors can revolutionise applications in various business verticals, including surveillance, security, automotive, machine vision, process and quality control, spectroscopy and medical imaging.

Emberion's graphene FET technology provides a platform that combines high electron mobility and large area-to-volume ratio for development of high performance transducers. Emberion owns various architectures under development for sensors and photodetectors. The CVD graphene devices can be integrated on a standard CMOS wafer as post-processed components, and the graphene devices can be integrated on a polymer substrate as a part of a flexible device stack. The technology has various applications based on its versatile nature.

### Market needs

The optical measurements and imaging are enablers for several important business and societal trends. The machine vision is one of the key enablers of automated systems based on artificial intelligence and ubiquitous connectivity, the Internet-of-Things. High-performance, affordable sensors covering broad wavelength range are needed. Hyperspectral sensing is bringing different type of analytics from laboratories into hand-held, connected devices.

### Objectives & challenges of your institution within the cluster

Emberion Oy is interested in working together with other leading European companies to create value chains that make European graphene and 2D material manufacturing competitive. It is important to be able to share investments with others to be successful in commercialising graphene and 2D technologies. Concretely, we are interested in research project of high TRL levels to develop high-quality and high-throughput manufacturing solutions for graphene based components.



# 7 WEB Page

www.graphenecluster.com



ABOUT US

COMMUNITY

JOIN US

NEWS

CONTACT



1 ABOUT US



2 GRAPHENE

## GRAPHENE EUREKA CLUSTER

3 CLUSTER  
COMMUNITY



4 JOIN US

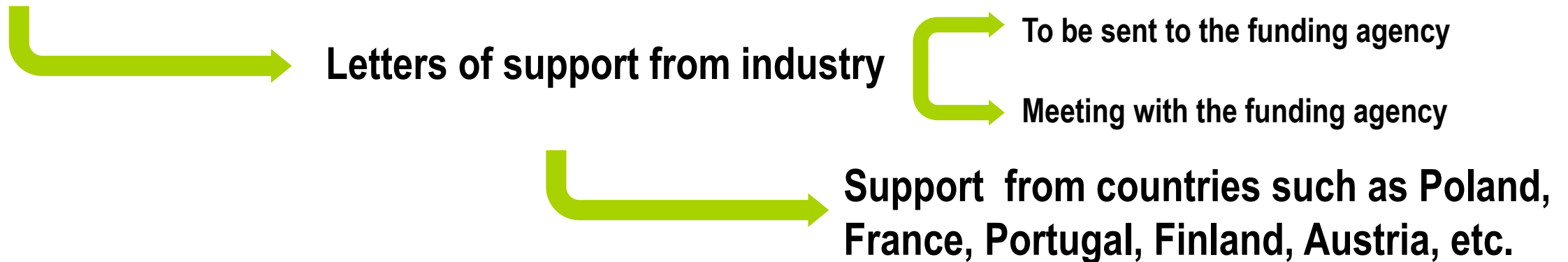


# 8 Summary

- **Strategic Research Agenda in preparation (version 3.0)**

1. Industrial Vision Statement
2. Roadmap

- **Information sent to NEW industrial contacts in order to reach a critical mass of participants in different EUREKA countries interested in supporting the Cluster**



- **Application label submission/request June 2018 in Helsinki (Finland)**

# Thanks for your attention!



**More information:**

[www.graphenecluster.com](http://www.graphenecluster.com)

**Interested in getting more info or joining, please contact:**

[info@graphenecluster.com](mailto:info@graphenecluster.com)

[antonio@phantomsnet.net](mailto:antonio@phantomsnet.net)

