It's the economy stupid!
The Importance of Physics to The Economies of Europe

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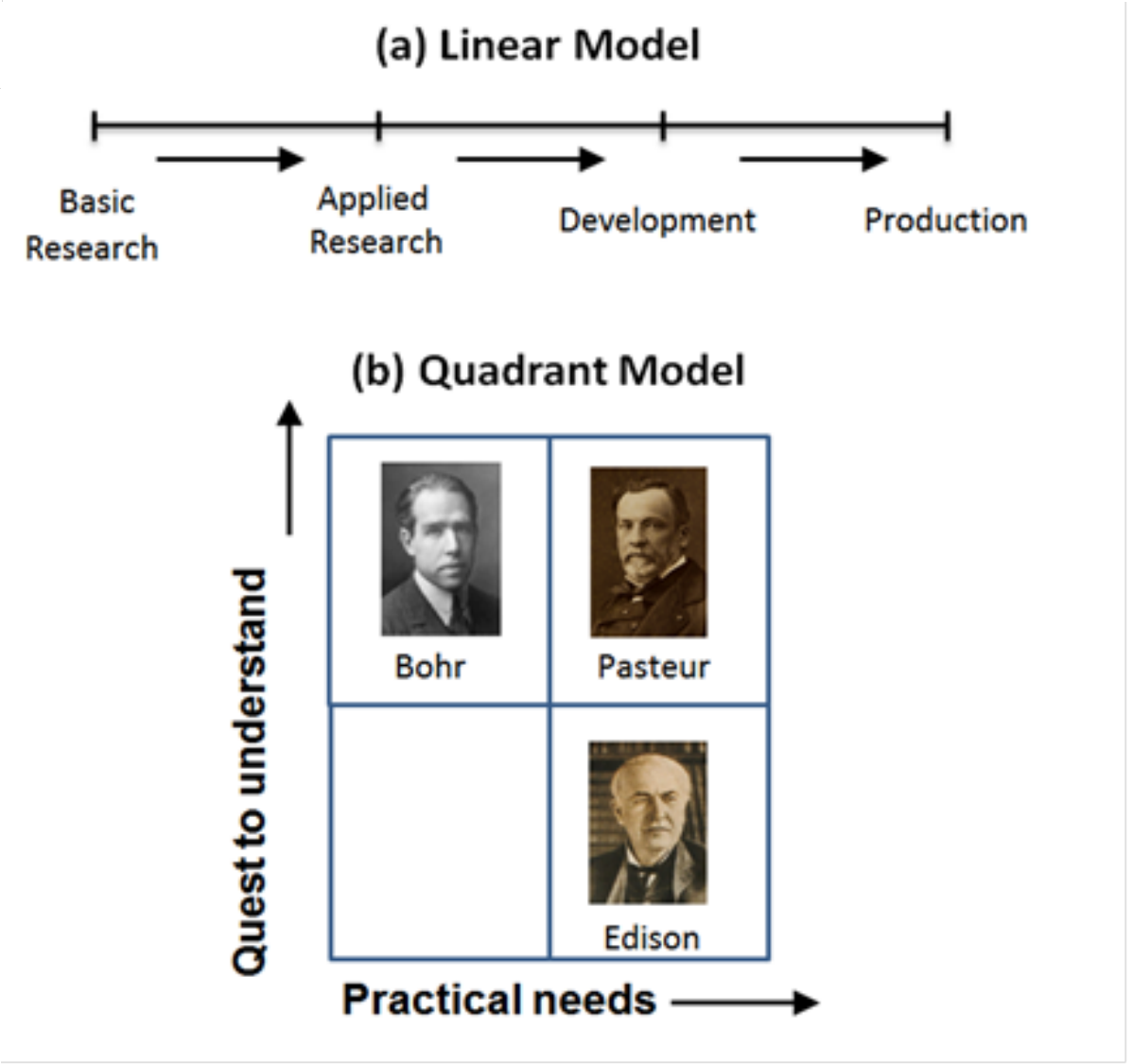
EPS TIG Workshop

Ravenna November 2013

Research Models



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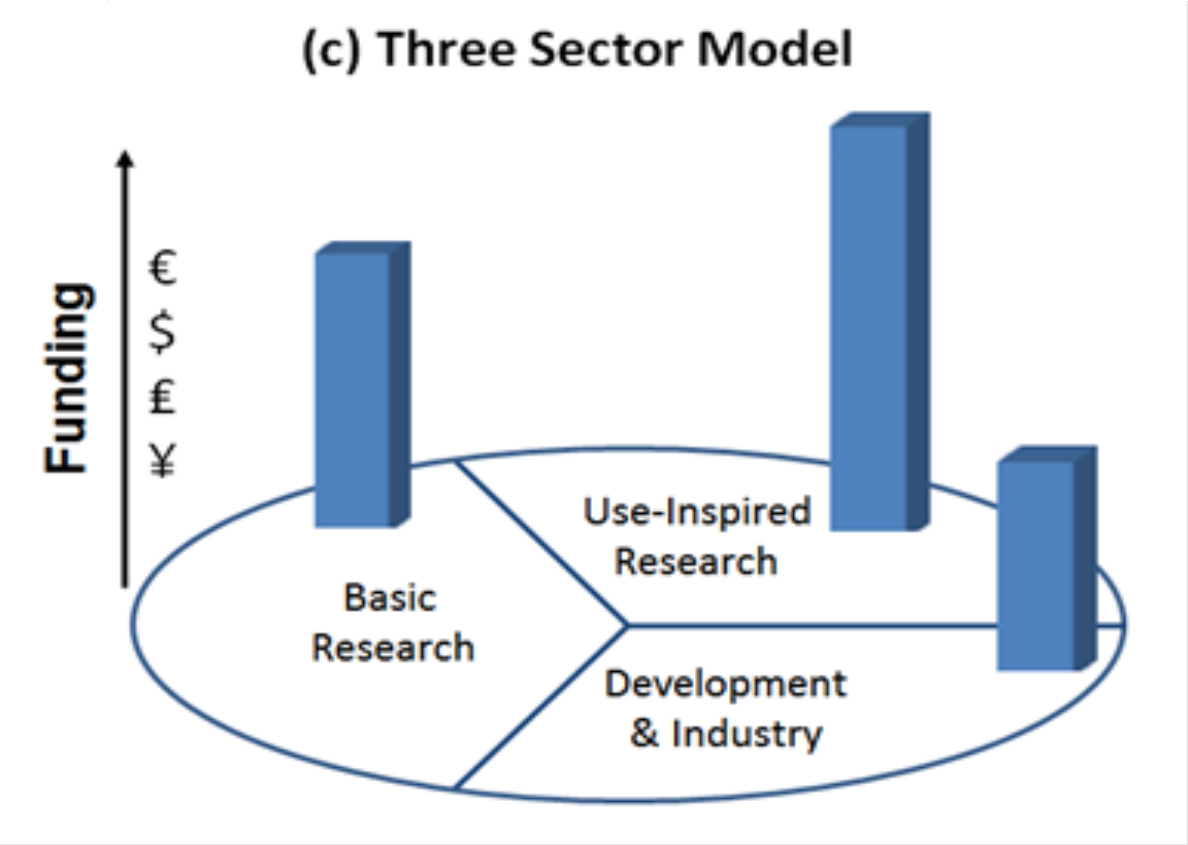


Innovations for an advanced world

1. **LASERS**

1958 First Optical Maser

1973 First barcode scanner

1985 First CD/DVD

- Today the laser industry is worth $6bn

“What industrialist, looking for new cutting and welding devices, or what doctor, wanting a new surgical tool as the laser has turned out to be, would have urged the study of microwave spectroscopy…quantum electronics ... a textbook example of widely applicable technology growing unexpectedly out of basic research”

C H Townes, *How the laser happened* (OUP,1999)

Innovations for an advanced world

2. **LCDs**

1936 First patent (Marconi Wireless)

1968 First useful display

- Over 80% of 200million TVs sold are LCDs
- Current global market is over 100bn
- $265bn predicted savings in USA from LED lighting by 2027

Innovations for an advanced world

3. **MRI Scanners**

1945 First NMR measurements

1980 First MRI image of a patient

- Current global MRI market $5.5bn

Innovations for an advanced world

4. **OPTICAL FIBRES**

1928 First patent – John Logie Baird

1988 First transatlantic optical fibre cable

- Today the fibre optic industry is worth $31bn
- 1.35 billion km now in service across the world
- 40% of bowel cancer operations are now performed via keyhole surgery

H-Tc : the world awaits

- 1986 discovery of H-Tc (IBM-Muller and Bednorz, Nobel prize 1987)

“Applications of H-Tc have been limited”

“They are fragile and brittle”

“ the main application is for MRI magnets”

Graphene – the future?

- 2004 discovery (Greim and Novoselov, Nobel prize 2010)
- 2012 EU allocates 1bn euro for research
- 2013 Wikipedia lists 22 possible applications

and yet….

Graphene Stock Investing: What the Pros Think

“Proceed with caution”

Tom Konrad, JPS Green Economy Fund

“Graphene is a complicated technology to deliver. The race to find value is more a marathon than a sprint”

Quenton Tannok, Chairman Cambridge Intellectual Property

“Widespread commercial viability of [graphene’s] commercial properties may still be further off than many investors seem to be hoping”

Frank Morris, Manager Ephipany Global Ecologic Mutual Fund

The Political Problem

- Politicians do not think in terms of several decades ahead (climate change problem?) – they want to be re-elected!

- Politicians like the money but who gets it and who gets the credit?

Investing in Physics

[Such] research may be a bad private investment, as resulting commercial applications cannot be exploited exclusively by any one company, but a good investment for society because such developments are a public good

C H Llewellyn–Smith, former D-G of CERN

Michael Faraday, replied to British Chancellor of the Exchequer Gladstone's question "What use is electricity?" (1850) with

"One day, sir, you may tax it"

Harvest of a Quiet Eye, IoP, 1977

Targeted investment
Picking winners

"Directing basic research towards economic opportunities is detrimental to growth and may reduce the growth rate by as much as one half"

Chris van Bochove,

(Leiden University, Basic Research and Prosperity, 2012)

Physics and the EU Economy Report 2013

Report Objective

To explain to policy makers that physics makes an important contribution to the economy and is not simply limited to academic research

Physics Evaluation Procedure

- Perform an objective statistical analysis of the contribution of physics to the business economy

- Use an independent consultancy firm, specialised in the treatment of business data (CEBR — Centre for Economics & Business Research, London, UK)

Data sources

- Use the NACE classification scheme (Nomenclature Générale des Activités Economiques dans les Communautés Européennes) as framework
- Eurostat's Structural Business Statistics (SBS)
- Use also other information from bodies such as World Trade Organisation, United Nations, US Census Bureau, Japan Customs …

NACE codes

Within NACE codes (Rev 2) 6-95 physics related sectors where there is a critical use of physics in terms of associated technology, expertise and skills have been identified.

Examples include:

Nuclear fuel processing, manufacture of electronic components, electrical equipment and motors, optical instruments and photographic equipment, telecommunications, aircraft and spacecraft manufacture of medical and surgical equipment, defence activities.

Code	Description	Code	Description
6.1	Extraction of crude petroleum	30.11	Building of ships and floating structures
6.2	Extraction of natural gas	30.2	Manufacture of railway locomotives and rolling stock
9.1	Support activities for petroleum and natural gas extraction	30.3	Manufacture of air and spacecraft and related machinery
20.13	Manufacture of other inorganic basic chemicals	30.4	Manufacture of military fighting vehicles
21.2	Manufacture of pharmaceutical preparations	30.91	Manufacture of motorcycles
23.44	Manufacture of other technical ceramic products	32.5	Manufacture of medical and dental instruments and supplies
24.46	Processing of nuclear fuel	32.99	Other manufacturing n.e.c
25.21	Manufacture of central heating radiators and boilers	33.11	Repair of fabricated metal products
25.3	Manufacture of steam generators, except central heating hot water boilers	33.12	Repair of machinery
25.4	Manufacture of weapons and ammunition	33.13	Repair of electronic and optical equipment
25.99	Manufacture of other fabricated metal products n.e.c	33.14	Repair of electrical equipment
26.11	Manufacture of electronic components	33.15	Repair and maintenance of ships and boats
26.12	Manufacture of loaded electronic boards	33.16	Repair and maintenance of aircraft and spacecraft
26.2	Manufacture of computers and peripheral equipment	33.17	Repair and maintenance of other transport equipment
26.3	Manufacture of communication equipment	33.2	Installation of industrial machinery and equipment
26.4	Manufacture of consumer electronics	35.11	Production of electricity
26.51	Manufacture of instruments and appliances for measuring, testing and navigation	38.12	Collection of hazardous waste

NACE (Rev 2)codes continued

26.6	Manufacture of irradiation, electromedical and electrotherapeutic equipment	38.22	Treatment and disposal of hazardous waste
26.7	Manufacture of optical instruments and photographic equipment	51.22	Space transport
26.8	Manufacture of magnetic and optical media	52.21	Service activities incidental to land transportation
27.11	Manufacture of electric motors, generators and transformers	52.22	Service activities incidental to water transportation
27.12	Manufacture of electricity distribution and control apparatus	52.23	Service activities incidental to air transportation
27.2	Manufacture of batteries and accumulators	60.1	Radio broadcasting
27.31	Manufacture of fibre optic cables	60.2	Television programming and broadcasting activities
27.32	Manufacture of other electronic and electric wires and cables	61.1	Wired telecommunications activities
27.33	Manufacture of wiring devices	61.2	Wireless telecommunications activities
27.4	Manufacture of electric lighting equipment	61.3	Satellite telecommunications activities
27.51	Manufacture of electric domestic appliances	61.9	Other telecommunications activities
27.9	Manufacture of other electrical equipment	62.09	Other information technology and computer service activities
28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	71.11	Architectural activities

NACE (Rev 2) codes continued

	vehicle and cycle engines		
28.21	Manufacture of ovens, furnaces and furnace burners	**71.12**	Engineering activities and related technical consultancy
28.23	Manufacture of office machinery and equipment (except computers and peripheral equipment)	**71.2**	Technical testing and analysis
28.25	Manufacture of non-domestic cooling and ventilation equipment	**72.11**	Research and experimental development on biotechnology
28.29	Manufacture of other general-purpose machinery n.e.c.	**72.19**	Other research and experimental development on natural sciences and engineering
28.49	Manufacture of other machine tools	**72.2**	Research and experimental development on social sciences and humanities
28.92	Manufacture of machinery for mining, quarrying and construction	**74.2**	Photographic activities
28.99	Manufacture of other special-purpose machinery n.e.c.	**74.9**	Other professional, scientific and technical activities n.e.c.
29.1	Manufacture of motor vehicles	**95.12**	Repair of communication equipment

NACE codes continued

Physics based activities which are NOT INCLUDED within the NACE codes are largely non market services and activities. Thus for example education and health, sports and entertainment are omitted as well as national and European physics research facilities, including CERN.

EPS CEBR report

- Statistics (prior to 2011) are available at the required level of detail from Euro Stat for 27 EU Member States, plus the EFTA countries Switzerland and Norway.

- Data has been collated for each country separately and EPS has access to the raw data for distribution purposes

- Final report published April 2013

CEBR final report

The full report (53 pages) has now been made available to all on the EPS website

www.eps.org/physicsandthe economy

Making Business Sense

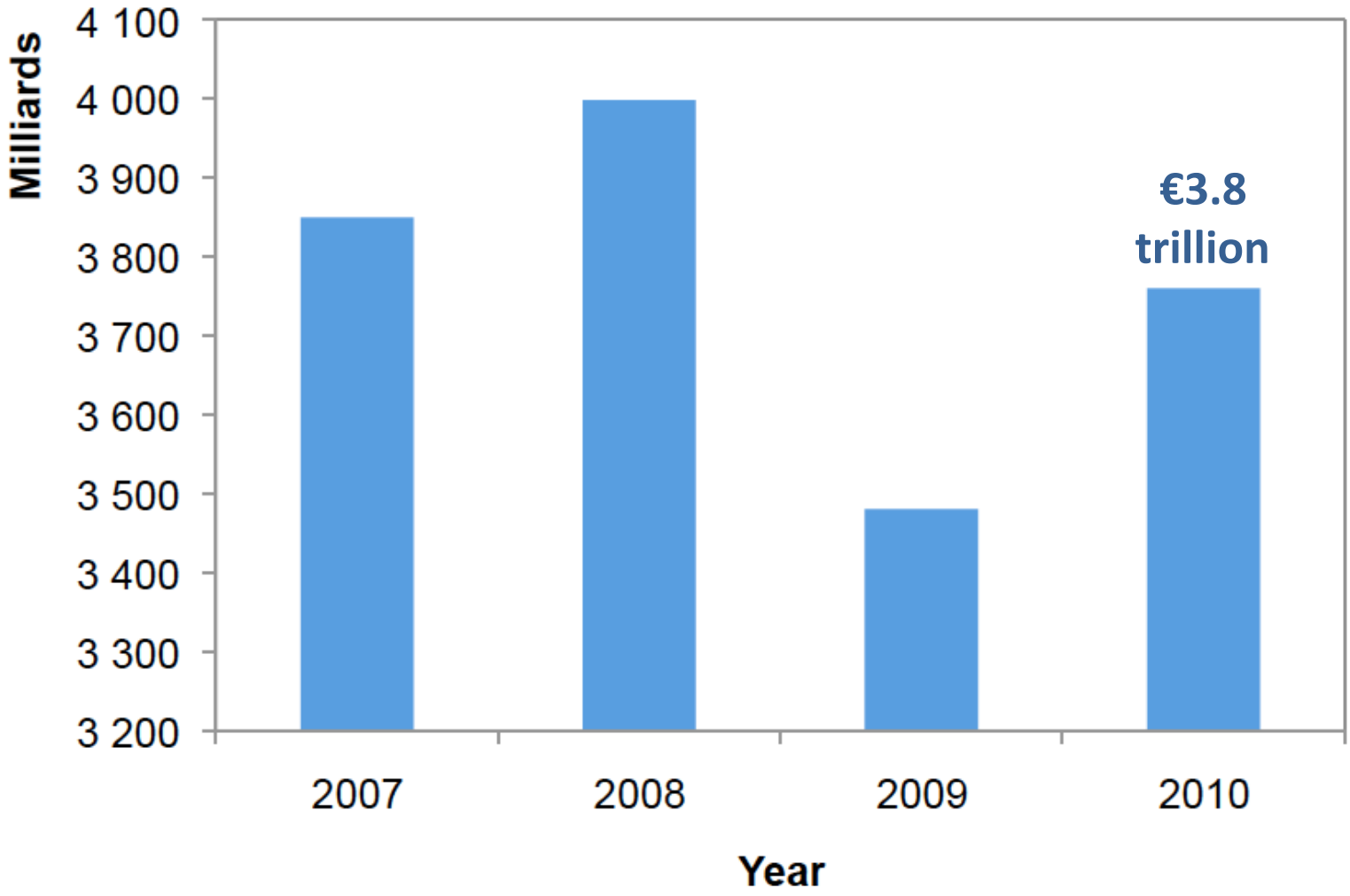
Contents

EPS Executive summary

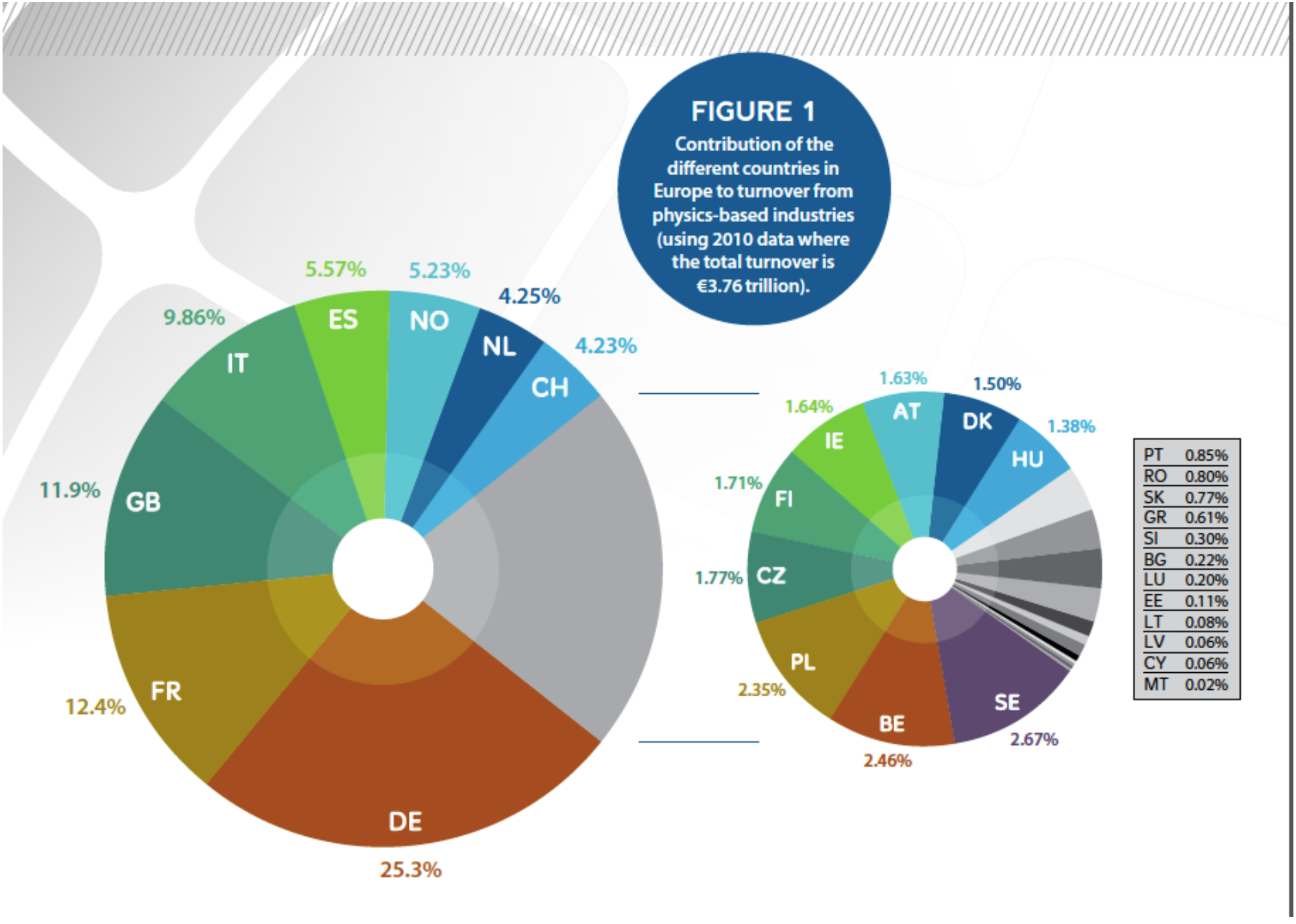
Results in Brief

€3.8 trillion	15.4 million	44.9%	€47 billion
In 2010, physics-based industries generated €3.8 trillion of turnover, representing over 15% of total turnover within Europe's business economy. Turnover per person employed in the physics-based sector substantially outperforms the construction and retail sectors.	In 2010, physics-based industries employed 15.4 million people. This is over 13% of total employment within Europe's business economy. Moreover, for every job created in physics-based industries, a total of 2.73 jobs are supported in the whole economy by these industries.	Gross Value Added (GVA) measures the value produced by a sector of the economy. Physics-based GVA is diverse. 44.9% comes from manufacturing, but more than 50% is spread between information & communications, professional, scientific & technical activities, oil & gas activities, and energy production.	The European physics-based sector is highly R&D intensive. Physics-based sectorexpenditure on R&D exceeded €47 billion every year over the period 2007-2010. R&D investment levels in 2010 exceeded those in 2007.

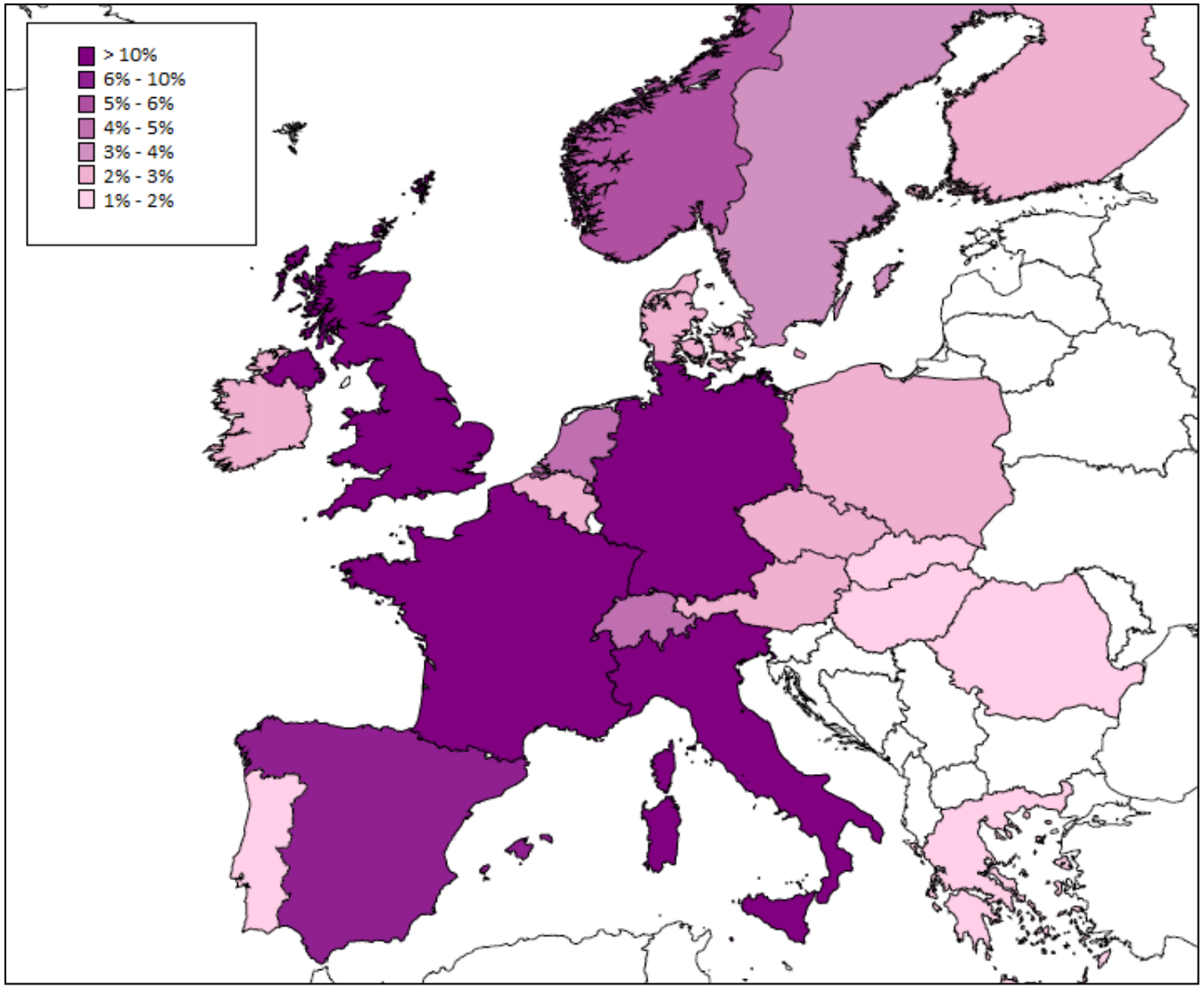
Turnover in physics-based industries (€ current prices)



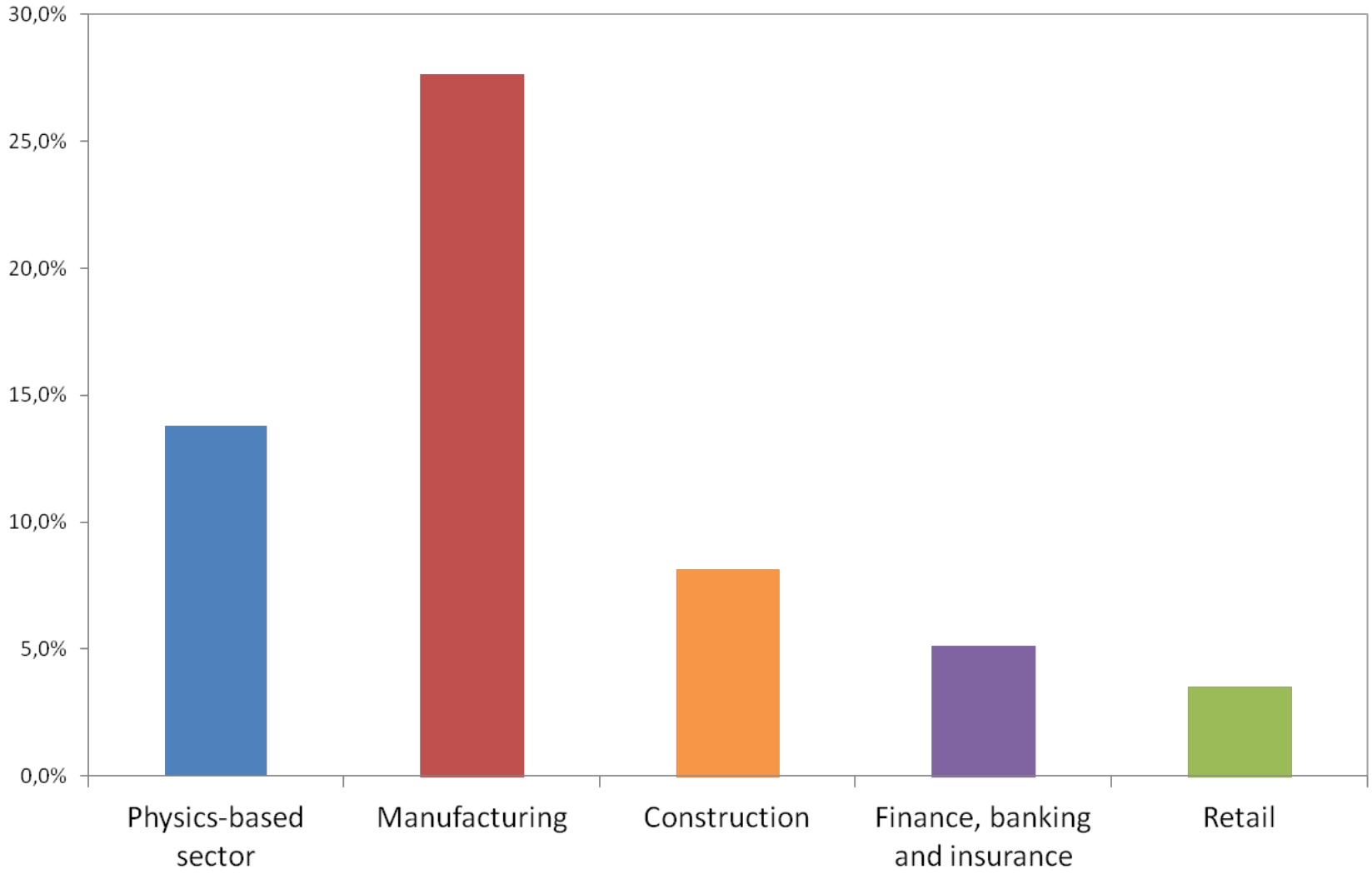
Contribution to total EU turnover



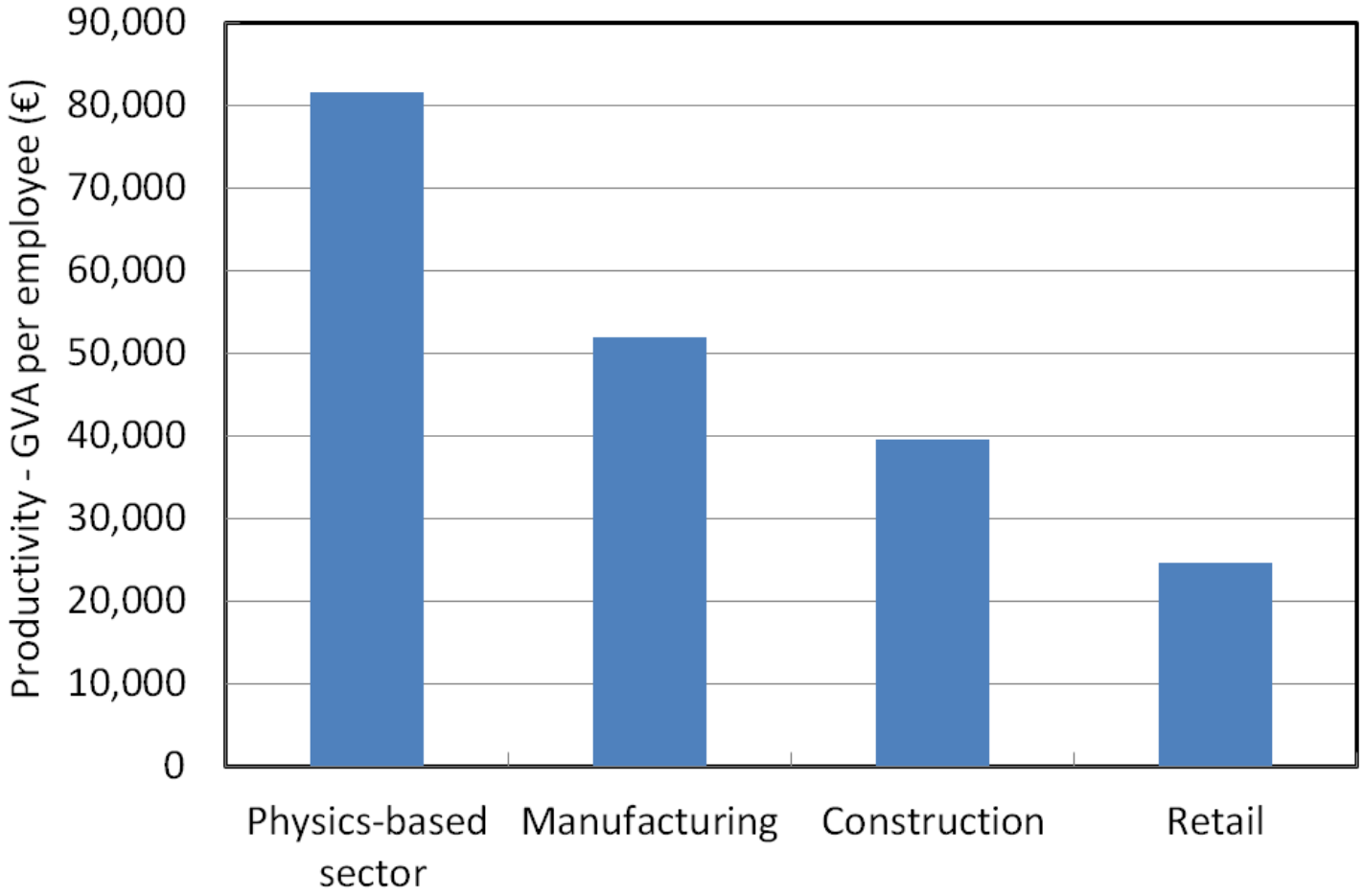
Share of total physics-based turnover in the EU-27, Norway & Switzerland; average 2007-10



Selected sectors' shares of EU27 output at basic prices, 2008



Productivity (GVA per employee)



Contribution of physics-based subsectors to total physics-based GVA

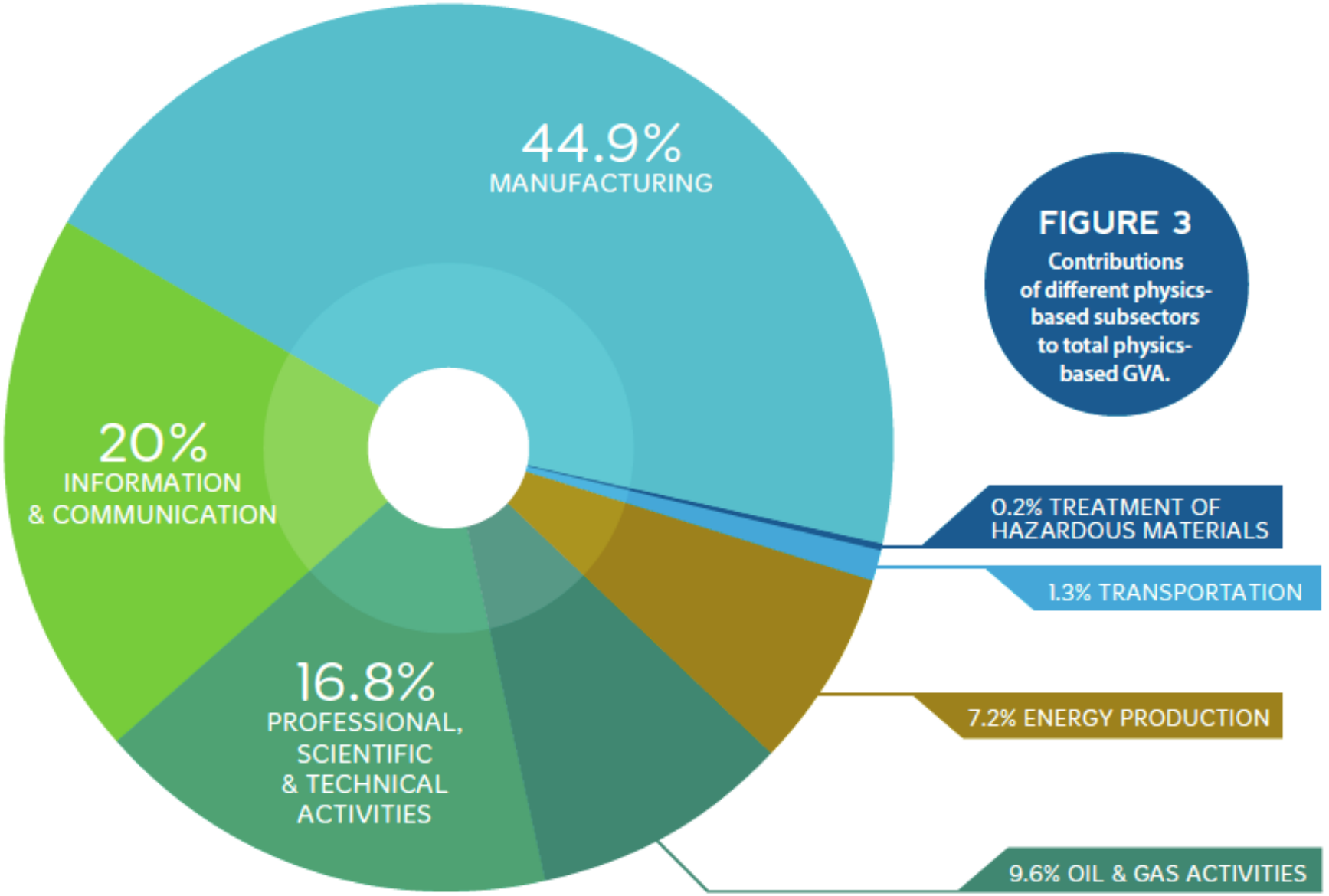
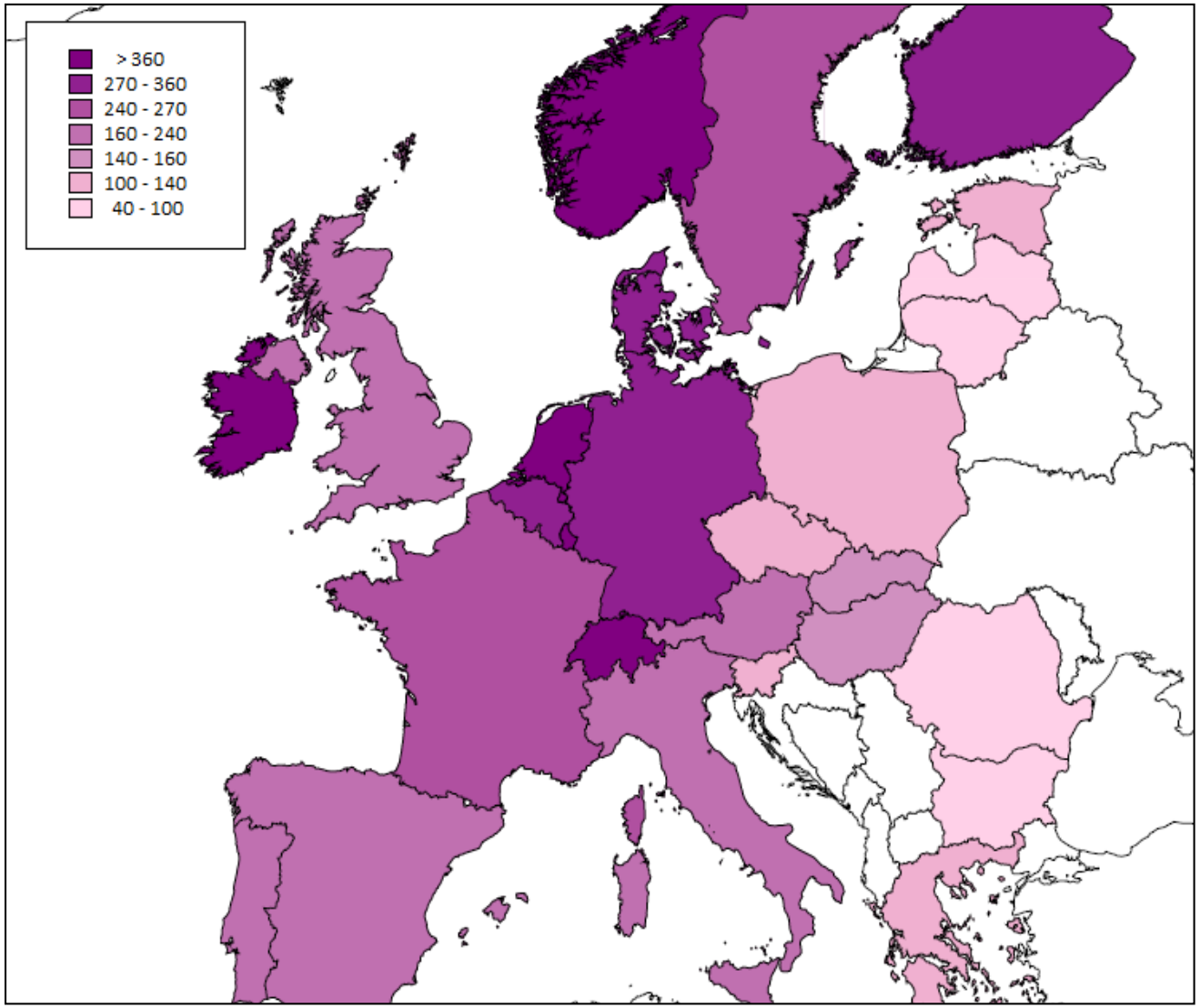
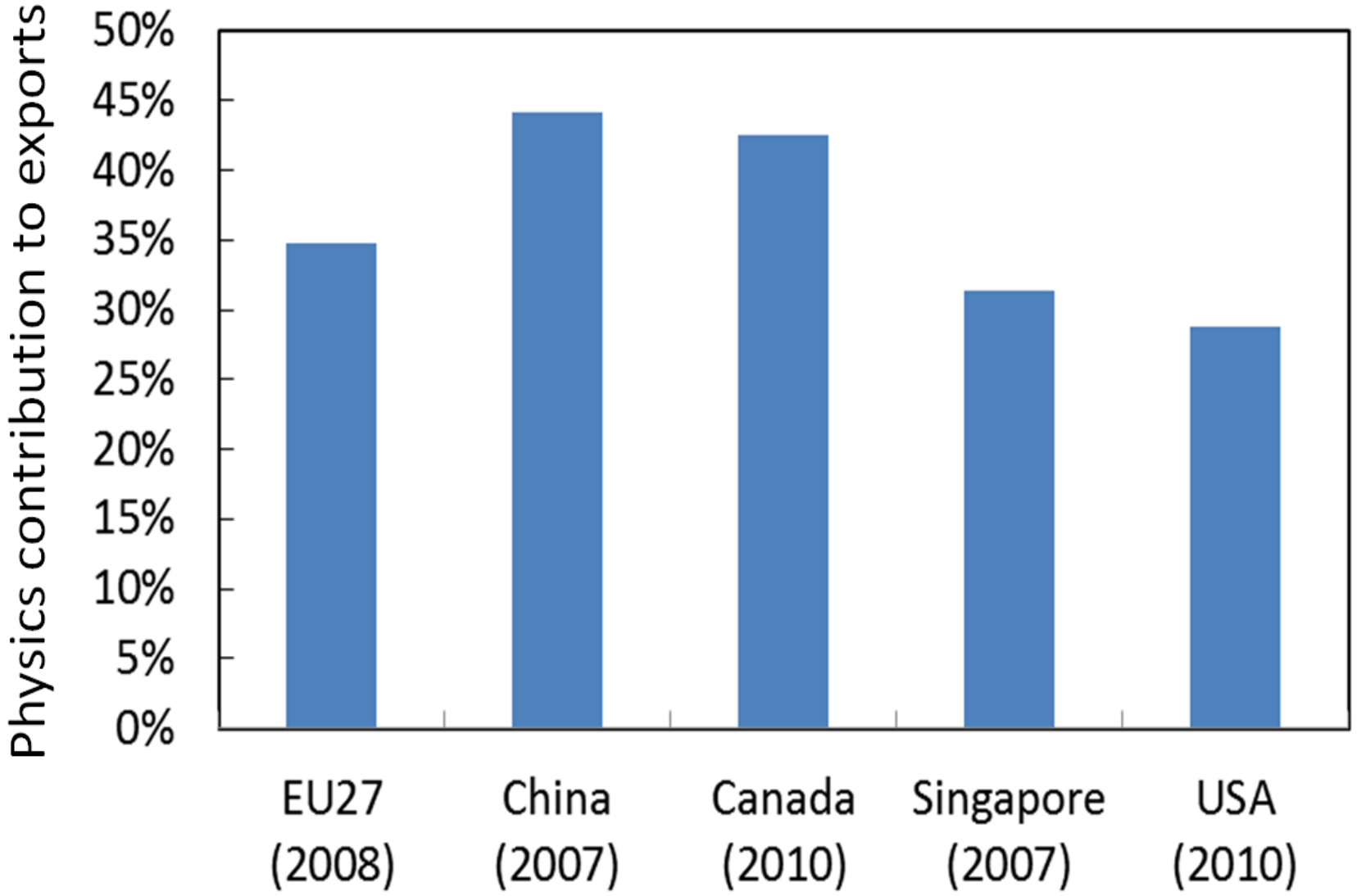


FIGURE 3
Contributions of different physics-based subsectors to total physics-based GVA.

Physics-based turnover per person employed, 2010, thousand €, EU-27 and Norway, Switzerland



Exports


Physics contribution to exports
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
EU27 (2008)
China (2007)
Canada (2010)
Singapore (2007)
USA (2010)

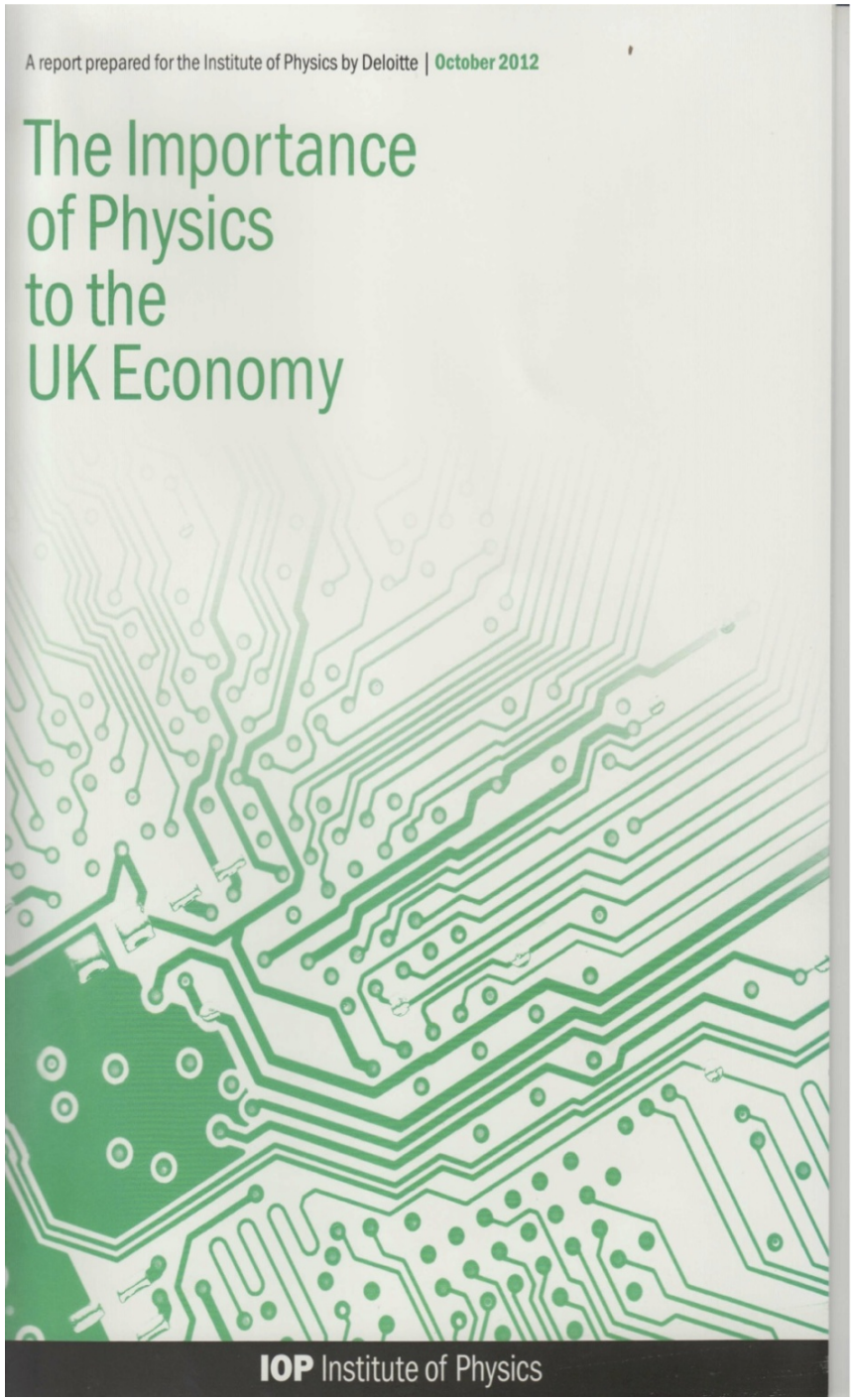
Intellectual Infrastructure

"…the best way is for governments to finance and invest in intellectual infrastructure and support research and technology so that we have a basis to work in the long term"

Tom Enders, Chief Executive Airbus, 2012

A report prepared for the Institute of Physics by Deloitte | October 2012

The Importance of Physics to the UK Economy



IOP Institute of Physics


A report prepared for the Institute of Physics by Deloitte | October 2012
The Importance of Physics to the UK Economy
IOP Institute
A report prepared for the Institute of Physics by Deloitte | October 2012
The Importance of Physics to the Scottish Economy
A report prepared for the Institute of Physics by Deloitte | November 2012
The Importance of Physics to the Northern Irish Economy

	GVA in Physics-Based Industry, millions of euro, current prices			
	2007	2008	2009	2010
Austria	22,680	24,574	22,279	23,419
Belgium	27,305	27,092	26,858	30,562
Bulgaria	2,855	3,172	3,120	3,294
Cyprus	964	1,006	997	1,149
Czech Republic	17,715	19,038	15,775	16,739
Denmark	23,381	27,025	22,936	24,961
Estonia	1,154	1,188	1,114	1,165
Finland	20,659	20,192	14,943	15,892
France	145,843	142,879	133,994	141,380
Germany	294,398	291,348	263,129	301,062
Greece	10,835	11,683	10,719	12,429
Hungary	11,386	12,301	10,926	12,225
Ireland	20,273	23,382	20,888	21,735

Europe should become the most competitive and dynamic knowledge based economy in the world.

EU Commission, 2003