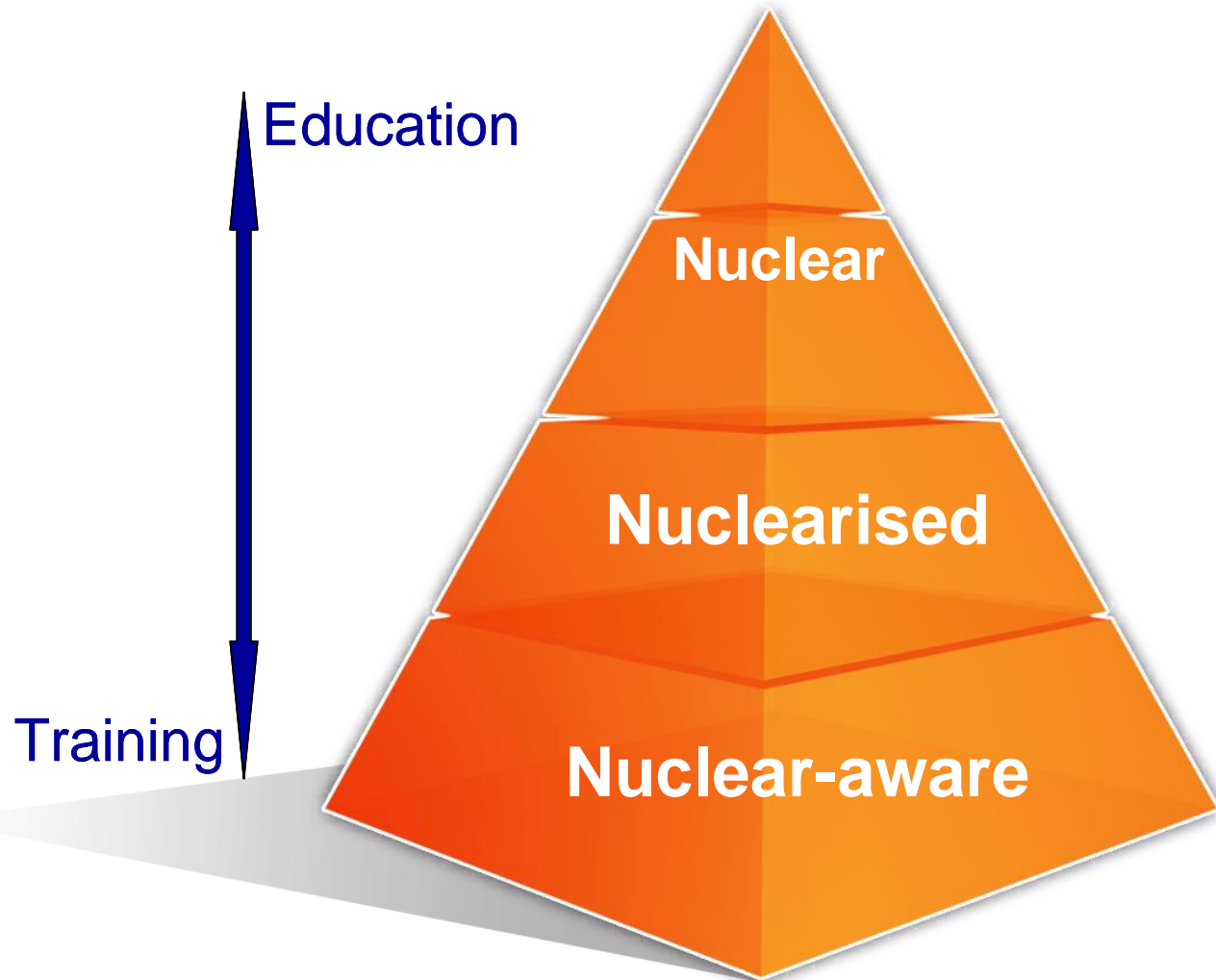


Recent Trends in Nuclear Education and Training to Match the Needs

Michel GIOT, Louvain School of Engineering, and SCK•CEN, Belgium
Maria Elena URSO and **Ron CAMERON**, OECD / NEA, France

Nuclear specialization of the Human Resources



Two topics:

- **Recent progress made by academic institutions**
- **Use of nuclear research infrastructure**

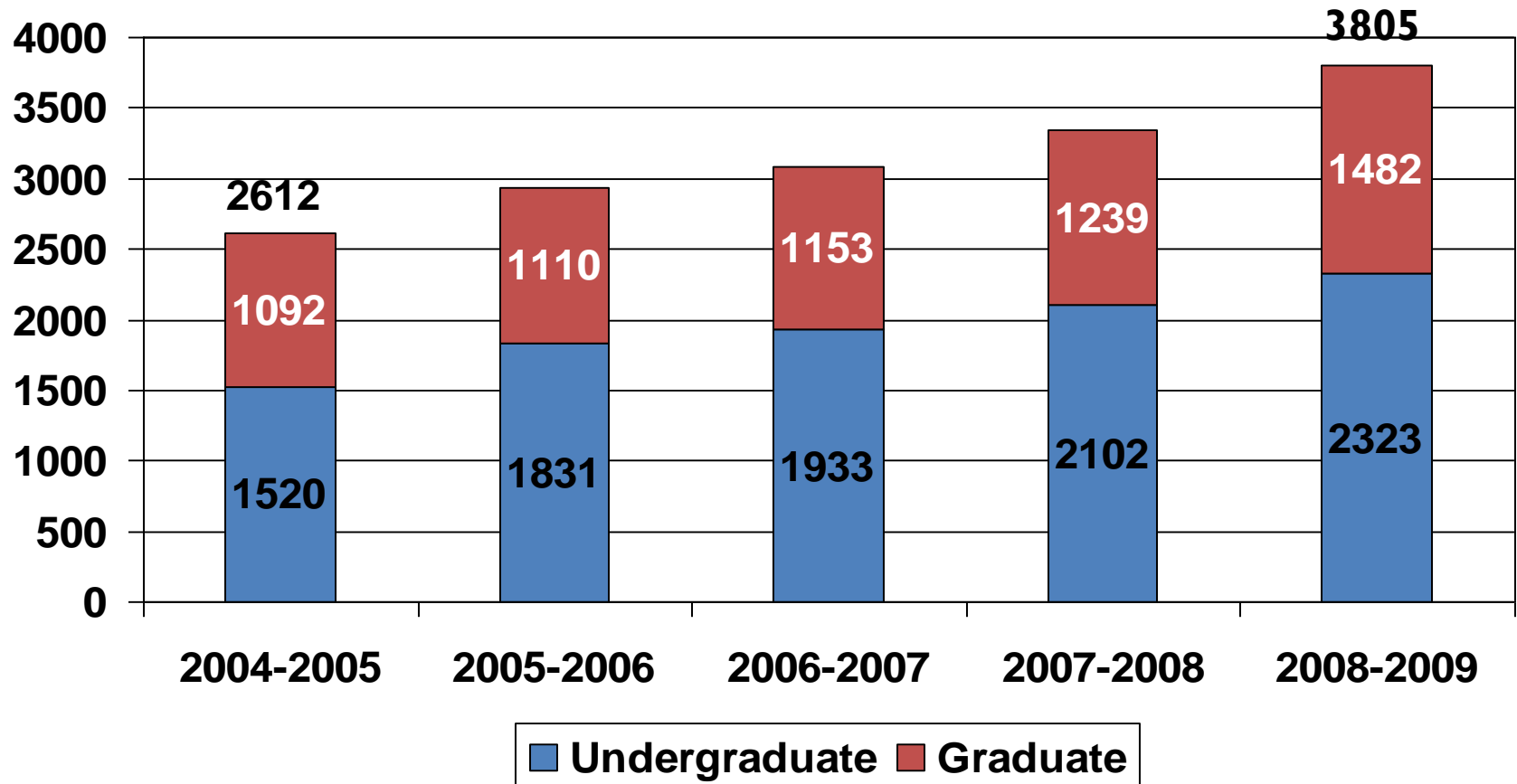
Recent progress made by academic institutions

- ▶ Larger numbers of students
- ▶ New courses and chairs
- ▶ More efficient cooperation with industry
- ▶ Participation in national networks
- ▶ Participation in international networks
- ▶ Development of innovative teaching methods
- ▶ Broadening the spectrum of courses taught

Note: in OECD countries, the government action has been patchy - with good initiatives in some countries but almost no action in others. The major developments have been led by industry.

Larger numbers of students

- ▶ Example: the US : 1800 to 600 to 3800 (source: J. Gutteridge and G.J. Brown, Nov. 2009)



New courses and chairs

- ▶ Nuclear Liaison (portal for all UK nuclear information, by John Roberts, U. Manchester):
 - ▶ now 14 institutions offer nuclear related taught courses in the UK:
 - U. Birmingham, Cambridge, Central Lancashire, Dundee, Hull, Imperial College London, Lancaster, Leeds, Liverpool, Manchester, Trent, Sheffield, Surrey, West of Scotland
- ▶ Germany:
 - ▶ 20 professors in 2010 instead of 5 as predicted in 2004.

More efficient cooperation with industry

► France:

MASTER OF SCIENCE

Nuclear Energy

2010-2011



→ Covers technical, economical, environmental and managerial aspects

→ International careers

- Engineer in nuclear industry
 - Design and construction,
 - Operation and maintenance,
 - Decommissioning and waste management,
 - Fuel cycle.

Research and Education

→ Two-years MSc Program taught in English

Direct access to second year for qualified students

First year (M1) basic courses
Physics, Mechanics, Chemical Engineering, and Economics

Second year (M2) five Majors

- Nuclear Reactor Physics and Engineering (Previously Nuclear Engineering)
- Nuclear Plant Design
- Operation
- Fuel Cycle
- Decommissioning and Waste Management

At leading academic institutions in Paris

→ Located in Paris (France)

<http://www.master-nuclear-energy.fr>

Contact: admin@master-nuclear-energy.fr

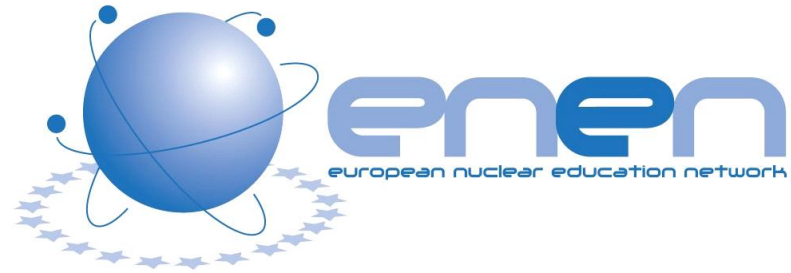


Participation in National Networks

BNEN: Belgian Nuclear Higher Education network	Total ECTS	KUL	UG	VUB	UCL	ULG	ULB
Nuclear energy: introduction	3	3					
Introduction to nuclear physics	3			3			
Nuclear reactor theory & experim.	8	2	3		3		
Nuclear thermal hydraulics	6				6		
Operation and control	3		3				
Reliability and safety	3	3					
Nuclear fuel cycle, applied radiochemistry	3					3	
Nuclear materials I	3					3	
Nuclear materials II	3	3					
Radiation protection and nuclear measurements	6		4	2			
Elective advanced courses	4						4
Master thesis and internship	15	X	X	X	X	X	x
Total	60						

Participation in international networks

- ▶ **ENEN Association**
(see Paper by Pr. Emilio Minguez)



- ▶ **ANENT: Asian Network for Education in Nuclear Technology (supported by IAEA)**



- ▶ sharing of information and materials of nuclear education and training
- ▶ exchange of students, teachers and researchers
- ▶ establishment of reference curricula and facilitating mutual recognition of degree
- ▶ serving as a facilitator for communication between ANENT member organizations and other regional and global networks

Development of innovative teaching methods

Distance learning options developed

▶ within **NTEC**

(Nuclear Technology

Education Consortium)

- ▶ in Spain at **UNED**: National University for Distance Learning (Madrid)
- ▶ by **JNEN** (6 universities) and JAEA provides the students with technical exercises at JAEA facilities
- ▶ ...

The logo for NTEC (Nuclear Technology Education Consortium) features the letters 'NTEC' in a large, bold, sans-serif font. Each letter is filled with a different color from a rainbow spectrum: 'N' is orange, 'T' is yellow, 'E' is green, 'C' is blue, and 'C' is purple.

Broadening the spectrum of courses taught

Japan: Tokyo University has launched a research and education program on “nuclear energy sociology”.

It includes nuclear energy law and legislation, nuclear nonproliferation and the harmonization of technology and society.

Role of Industry

- ▶ Establish partnerships with the academic community
- ▶ Give access to simulators
- ▶ Develop training centers
- ▶ Implement introductory courses for all newly recruited employees

UNITED STATES



LYNCHBURG

AREVA NP Training Center
1300 Old Graves Mill Road
Lynchburg VA, 24501



Westinghouse
Energy Center Site
Monroeville, PA



GE Energy
Schenectady, NY

Use of Nuclear Research Infrastructure

▶ Introduction

- ▶ Importance
- ▶ Awareness level
- ▶ Initiatives
- ▶ Ageing: the number of smaller teaching reactors is in some decline

▶ Survey SNETP /ETKM – OECD/NEA

- ▶ Use of Research Reactors
- ▶ Use of Thermal Hydraulic Facilities

▶ Conclusions and Recommendations

Use of Research Reactors

EU 27 +	Number of operated RR's	60
	Number of RR's used for lab sessions at BSc and MSc levels	28 (mainly small RR's)
	Number of RR's used for more than 120 hrs /y for lab sessions	8 (3 due to shut down within 5 to 10 years)
	Number of students having lab sessions	2750
	Max. number of students if necessary	4100
	Number of PhD theses/y using RR's	70 (average over 5 y.)
	Number of MSc theses/y using RR's	70 (average over 5 y.)
Japan	Number of RR's used for lab sessions at BSc and MSc levels	5
	Number of RR's used for more than 120 hrs /y for lab sessions	2
Korea	Number of RR's used for more than 120 hrs /y for lab sessions	1

An example: the “Eugene Wigner Course”



- ▶ A 3 week course on reactor physics experiments
- ▶ On 3 different research- training- reactors (Budapest, Prague and Vienna) + visit to Bohunice (Slovakia, NPP and Radwaste treatment Centre)

Use of Thermal Hydraulic Facilities

- ▶ Different types:
 - ▶ Very large and complex
 - ▶ Integral test facilities
 - ▶ Analysis of severe accidents
 - ▶ Experiments with down-scaled loops or with simulant fluids
 - ▶ Analytical experiments
 - ▶ Loops with a test section in a RR

- ▶ Ageing is less a problem
- ▶ Large potential for increase of the use: factor of 3 !
- ▶ EU 27+: 20 PhD theses/y 20 MSc theses/y

Recommendations and Conclusions

- ▶ Impact of the accident in Japan ? New workforce needed anyway
- ▶ More intensive use of Nuclear Research Infrastructure: RR + THF + instrumentation and control systems
- ▶ Replacement of aged RR's (needs of universities): joint efforts between countries
- ▶ New generation of pedagogical supports in connection with scientific and technological progress + communication technologies + upgraded lab sessions
- ▶ At regional scale: “experimental weeks” or “short weeks”
- ▶ Financial support: mobility grants (mixed public – private funding)