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International Centre for Theoretical Physics

United Nations
Educational, Scientific and
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IAEA
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Joint ICTP-IAEA School of Nuclear Energy Management

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Competence Building and Nuclear Education

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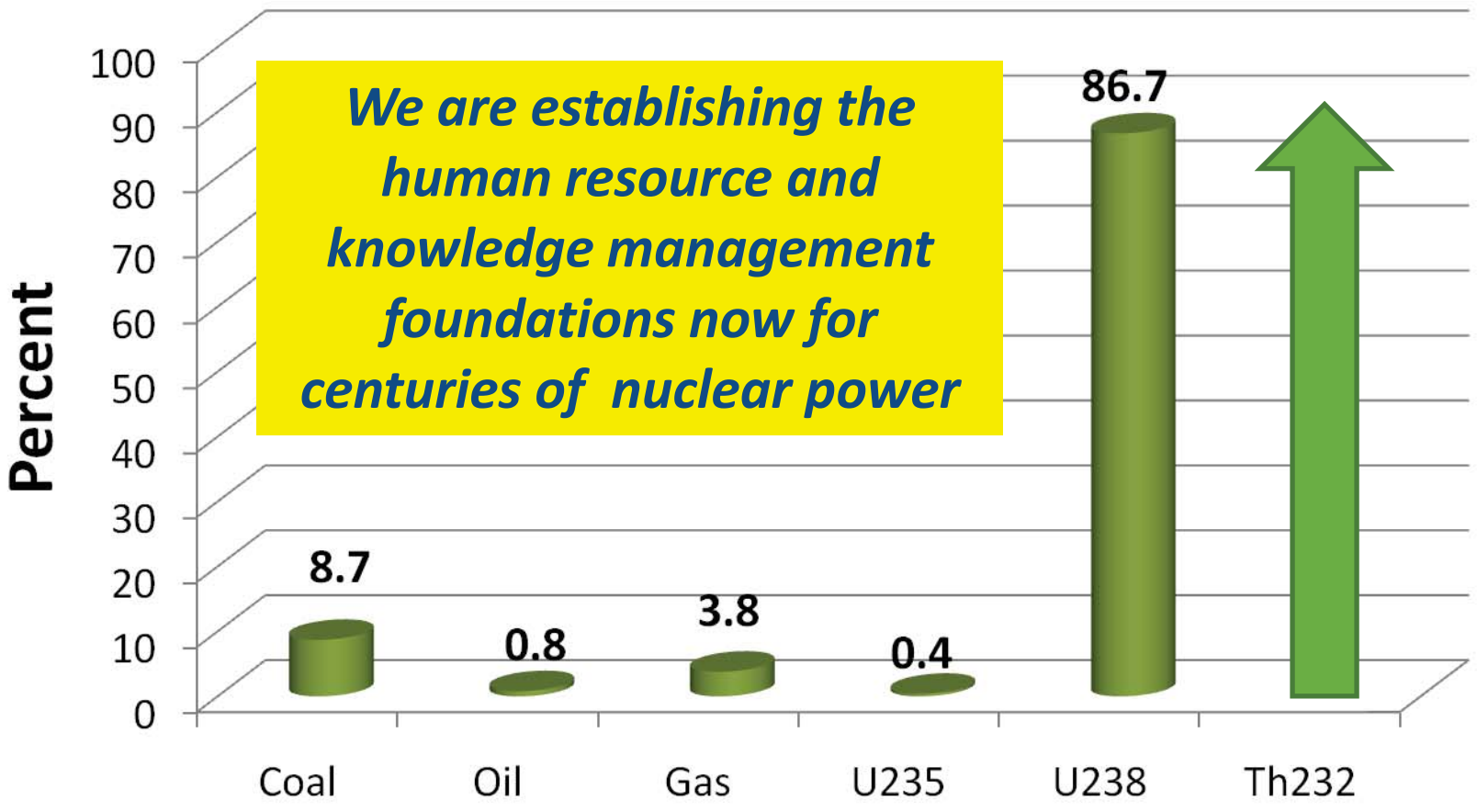
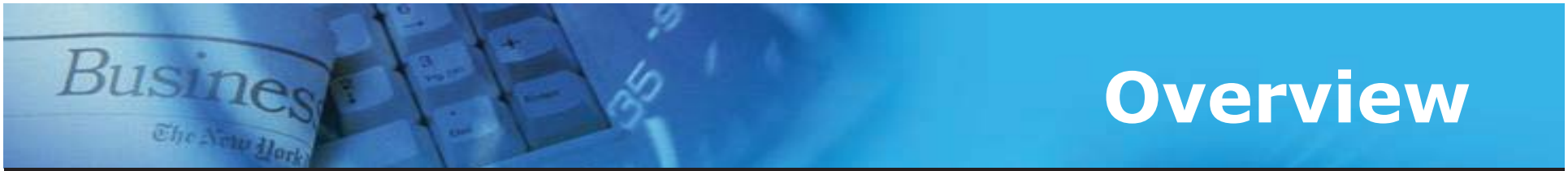
World Energy Supply





Overview

- **Global nuclear power has to grow rapidly if we want to manage climate changes**
  - 56 plants in next 10 years planned
  - >50 potential new entrants contacted IAEA
  - Agency predictions: 2 to 3 times increase by 2050
  - Hundreds of plants to thousands by end of century
  - **FUKUSHIMA RESPONSE….**
- **Nuclear power is knowledge-based industry,**
- **Human Resources are the major factor for growth.**

Knowledge Requirements

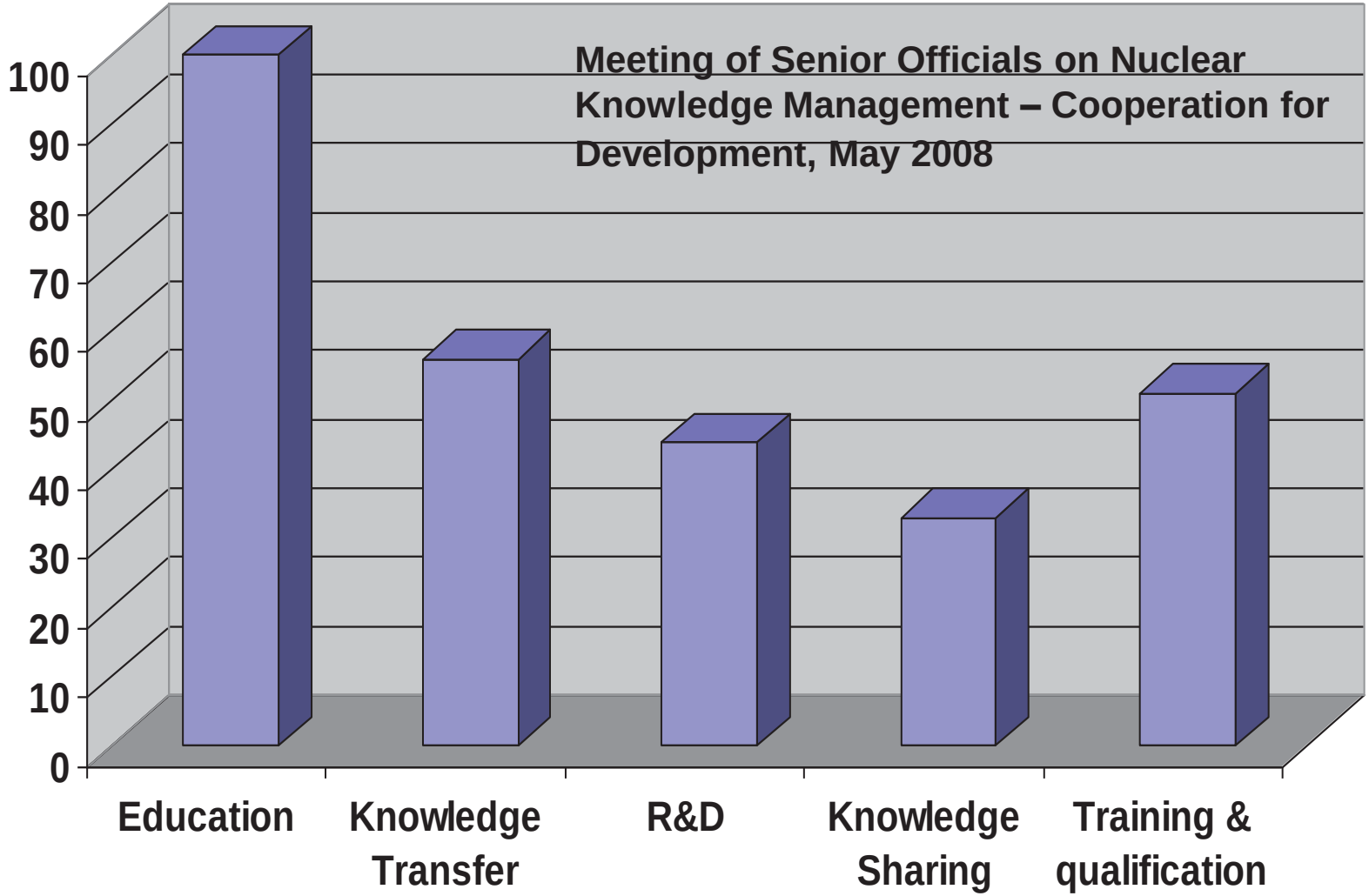
Type of Knowledge	Typically Required by
Know-What (Understanding what is needed for effective decisions)	Managers, Plant Owners, Policy-makers
Know-How (Application of knowledge)	Operators, Regulators, Suppliers, Constructors
Know-Why (Generation of knowledge)	Designers, Developers, National Laboratories, Universities, Vendors, Regulators

SAFETY FIRST!!!

- Safety culture is difficult to measure, establish, and maintain
- Learning: “If you don’t learn from operating experience you are doomed to repeat it”
- Complacency: “It can’t happen here”
- Corporate: “If production is more important than safety, then that organization will fail”
- Management: “There is no substitution for technical competency”

- WANO: ~1000 reported events/year; most reactors are in experienced nuclear countries
  - How to make effective use of information (confidentiality vs openess)
- Hardware is easy to fix, human behaviour is much more difficult
  - Incidents at plants are almost always human error
  - Attitudes and beliefs hard to measure
  - Importance of knowing what you don't know, questioning attitude, life-long learning
  - Transparency and empowerment a function of background and experience

National Priorities of IAEA Member States



Statutory Obligation

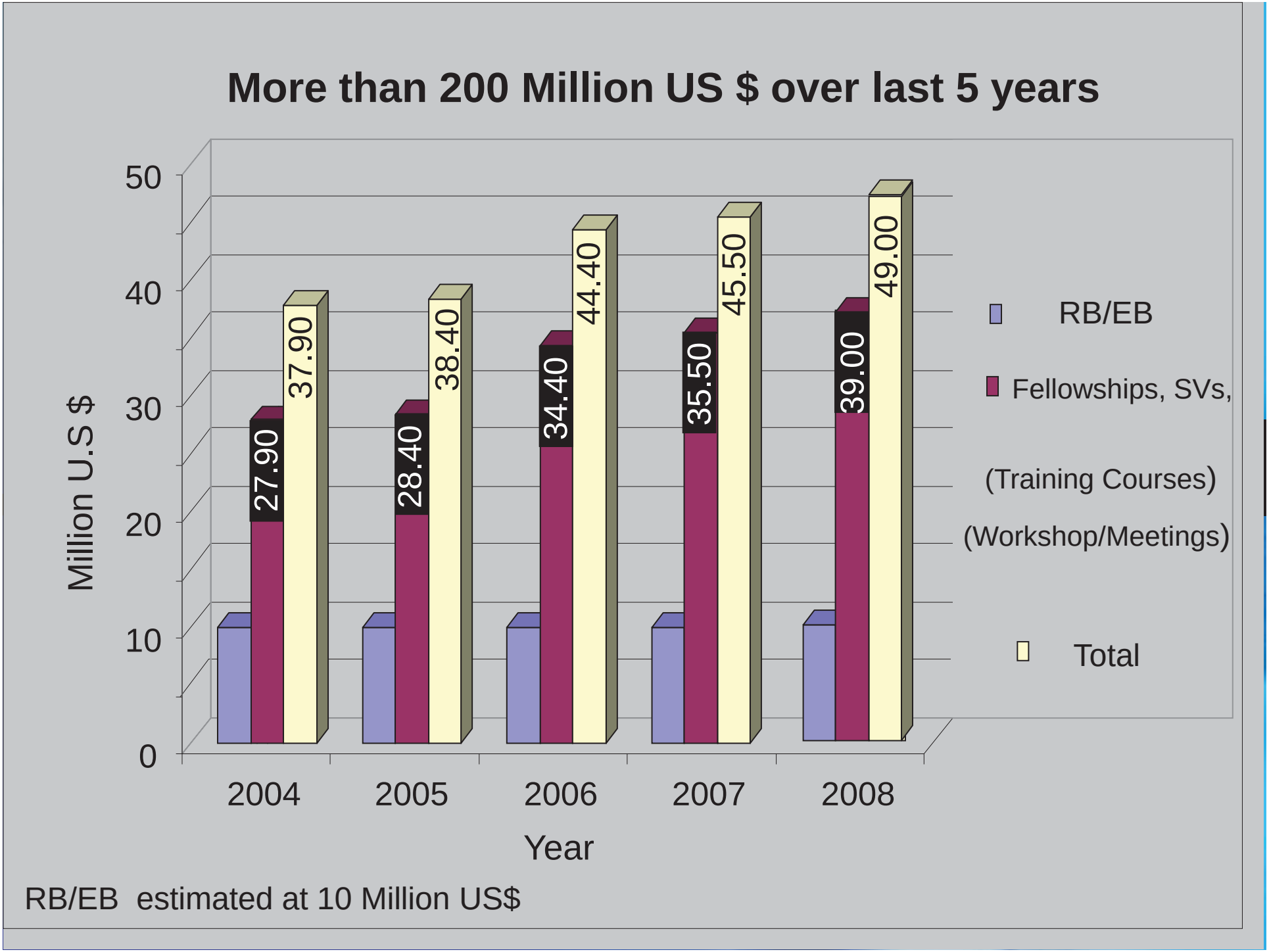
- Article 2 of the Statute mandates the Agency to
  - *3. To foster the exchange of scientific and technical information on peaceful uses of atomic energy;*
  - *4. To encourage the exchange of training of scientists and experts in the field of peaceful uses of atomic energy;*
- The Agency,
  - Assists Member States to develop competent human resource in nuclear science and technology
  - Facilitates knowledge transfer from centers of competence to areas of growth (the developing countries)
  - Provides direct assistance to education and training centers

General Conference Resolutions

- (a) **Recognizing that preserving and enhancing nuclear knowledge and ensuring the availability of qualified manpower are vital to all aspects of human activity related to the continued and expanded safe and secure utilization of all nuclear technologies for peaceful purposes,**

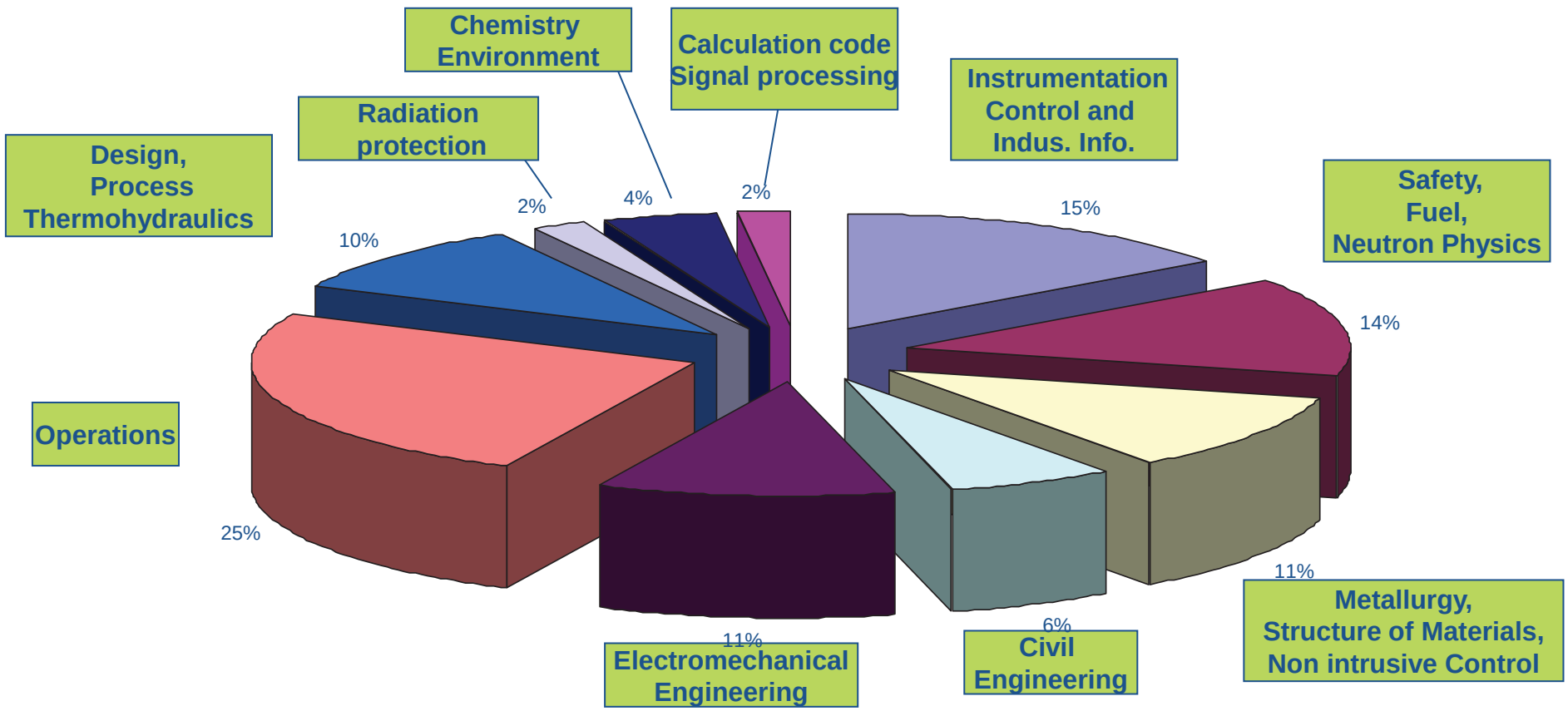
- 3. Urges the Secretariat to continue to strengthen, subject to the availability of resources, its current and planned efforts in this area, recognizing the need for a focused and consolidated approach, to consult with Member States and other international organizations, to take into account the results of relevant international meetings in the ongoing **development of a comprehensive Agency strategy for all aspects of nuclear education, training and qualification, as well as nuclear knowledge preservation and enhancement,** and to further increase the level of awareness of its efforts in the preservation and enhancement of nuclear knowledge.

More than 200 Million US $ over last 5 years

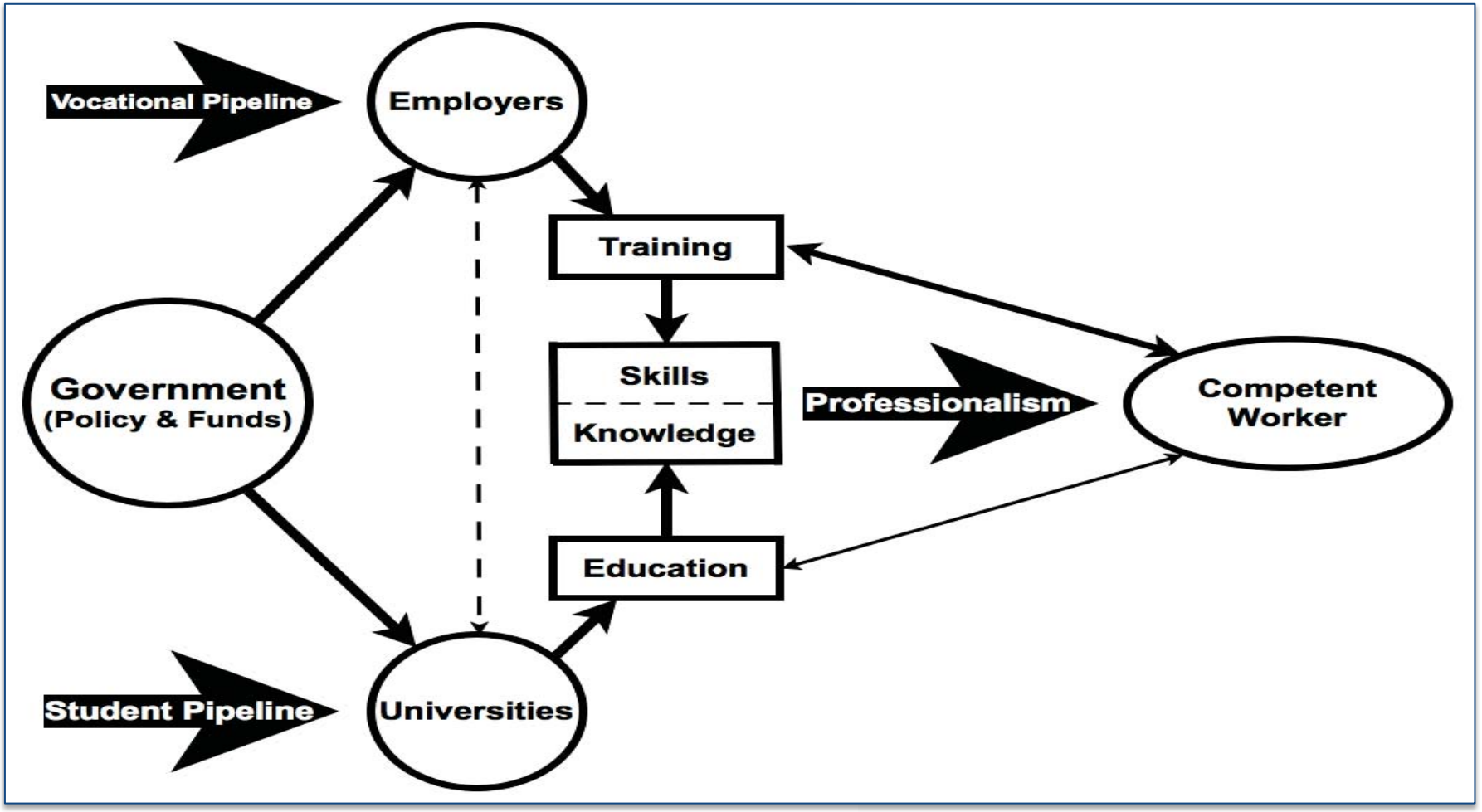


RB/EB estimated at 10 Million US$

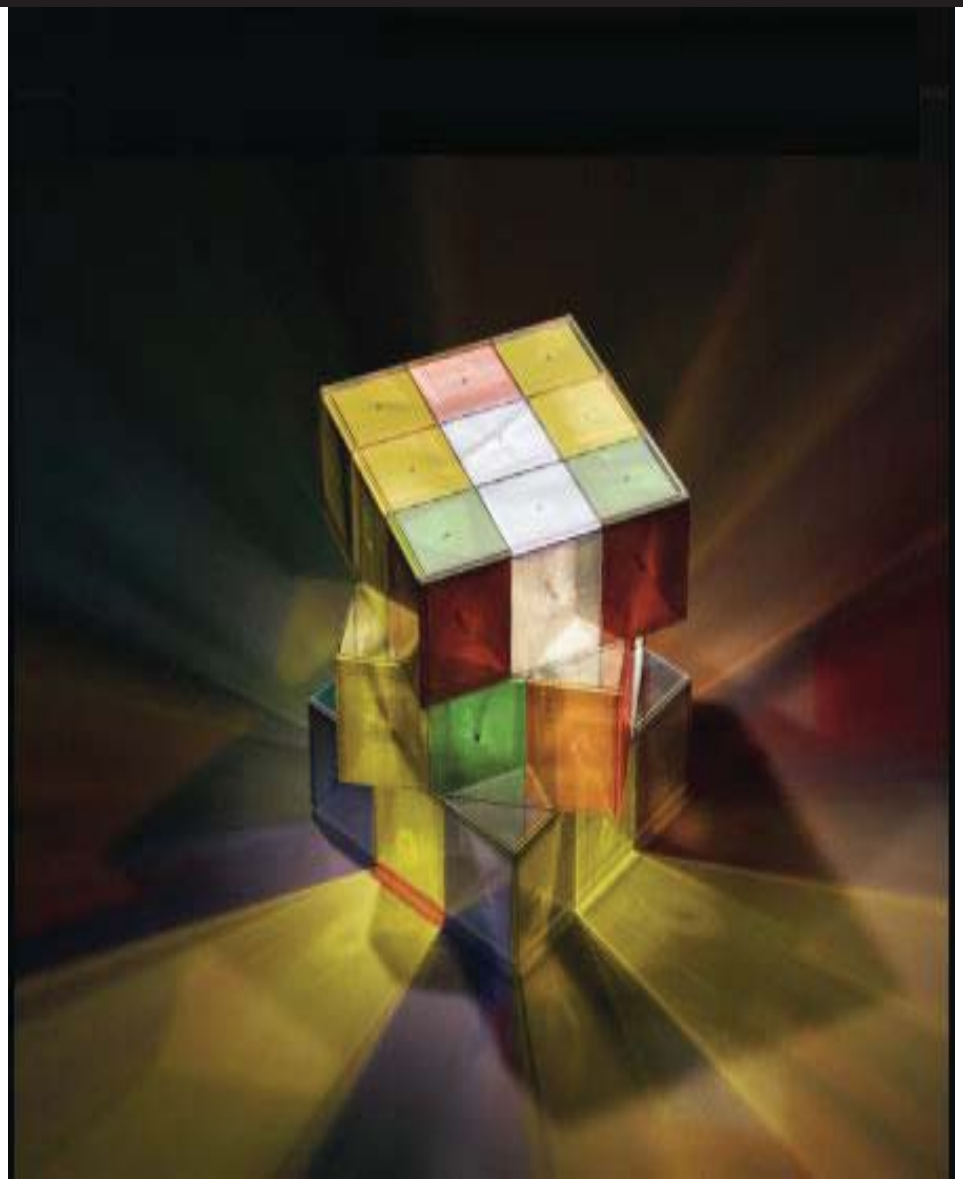
Specialist needed for Nuclear power development



Nuclear E&T Stakeholders



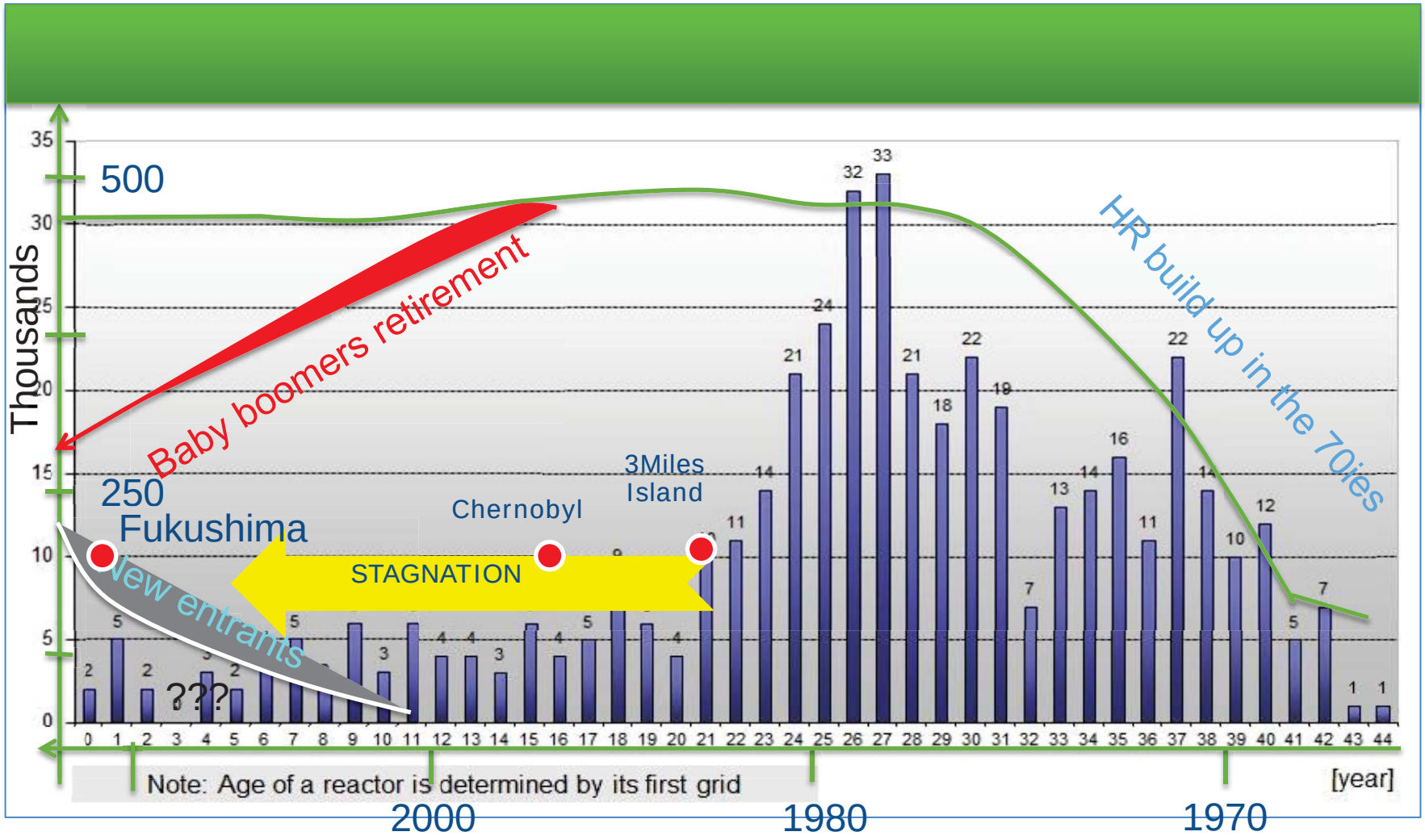
"Rubik Cube" of nuclear education



- ***The Students***
- ***The Teachers***
- ***Courses and textbooks***
- ***Infrastructure(R&D)***
- ***Nuclear facilities***
- ***Outreach to society***

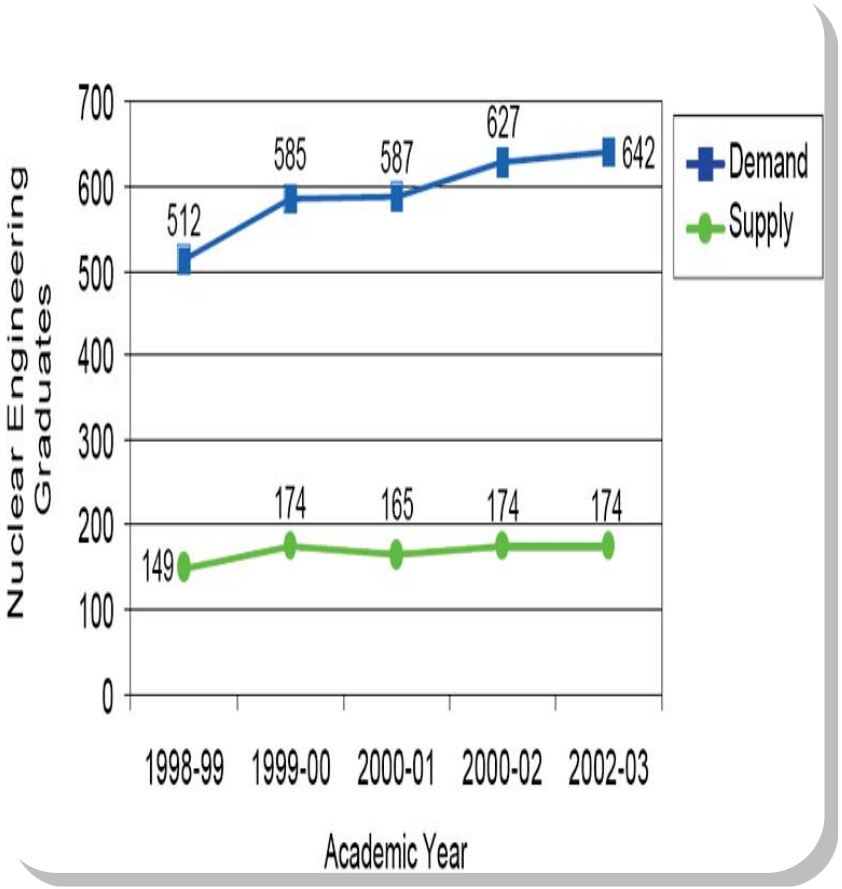
Nuclear Competence Survey

Global Nuclear Human Resource

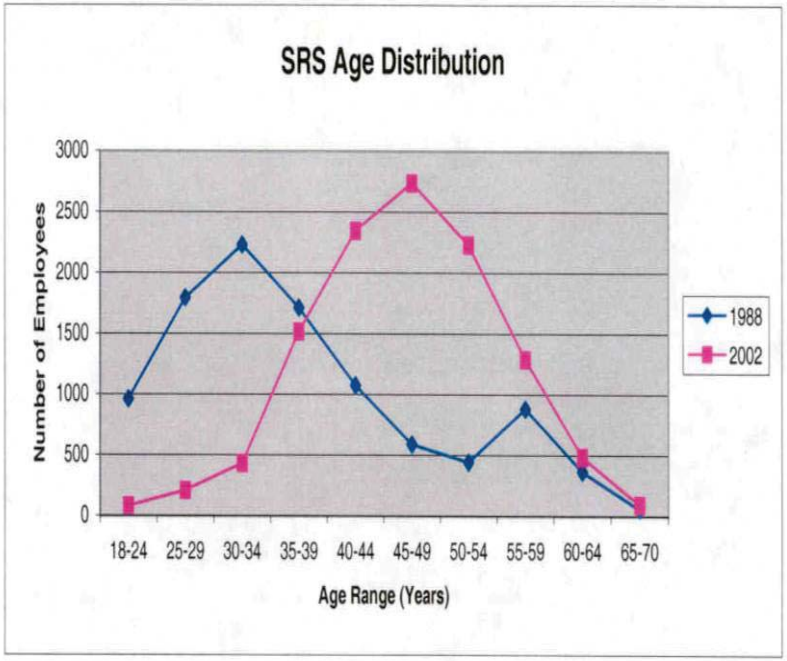


USA landscape

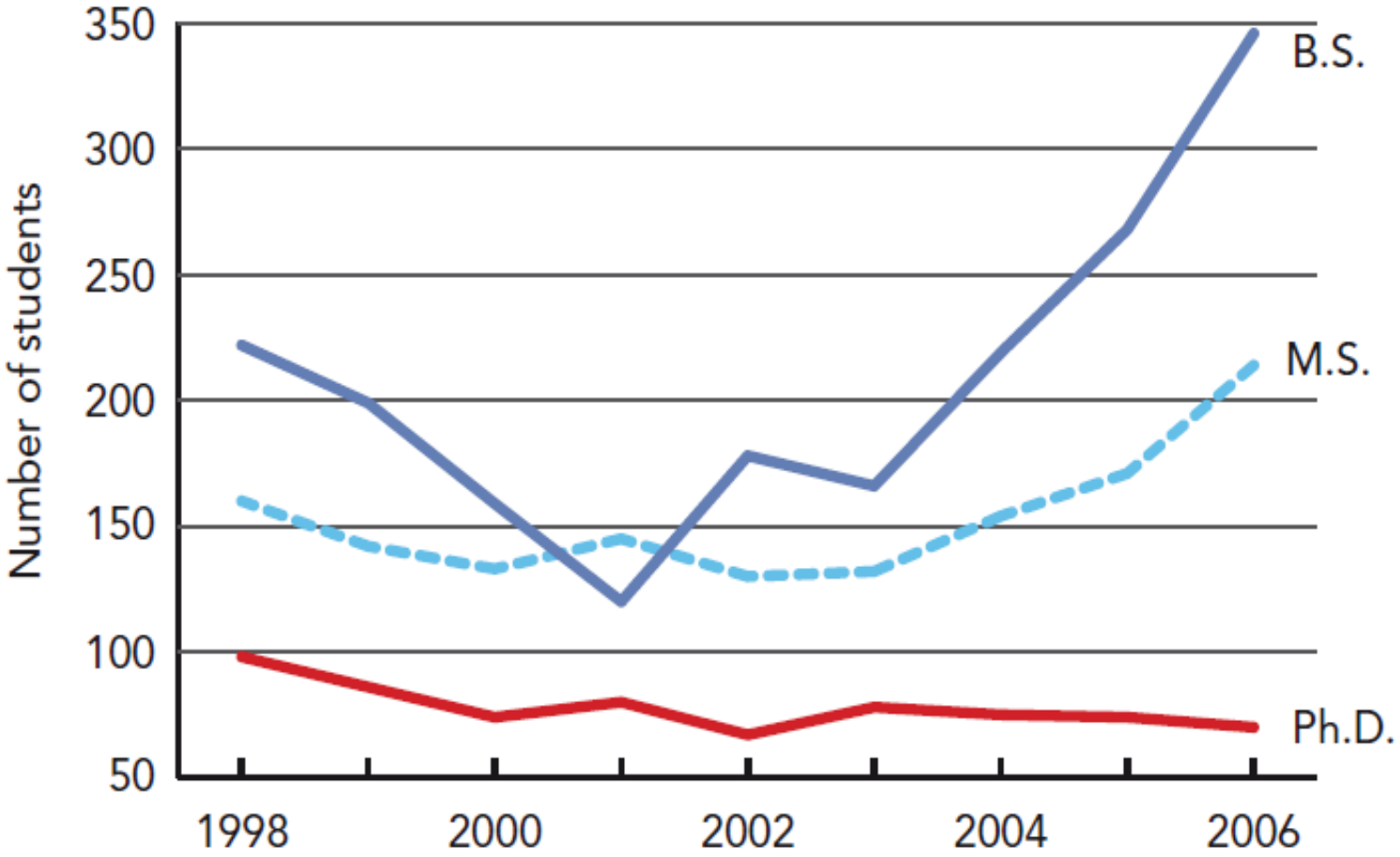
Nuclear Engineering



Trends in Nuclear Chemistry Programs

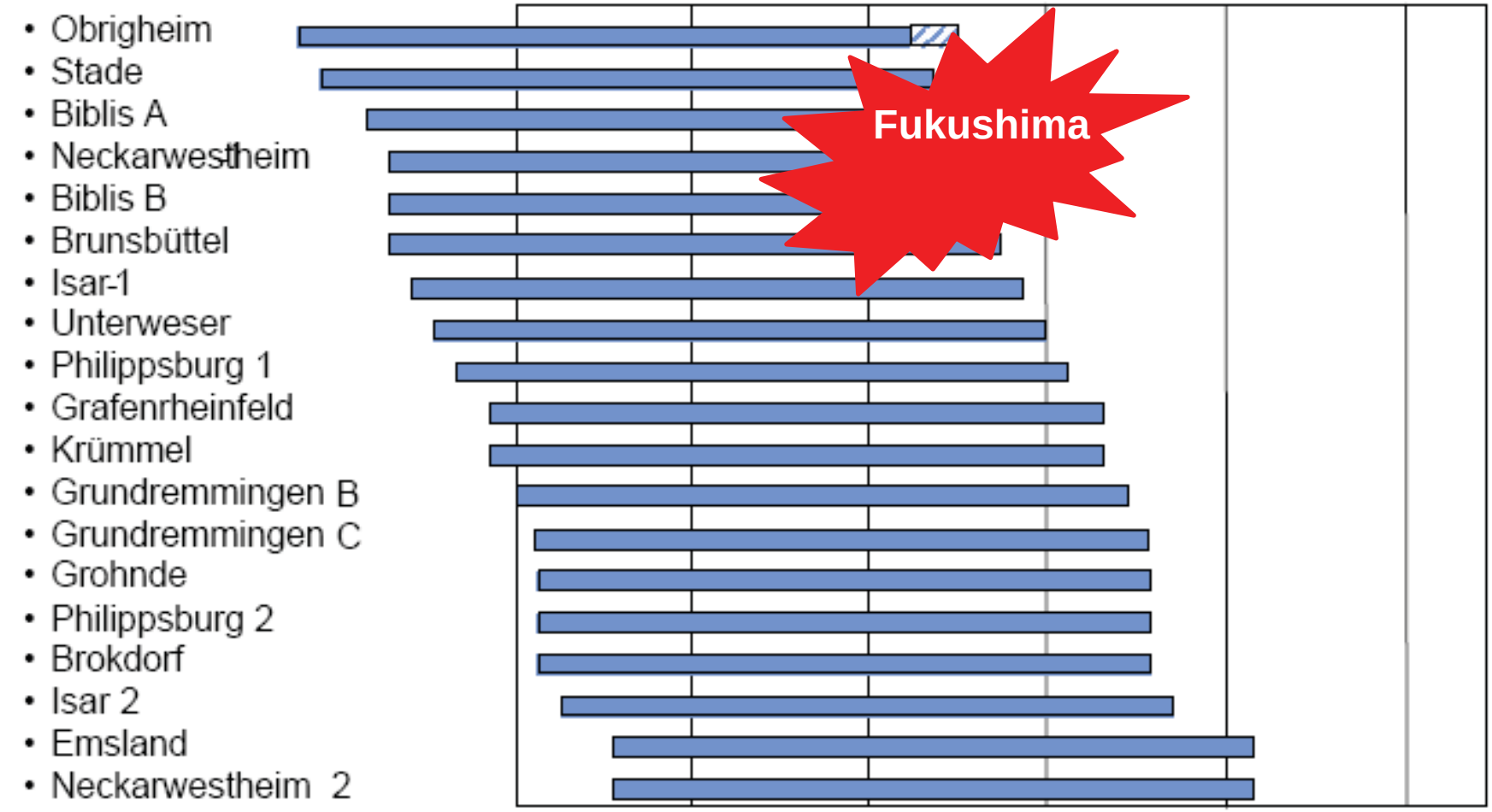


Nuclear engineering in US



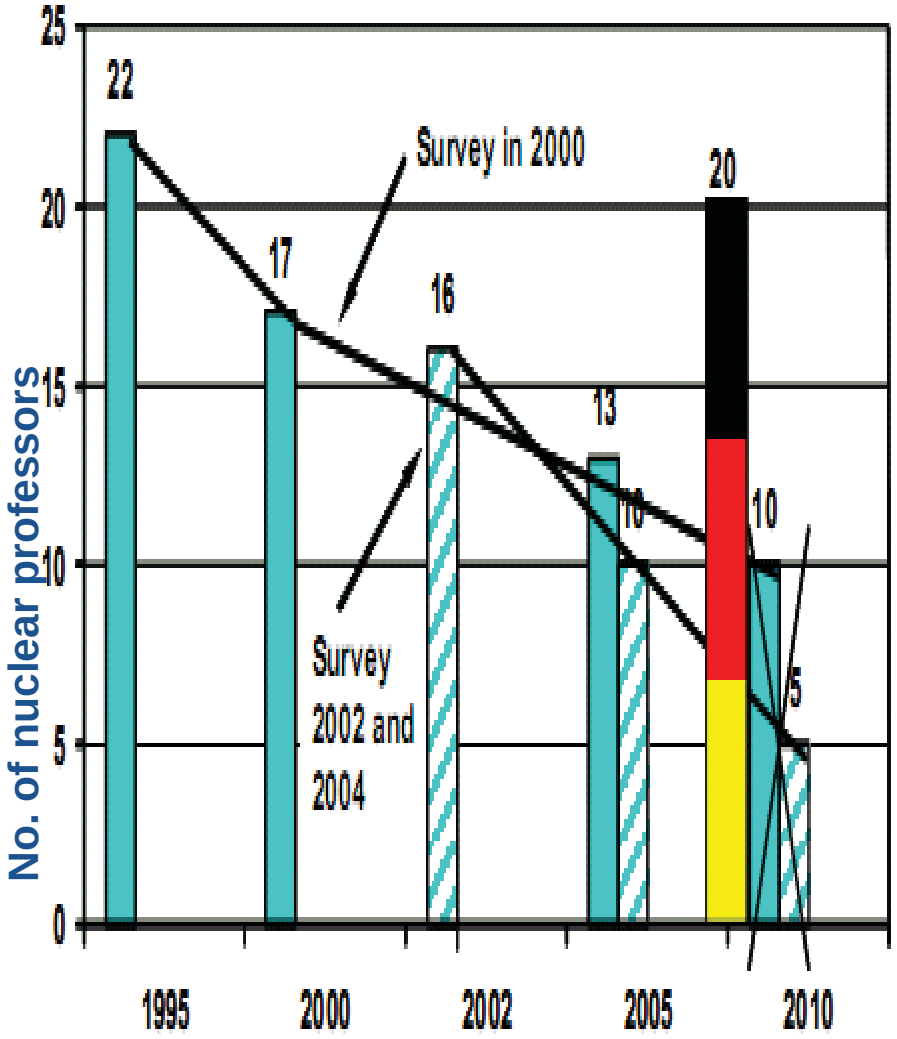
The German Phase-out

Operation times of the 19 nuclear power plants in Germany

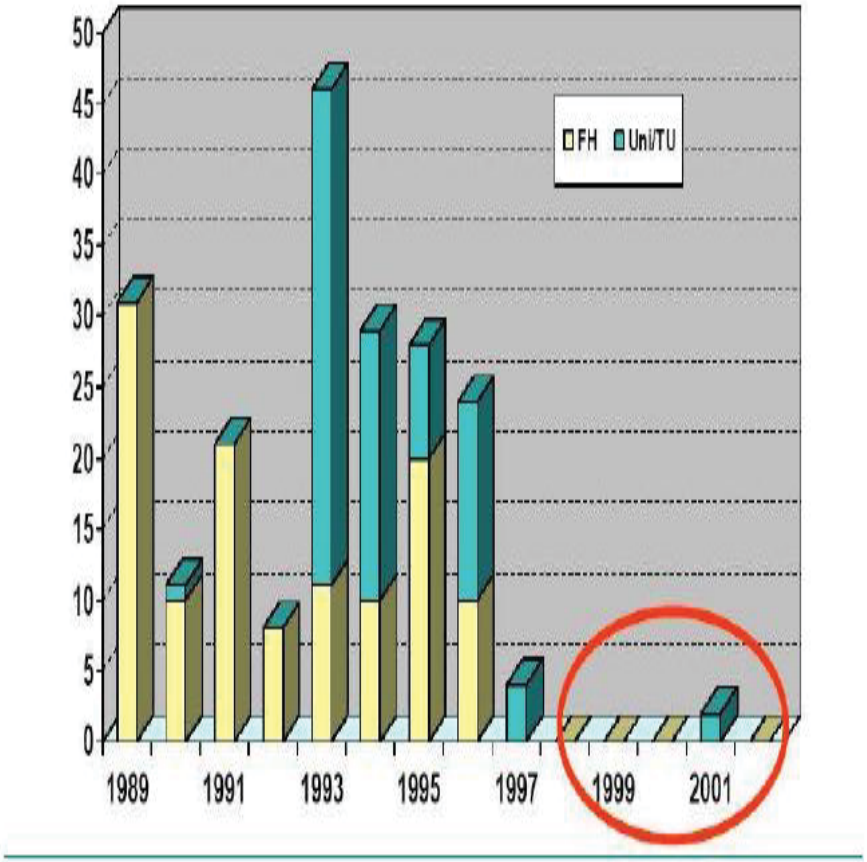


Source: Forschungszentrum Karlsruhe

German R&T issues

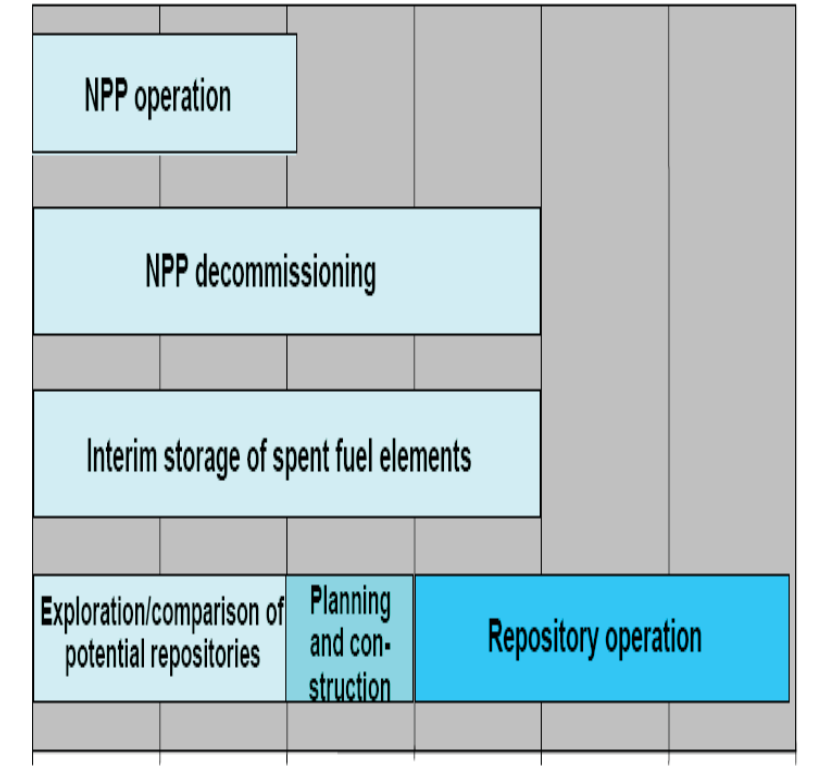


Diplomas in the Fields of Nuclear



Need for nuclear specialists in Germany

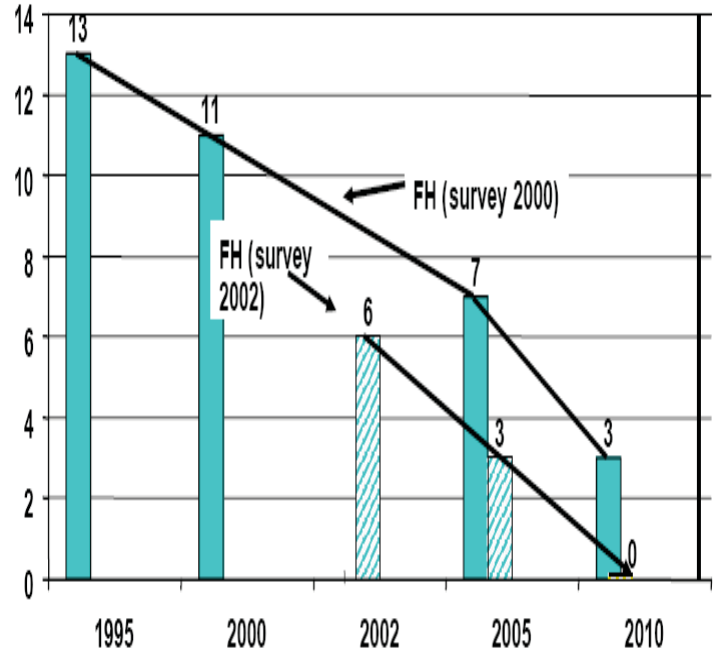
Opt-out" and remaining activities until repository storage



Source: Forschungszentrum Karlsruhe

Nuclear engineering lectures offered by German higher technical colleges

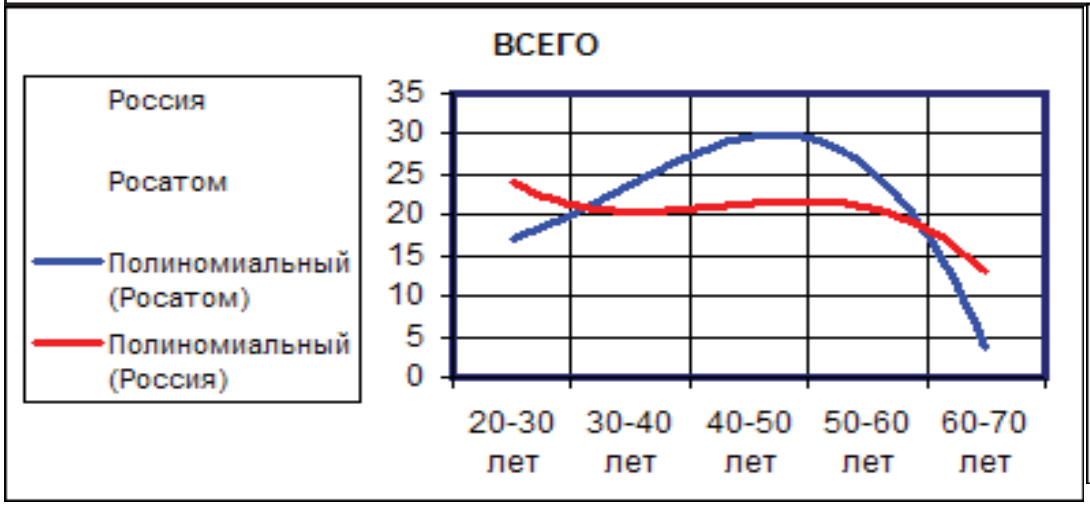
(Evaluation of the surveys made by the KTG (1994), FZK (2000), and FZK (2002))

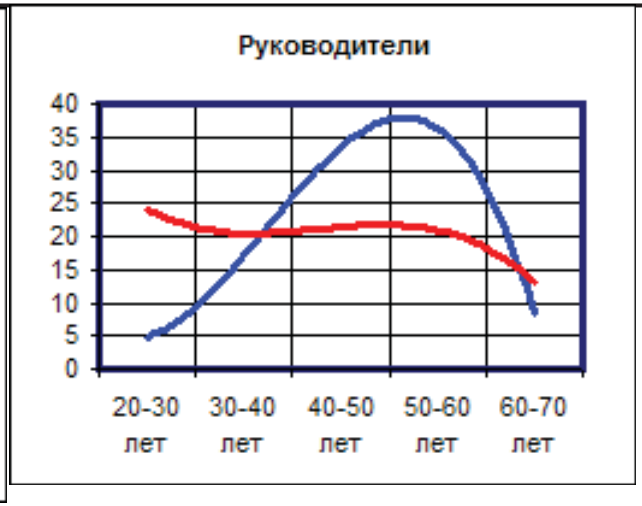


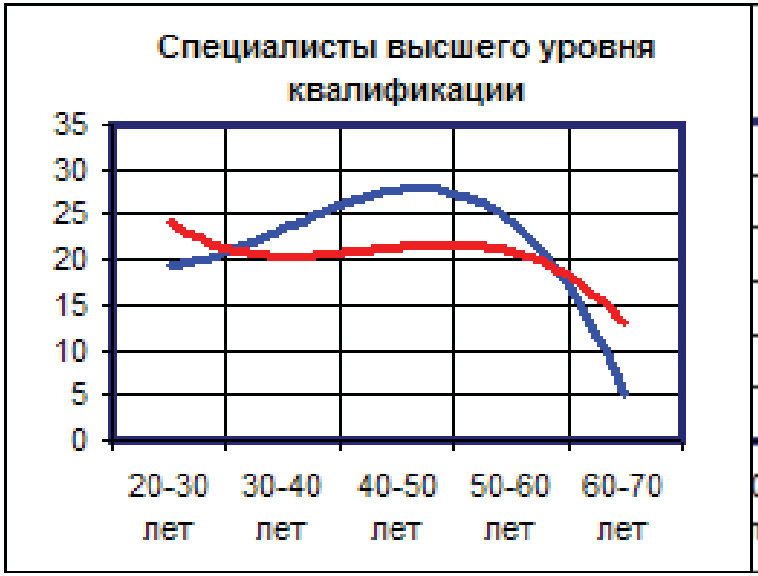
*) in the subjects of reactor physics, reactor technology, reactor safety, nuclear chemistry, radiochemistry and radiation protection

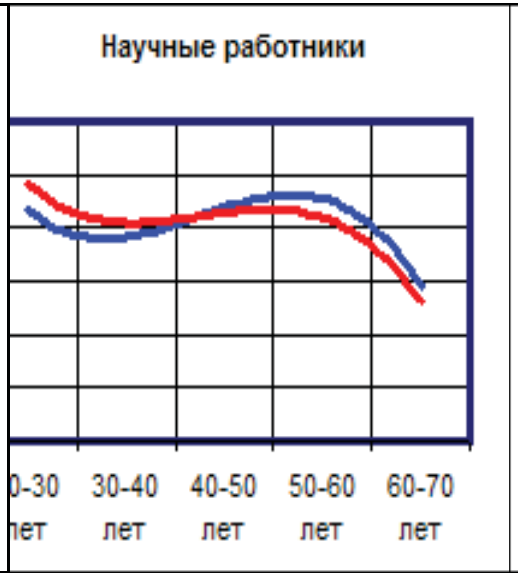
Source: Forschungszentrum Karlsruhe

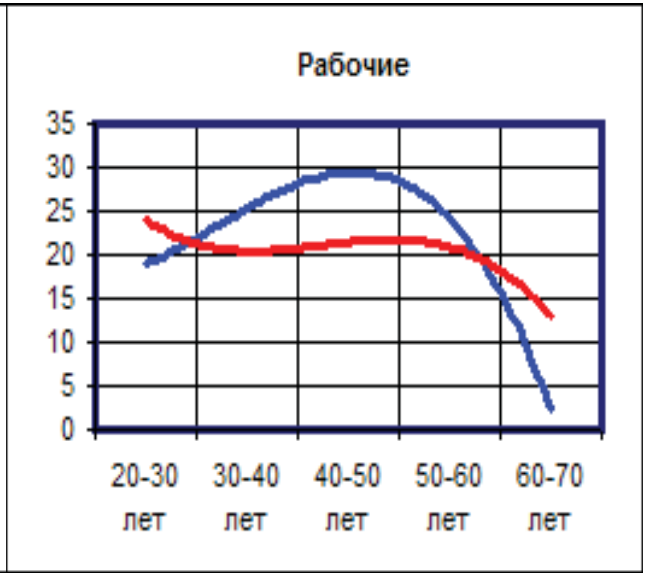
The Russian nuclear workforce



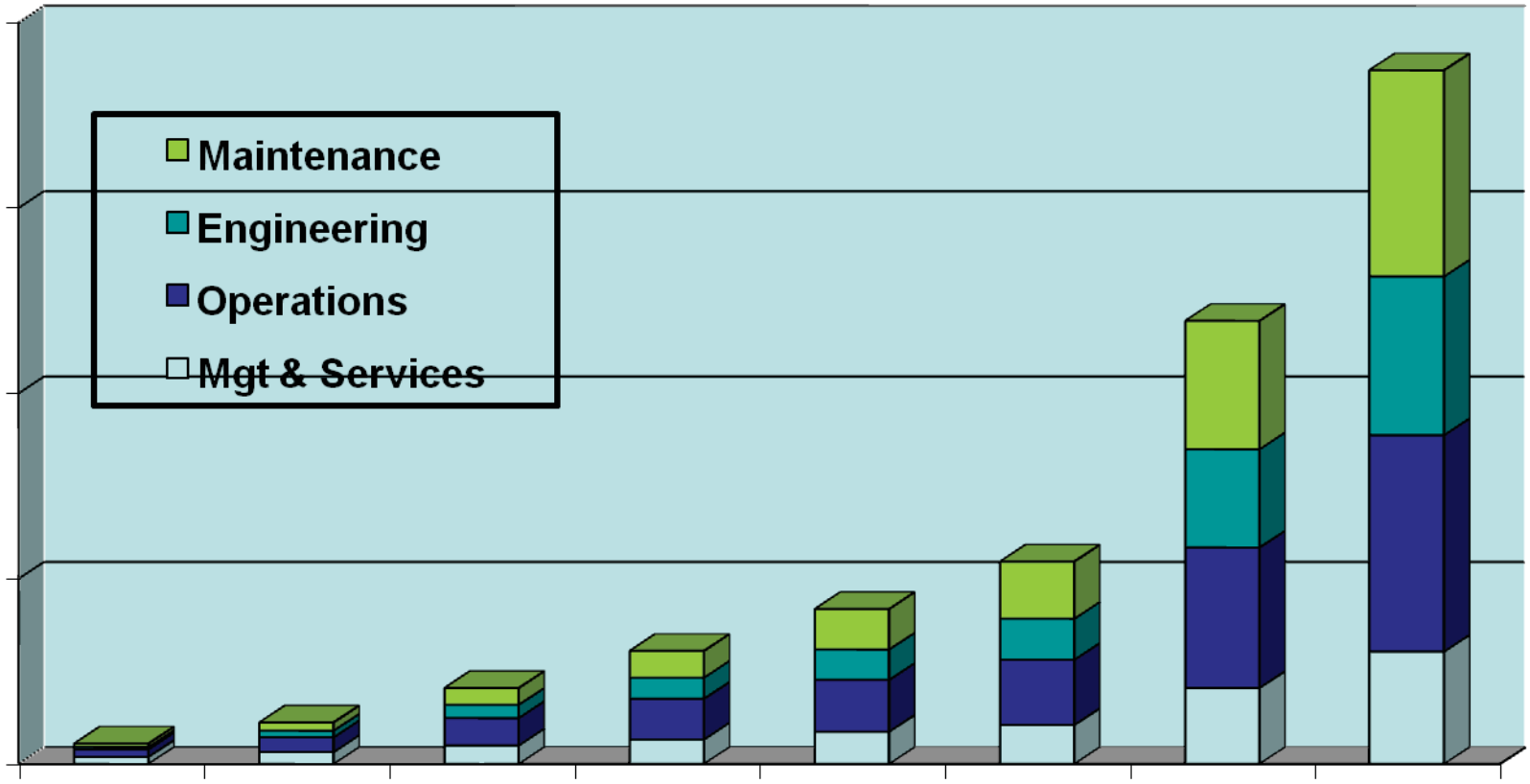






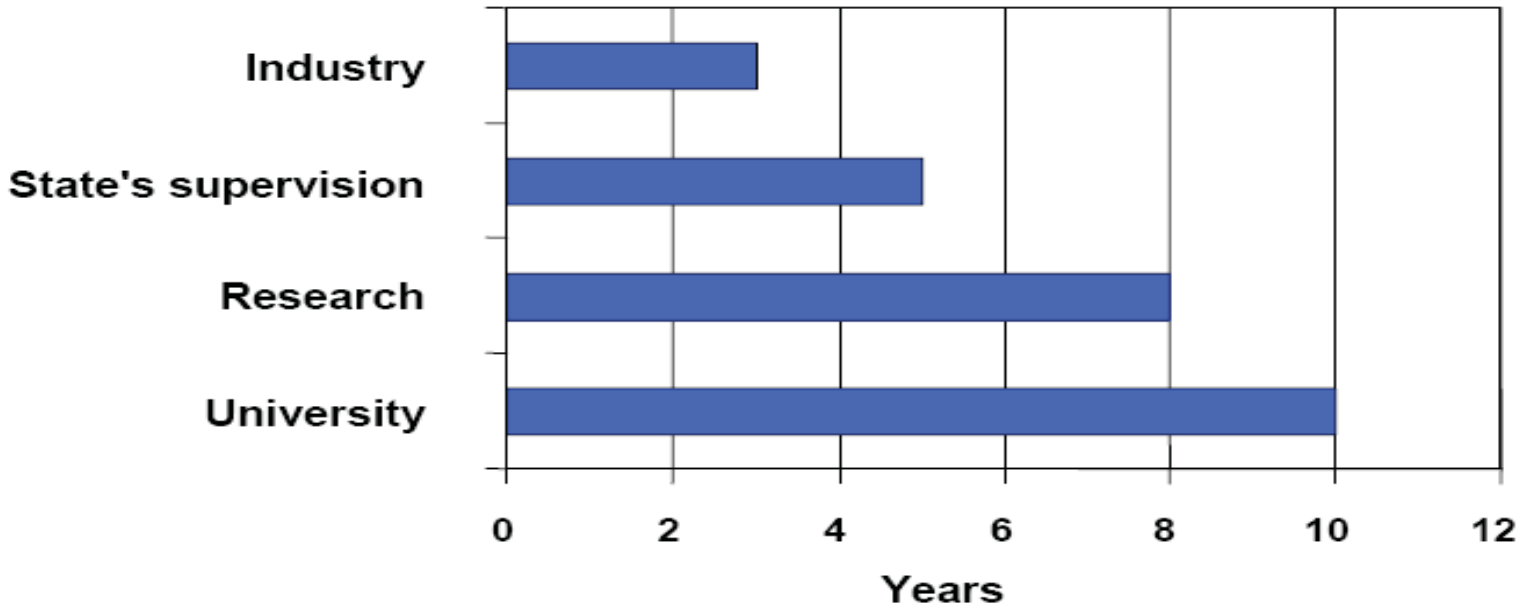


Manpower for Operating China NPPs



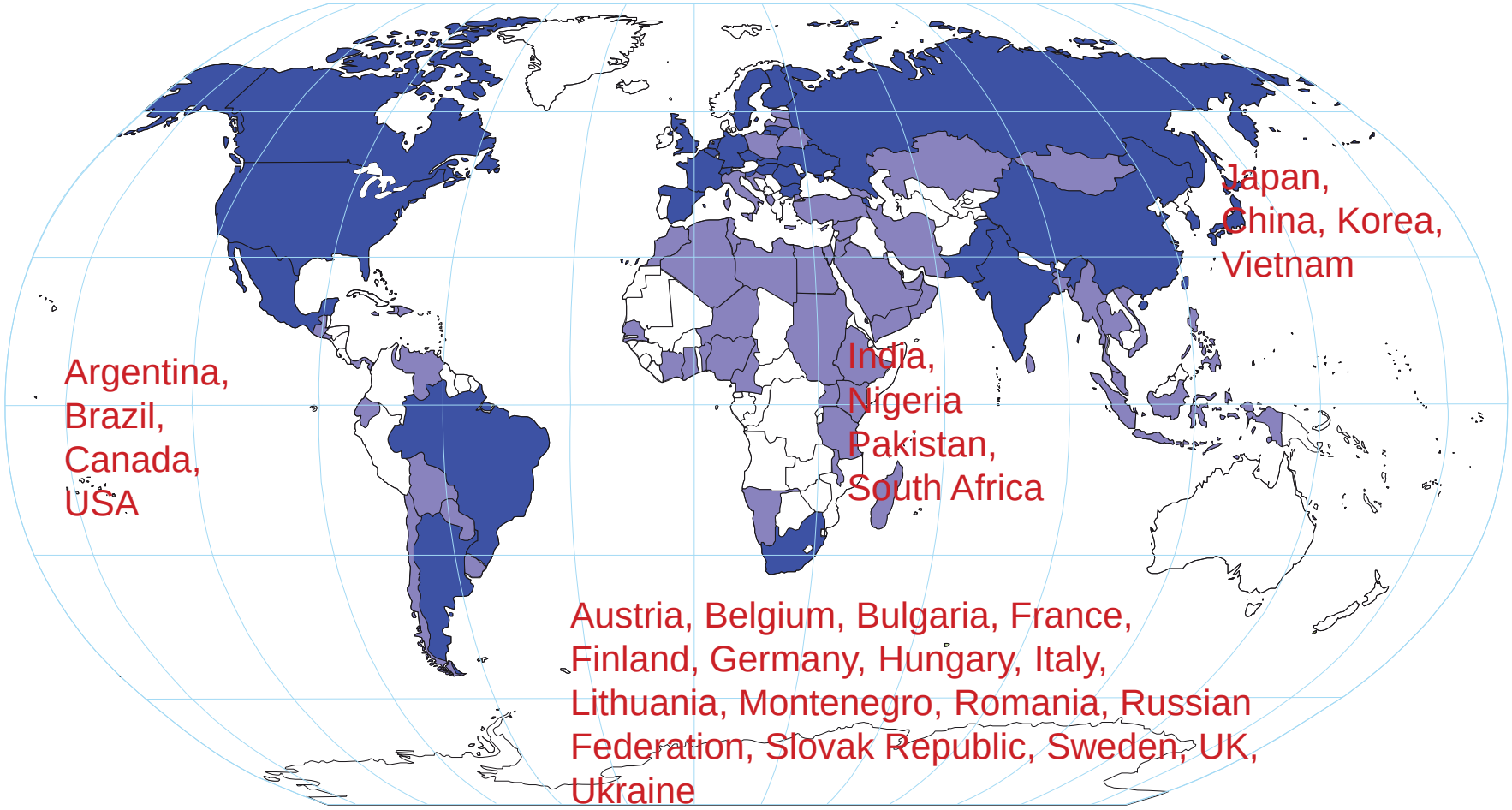
Time to build competence

Times for establishing nuclear engineering competence

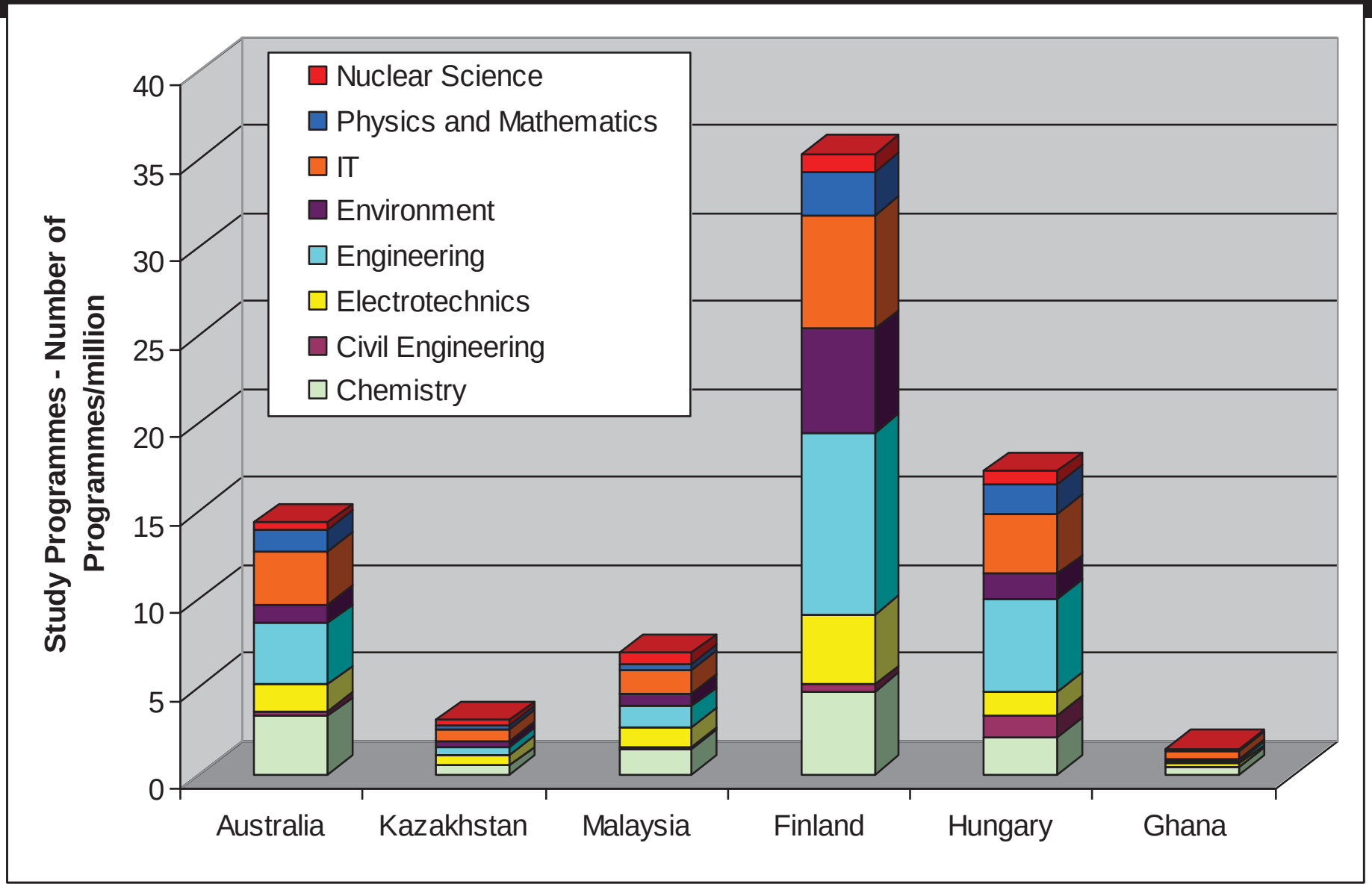


Source: S. Griffiths, J. Royen: „Assuring future nuclear safety competence “, NEA News 2000 - No. 18.1

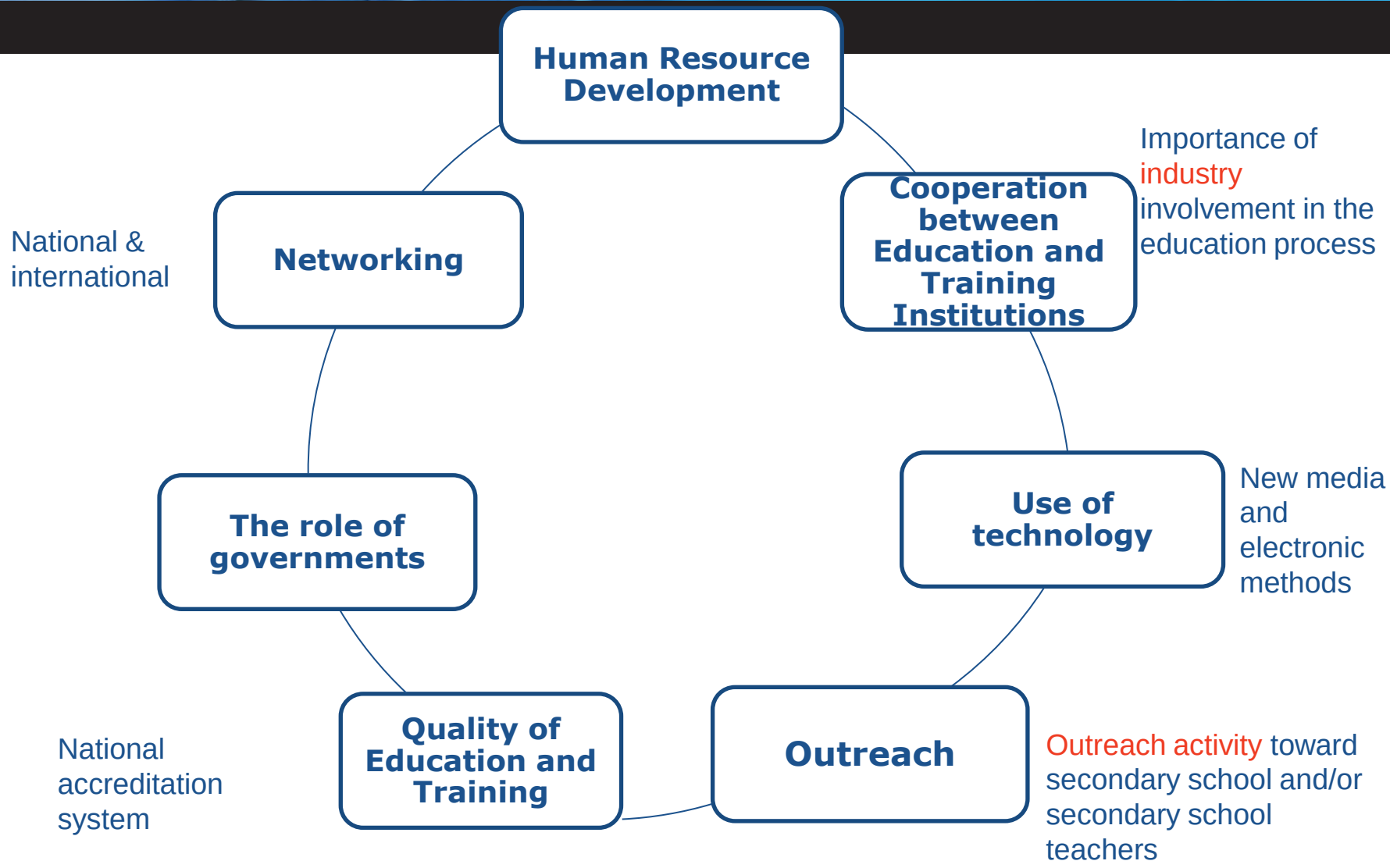
Global Review of Nuclear Education



Benchmarking Educational Capacity

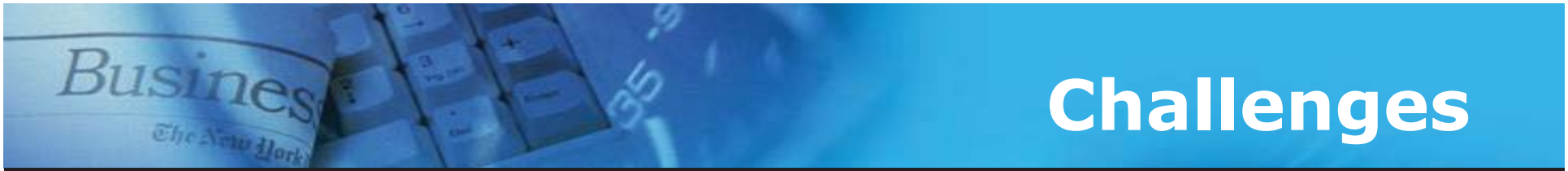


Nuclear Competence Building



Working together!

- Industry and educational institutions working together
  - Even better: industry/government/educational institutions
- Highly Integrated programs:
  - 2-year with 4-year education programs
  - Plant staff and students
  - Internships part of curriculum
  - Several education institutes working together
- Hands-on training
- Teach the teachers



Challenges

- **International "standards" by industry/academia**
  - e.g., new programs for masters level with similar scope but different length/depth, residency requirements, and input qualifications
  - Introducing elements of "safety culture" into education
  - Still large component of "hands-on" training needed
  - More women to increase total talent pool
  - Early training in non-technical skills: law, economics, finance, business ...

Challenges

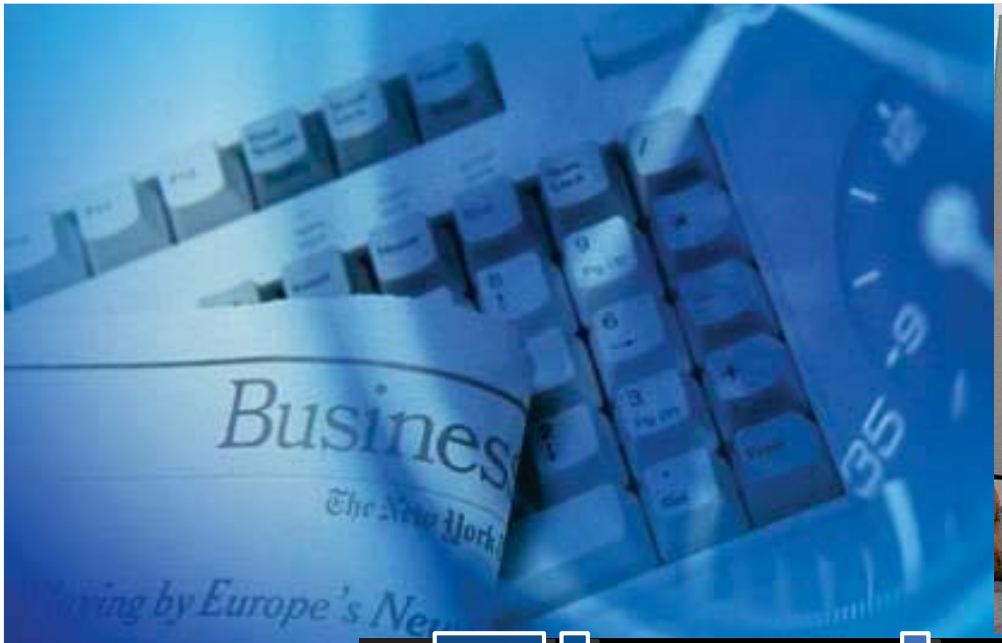
- **Instructors at all levels need practical experience**
  - Avoiding ‘inbreeding’ where instructors without industry experience are training new instructors who will also not get industry experience ...

IAEA Role

- IAEA has a strong knowledge management mandate and comprehensive programs
- IAEA provides support through the Technical Cooperation program (national and regional HR development projects)
- New direction id E-Learning
  - CLP4NET
  - CONNECT
  - Other initiatives
    - MSci, PhD, Specialised training courses, etc .

Conclusions

1. Competence building has come a long way forward
2. Government policy and consistency essential for sustainable nuclear education
3. Importance of vision in all areas
4. Balance between formal and practical training for both students and teachers
5. Safety culture should continue to be a key issue for human resource development



Thank You !

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