ECVET Seminar for the Nuclear Energy Sector
25-26 September 2012, MADOU building in Brussels

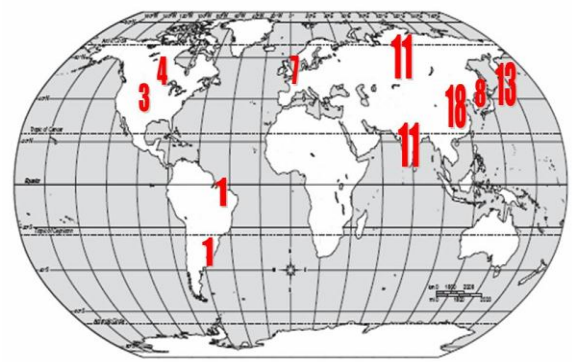
From Knowledge Transfer to Competence Building in Euratom :

DG RTD efforts to support and implement ECVET in the nuclear sector

Georges Van Goethem
European Commission
DG Research & Innovation - Dir Energy - Unit K4 Fission
Tel +32 2 295 14 24 - georges.van-goethem@ec.europa.eu

European Commission

Table of Contents



European Commission

Nuclear Power Plants in the EU (September 2012)
Total of 132 units operable in 14 Member States (total installed capacity of 122 GWe)

1– Introduction: challenges for education & training in the EU

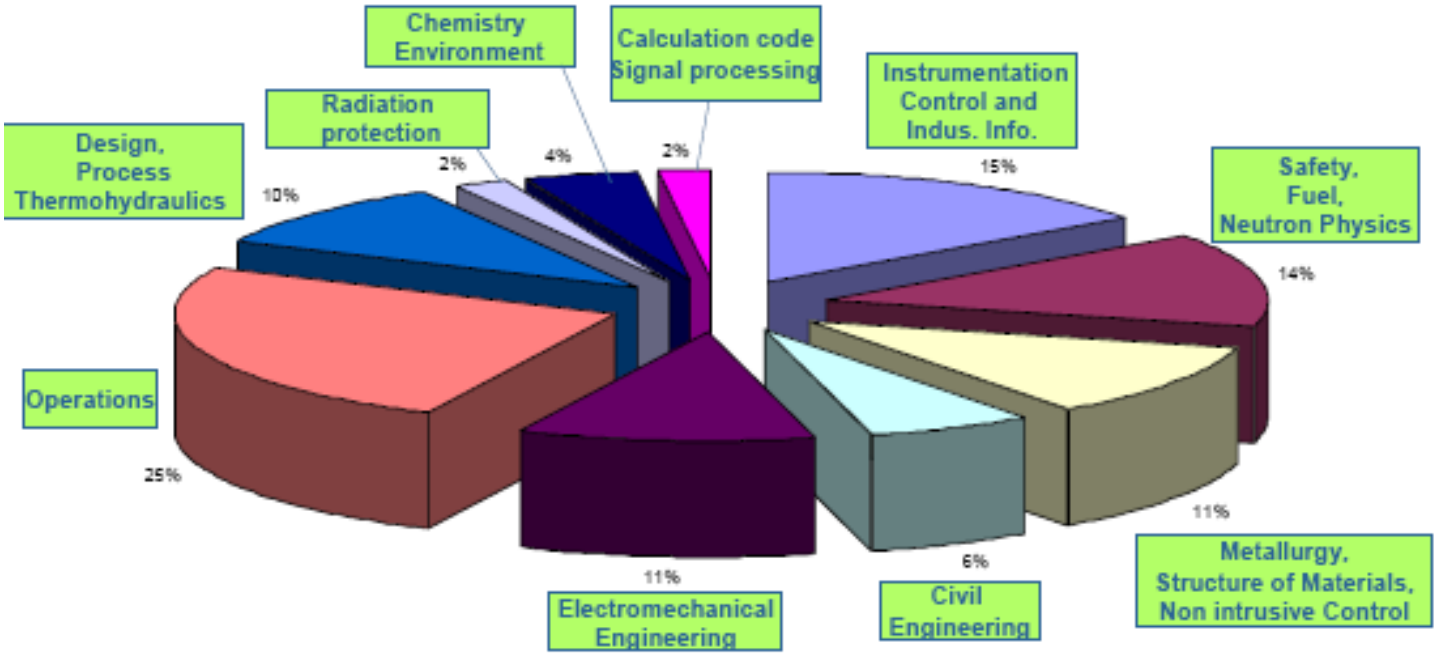
(1) socio-economic end-user requirements

- possible shortage of skilled professionals and ageing population; new approaches for human resource development in a multicultural environment; high-level decisions needed over long time scales

- need for public understanding and acceptance; increasingly multidisciplinary and international character (especially in the energy sector); different national policies amongst EU Member States regarding the energy mix

- pan-European mobility in science and technology; new sociological characteristics of learners (e.g. "Y" generation) ; towards a common language between the world of education and the world of work; impact of the new EU tools for E&T

Discussion with Human Resources Department: list of standard job profiles

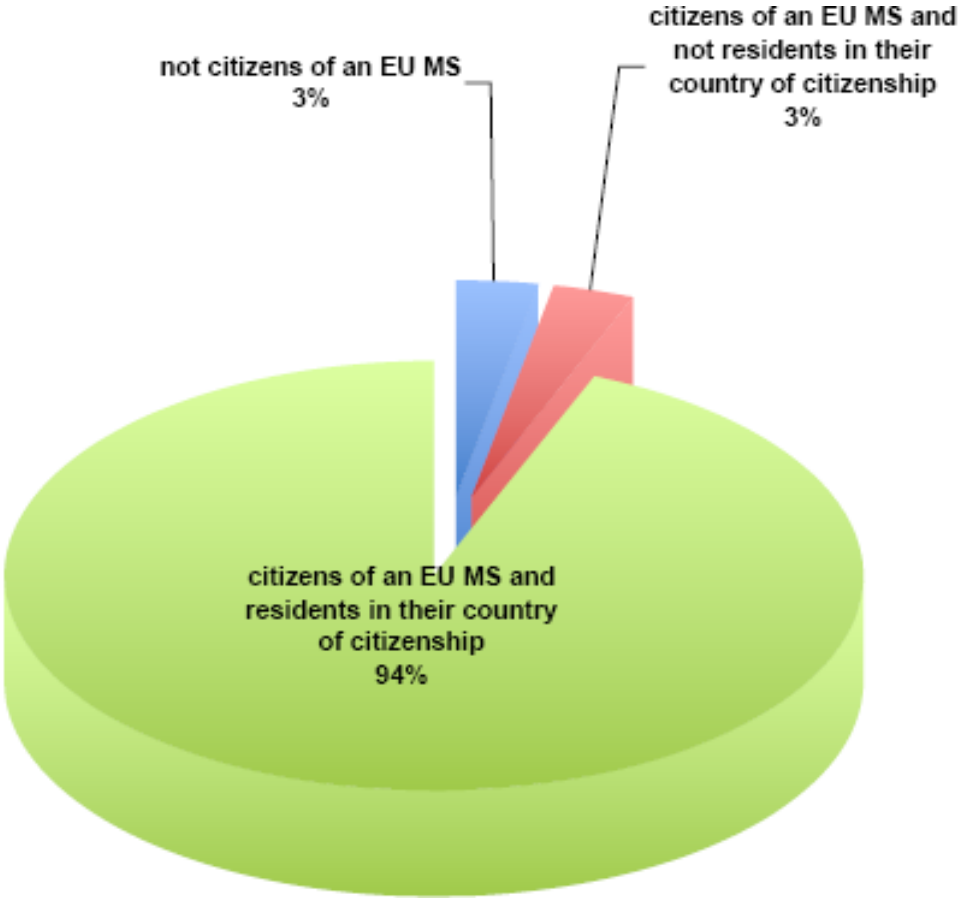


Job interview of applicants : principal question asked by HRD

is no longer: *"what did you do to obtain your degree ?"*

but rather: *"**what can you do now that you have obtained your degree** ?"*

Share of the human resource in science and technology aged 25-64 years in the EU-27 in 2009 divided by citizenship

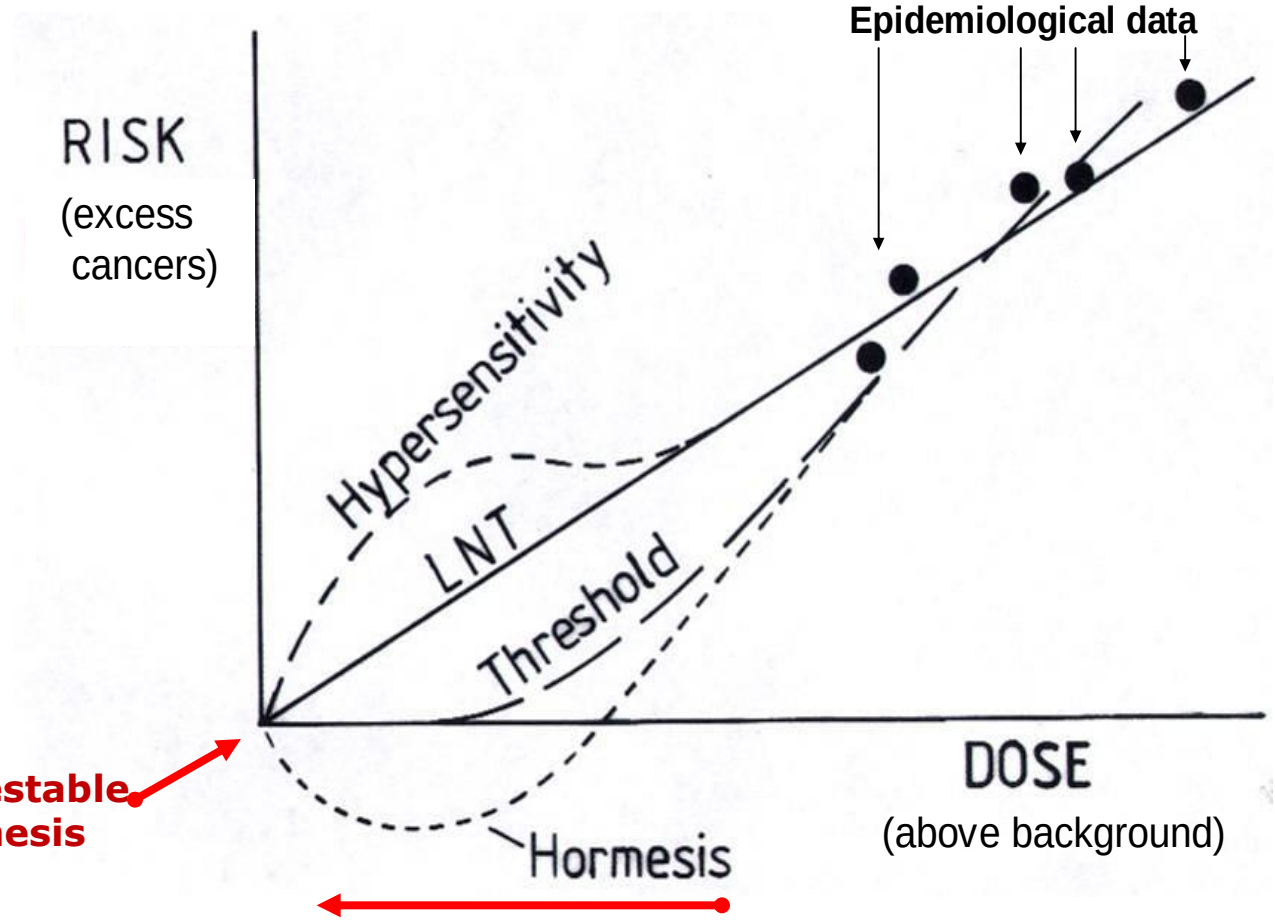


The share of S&T human resource within the total labour force in the EU-27 in 2009 (217 827 000) was 40% in 2009 (that is: individuals working in an S&T occupation as professionals and technicians)

=> international mobility of the human resource in science and technology in the EU-27: relatively poor mobility
Source: Eurostat, Statistics in focus, How mobile are highly qualified human resources in science and technology, http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-007-075/EN/KS-SF-007-075-EN.PDF

Radiation protection:

low dose risk extrapolation



LNT: a testable hypothesis

Low Dose Research

Competing theories of "linear no-threshold" model and "hormesis"

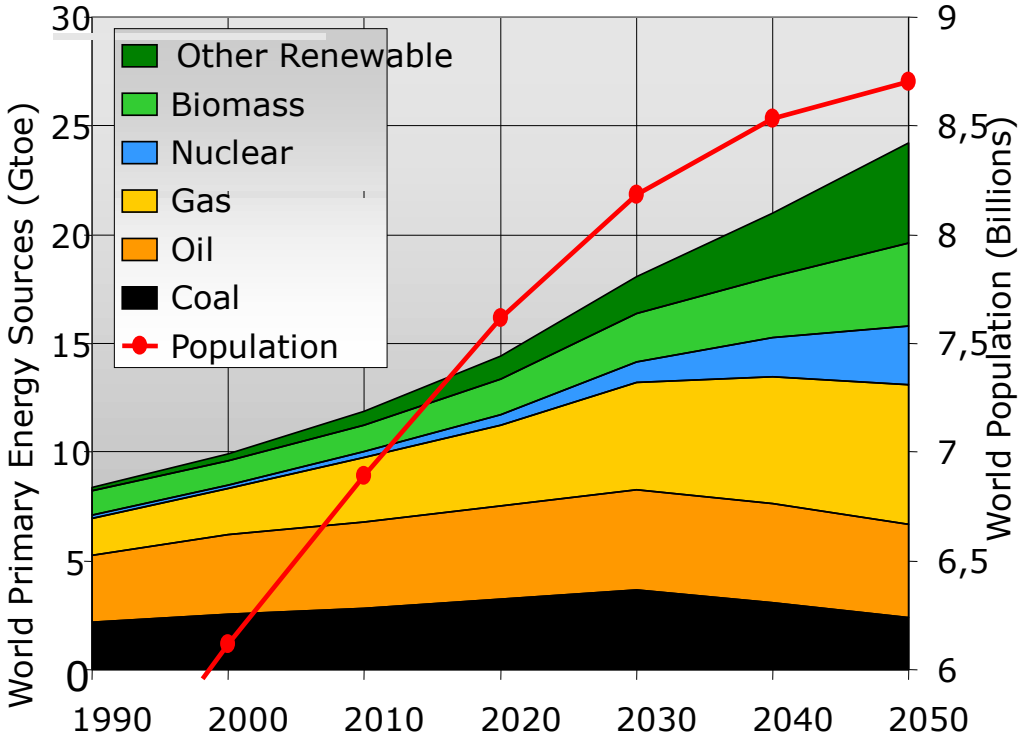
Challenges for education & training in the EU

(2) scientific – technological end-user requirements

Technical miracles of the 20th century

1. **Electrification**
2. **Automobile**
3. **Airplane**
4. **Safe and Abundant Water**
5. **Electronics**
6. **Radio and Television**
7. **Agricultural Mechanization**
8. **Computers**
9. **Telephone**
10. **Air Conditioning and Refrigeration**
11. **Interstate Highways**
12. **Space Exploration**
13. **Internet**
14. **Imaging Technologies**
15. **Household Appliances**
16. **Health Technologies**
17. **Petroleum and Gas Technologies**
18. **Laser and Fiber Optics**
19. **Nuclear Technologies**
20. **High Performance Materials**

(Source: USA Nat'l Academy of Engineering, 2000, ***http://www.greatachievements.org/)***

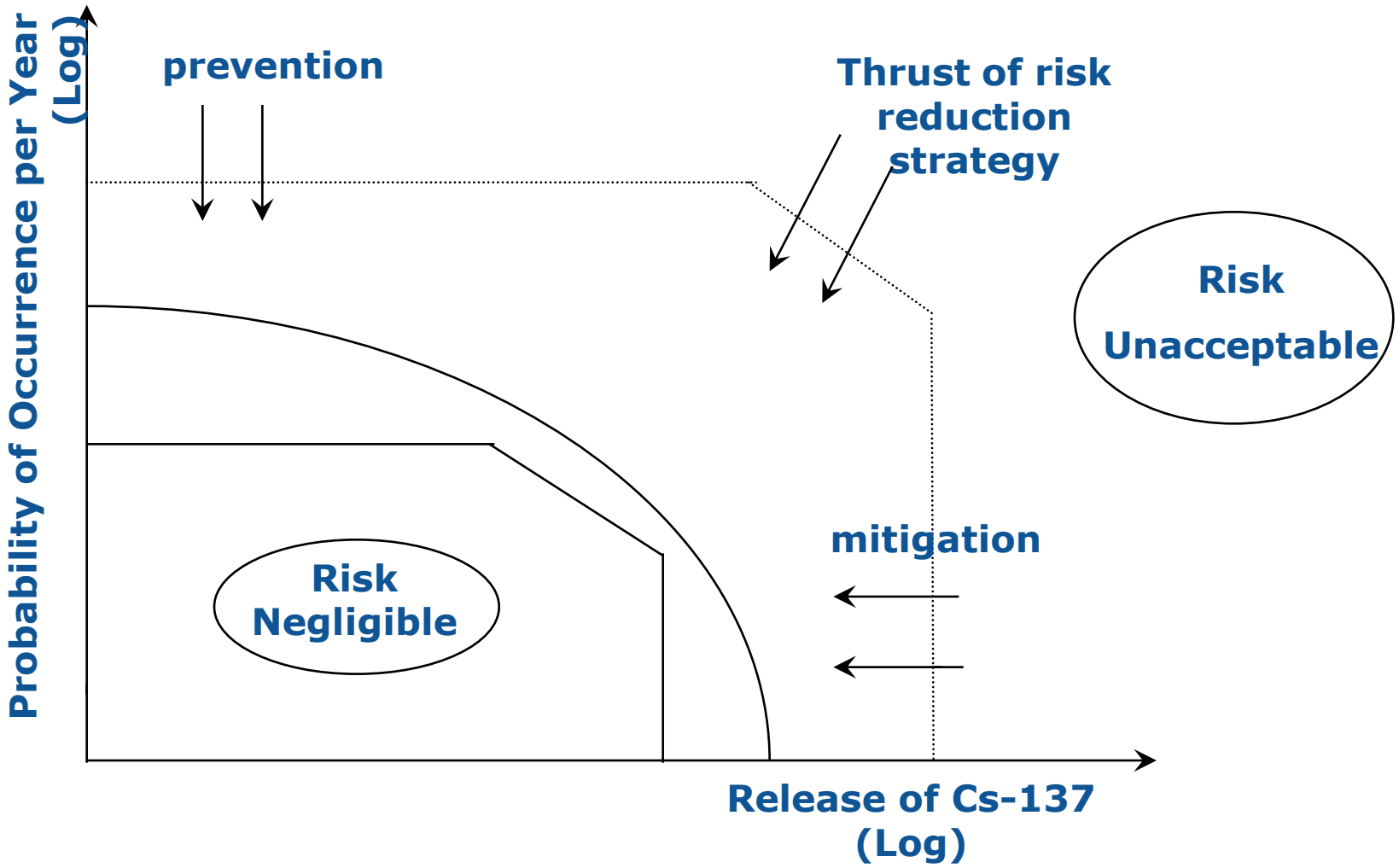


Source IEA : Energy to 2050 - Scenarios for a Sustainable Future

21-st century:
paradigms of growing energy needs & world population (including ageing) pose a serious challenge…

Risk acceptance criterion:

frequency vs consequences (Farmer F.R., IAEA, 1967)



Challenges for job mobility and competence development in the EU

(1) EQF : common European reference system to improve transparency between different countries' national qualifications systems and frameworks (*European Qualifications Framework for Lifelong Learning*)

(2) Europass : portfolio of documents to be used by individuals to describe their qualifications and competences (should contain a clear reference to the appropriate EQF level)

(3) a common language between the world of education and the world of work
(*European Skills, Competencies and Occupations* taxonomy /ESCO tool developed by DG EMPL and DG EAC)

Specific case of nuclear power plants and fuel cycle facilities: what are the (higher level education) jobs that require a national licensing qualification ?

- SPAIN (CSN): reactor operator, shift supervisor, chief of radiological protection service

- UK: HM inspector (HSE), nuclear waste assessor (environment agency)

- BELGIUM (FANC): radiation protection expert (= "health physics expert", Class 1 academic)

- FINLAND (STUK): manager of NPP, reactor operator, individuals responsible for
(1) emergency response arrangements, (2) physical protection, (3) nuclear material safeguards

Descriptors defining levels in the European Qualifications Framework (EQF)

Level 1	The learning outcomes relevant to Level 1 are	• basic general knowledge
Level 2	The learning outcomes relevant to Level 2 are	• basic factual knowledge of a field of work or study
Level 3	The learning outcomes relevant to Level 3 are	• knowledge of facts, principles, processes and general concepts, in a field of work or study
Level 4	The learning outcomes relevant to Level 4 are	• factual and theoretical knowledge in broad contexts within a field of work or study
Level 5*	The learning outcomes relevant to Level 5 are	• comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge
Level 6**	The learning outcomes relevant to Level 6 are	• advanced knowledge of a field of work or study, involving a critical understanding of theories and principles
Level 7***	The learning outcomes relevant to Level 7 are	• highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research • critical awareness of knowledge issues in a field and at the interface between different fields
Level 8****	The learning outcomes relevant to Level 8 are	• knowledge at the most advanced frontier of a field of work or study and at the interface between fields

Source: "The European Qualifications Framework for Lifelong Learning (EQF)" – EC 2008 / http://www.ecvet-team.eu/sites/default/files/eqf_brochure_2008_en.pdf

Who are the end-users of Euratom E&T ?

(Drivers and Enablers)

Decision Making

- Should Euratom E&T be driven principally by public concerns or by industrial needs? - Who are then the best representatives (e.g. environmental organisations for public or "technological platforms" for industry ?)

Risk Governance

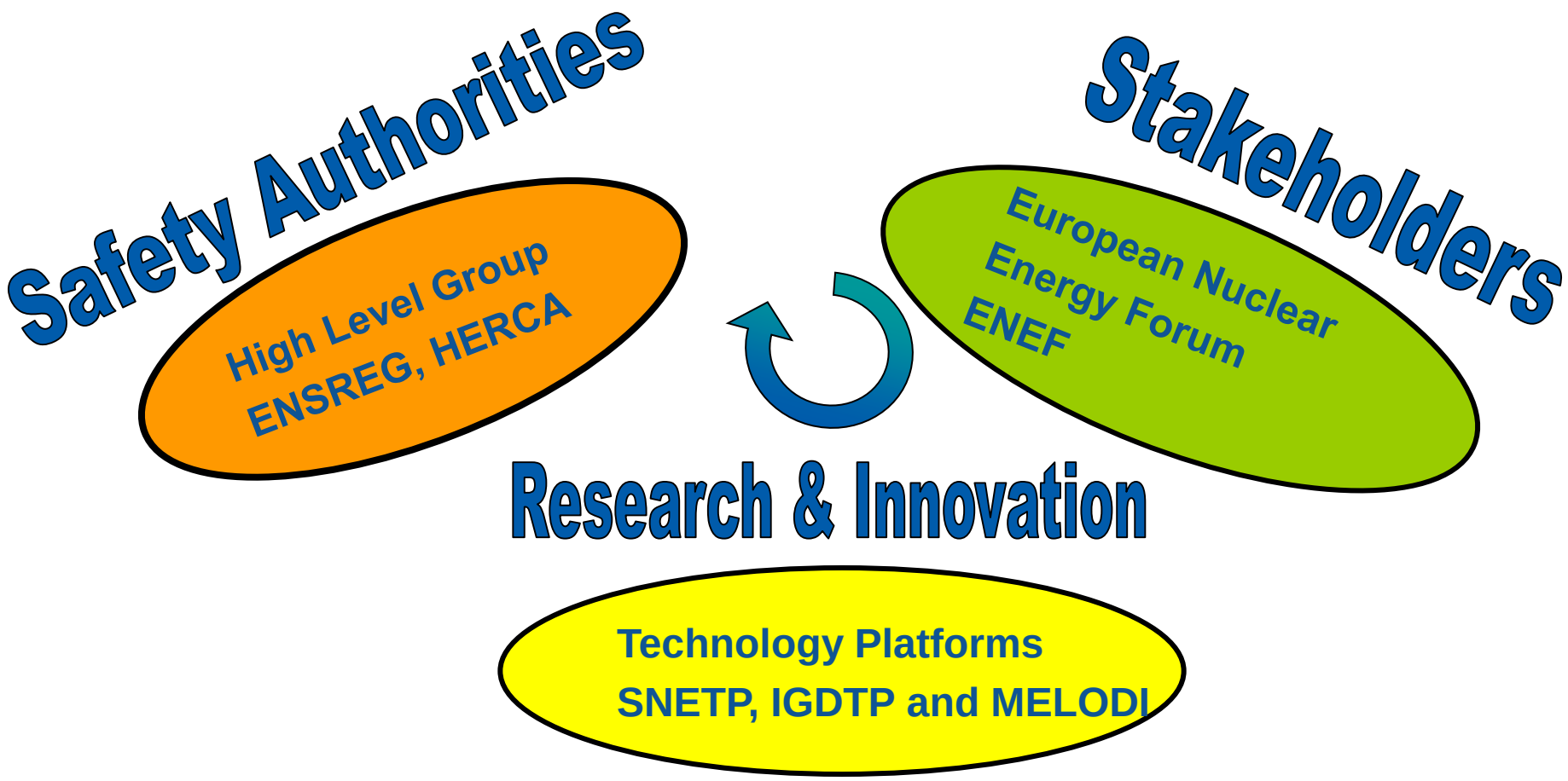
- How to deal with and how to communicate about uncertainties? (e.g. climate change, GMOs, stem cells) - What is an acceptable level of technological risk for the public at large? - What kind of Euratom E&T is needed to improve the risk governance?

EU Research programme

- What is the public perception of Euratom E&T programmes? (policy makers and opinion leaders) - What could be improved to better "serve" the end-users? - More generally, how is the role of the scientific experts perceived in today's society?

Drivers and enablers for changes / "*DRIVERS*"
European Technology Platforms and Stakeholders

- research organisations
  (e.g., public and private sectors, industrial and medical)
- systems suppliers
  (e.g., vendors, engineering companies, manufacturers)
- energy providers
  (e.g., electrical utilities, co-generation plants for process heat)
- public authorities (in particular, regulatory bodies)
- higher education and training institutions
  (in particular universities)
- civil society (policy makers and opinion leaders),
  interest groups and NGOs



- ENSREG = "European Nuclear Safety Regulators Group"
http://ec.europa.eu/energy/nuclear/ensreg/ensreg_en.htm
- HERCA = "Heads of European Radiological Protection Competent Authorities" - http://www.herca.org/index.asp

- ENEF = "European Nuclear Energy Forum"
http://ec.europa.eu/energy/nuclear/forum/forum_en.htm

- **SNE-TP = "Sustainable Nuclear Energy Technology Platform"** - http://www.snetp.eu/
- **IGD-TP = "Implementing Geological Disposal of Radioactive waste"** - http://www.igdtp.eu/
- **MELODI = "Multidisciplinary European Low Dose Initiative"** - http://www.melodi-online.eu/

Drivers and enablers for changes / *"ENABLERS"*

Europe 2020 strategy for smart, sustainable and inclusive growth

- ***RESEARCH***

  "Innovation Union"

  - Turning ideas into jobs, green growth and social progress

  => "Horizon-2020" under "Smart and inclusive growth" (MFF 2014–2020)

- ***ENERGY***

  "Resource efficient Europe"

  - Towards a resource-efficient, low-carbon economy

  ⇒ EU Energy Policy: sustainability, security of supply, competitiveness

- ***EDUCATION***

  "An agenda for new skills and jobs"

  - Towards lifelong learning and borderless mobility

  => improve employability in a global economy at all education levels

European Commission

"European Human Resource Observatory in the Nuclear Energy Sector"

EHRO-N

(http://ehron.jrc.ec.europa.eu/)

Institute for Energy and Transport

1ST SITUATION REPORT ON EDUCATION AND TRAINING IN THE NUCLEAR ENERGY FIELD IN THE EU (COM(2011) 563, Brussels, 16.9.2011)

http://ec.europa.eu/energy/nuclear/safety/doc/com_2011_0563_en.pdf

……. **EHRO-N** is therefore the initiative to fill this gap, especially as it can provide a continuous monitoring and scanning of future challenges. **EHRO-N will be the central information source** for all stakeholders in the EU interested in the optimisation and rounding up of the initiatives taken. Member States are therefore invited to fully support the Commission in developing this promising tool.

……

=> First EHRO-N report on the supply and demand for nuclear experts for the present and future nuclear projects in the EU by 2020 (analysis done on data received from spring 2010 to spring 2011). Nuclear experts were for the purpose of this report defined as *the core experts, mainly nuclear scientists and nuclear engineers, needed to perform nuclear projects in a nuclear organisation*.

……..

"PUTTING INTO PERSPECTIVE THE SUPPLY OF AND DEMAND FOR NUCLEAR EXPERTS BY 2020 WITHIN THE EU-27 NUCLEAR ENERGY SECTOR", April 2012, EHRO-N report, JRC-IET, EUR 25291 EN

BREAKDOWN PER PROFILES OF EMPLOYEES IN THE EU-27 NUCLEAR ENERGY SECTOR (1/2)

The French nuclear energy sector employs the biggest share of all nuclear experts in the EU-27. The need for specific profiles of employees for the French nuclear energy sector (a study done for up to 2012) was taken as the basis for a hypothetical breakdown by main profiles of employees in the nuclear energy sector for the EU-27 as a whole.

Thus, in the EU-27, the workforce in the nuclear energy sector, which in total is estimated at some 500 000, is hypothetically divided like this:

1. **16% are nuclear experts,**
2. **74% are nuclearised engineers, other graduates, and technicians, and**
3. **10% are support and other employees (so called nuclear-aware employees).**

A similar breakdown is proposed in the so called competence pyramid mentioned in the most recent OECD report on "Nuclear Education and Training: From Concern to Capability" (11 April 2012, NEA no 6979)

http://www.oecd-ilibrary.org/nuclear-energy/nuclear-education-and-training_9789264177604-en

=> Both, the nuclearised and nuclear-aware employees need to be trained in order to acquire the competences and skills necessary to perform their activities in the nuclear energy industry.

BREAKDOWN PER PROFILES OF EMPLOYEES IN THE EU-27 NUCLEAR ENERGY SECTOR (2/2)

Thus, in the EU-27, the workforce in the nuclear energy sector is divided like this:

Profiles:

- **16% of nuclear engineers, nuclear physicists, nuclear chemists, radioprotection specialists (or, in short, nuclear experts),**

- **26% of non-nuclear engineers,**
- **20% of other graduates,**
- **28% of technicians, and**

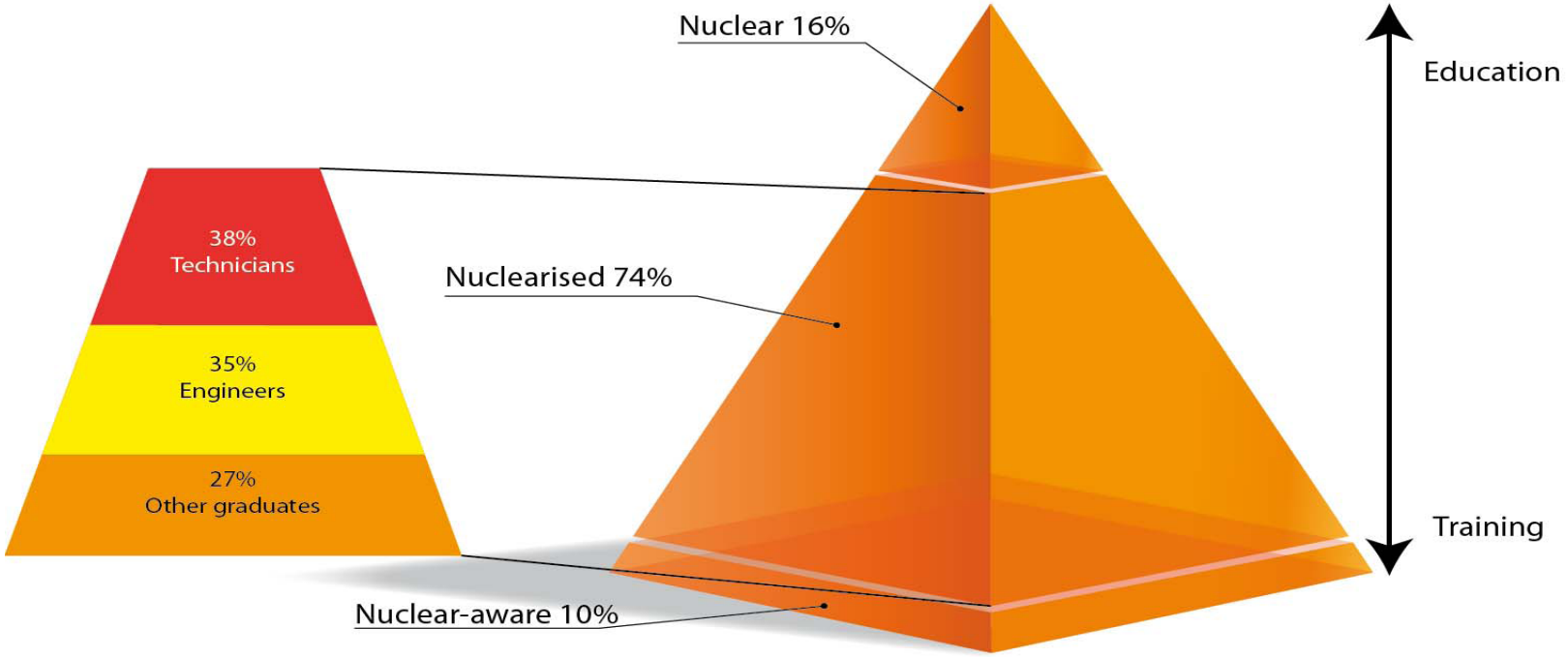
- **10% of support and other profiles.**

The family of 74% or 370 000 (500 000*74%) of nuclearised engineers, other graduates and technicians is made up of:

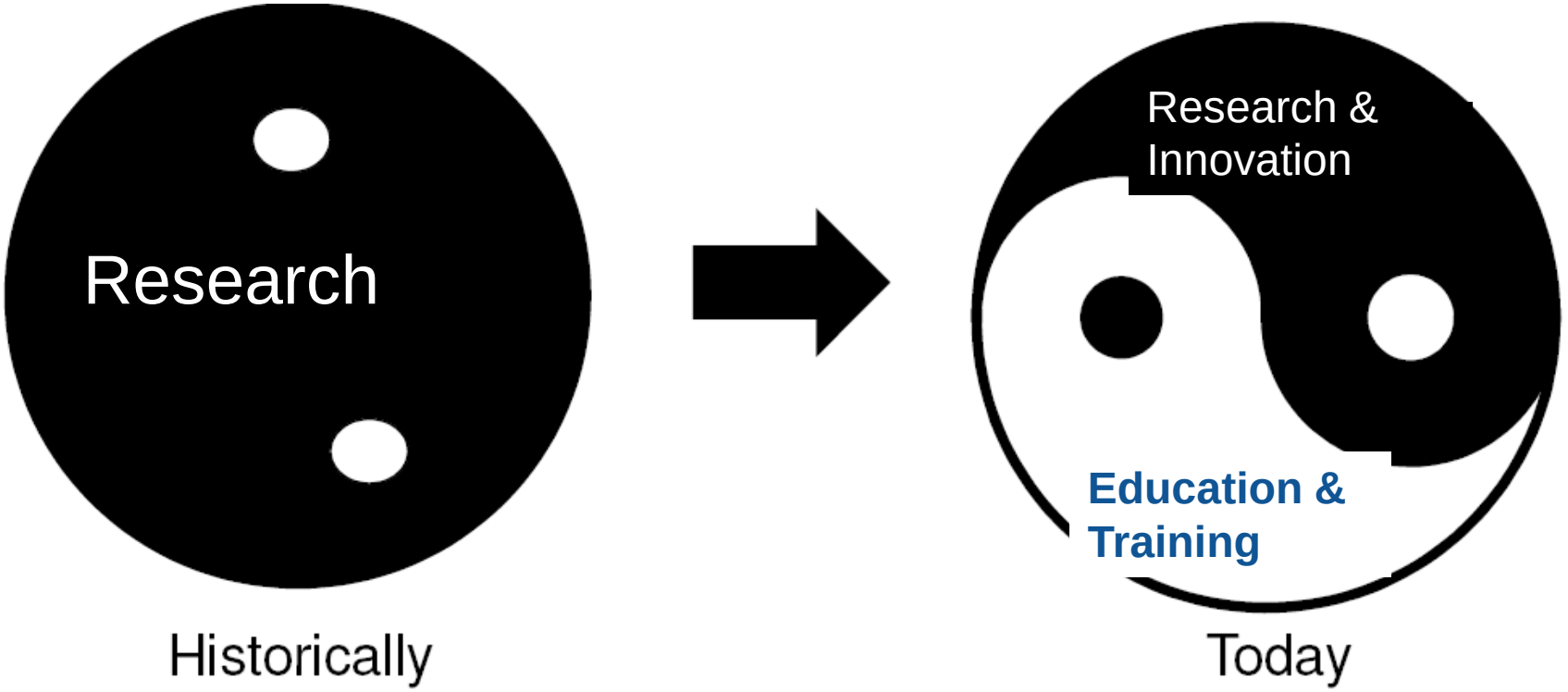
- **38% or 190 000 technicians,**
- **35% or 175 000 engineers, and**
- **27% or 135 000 are other graduates.**

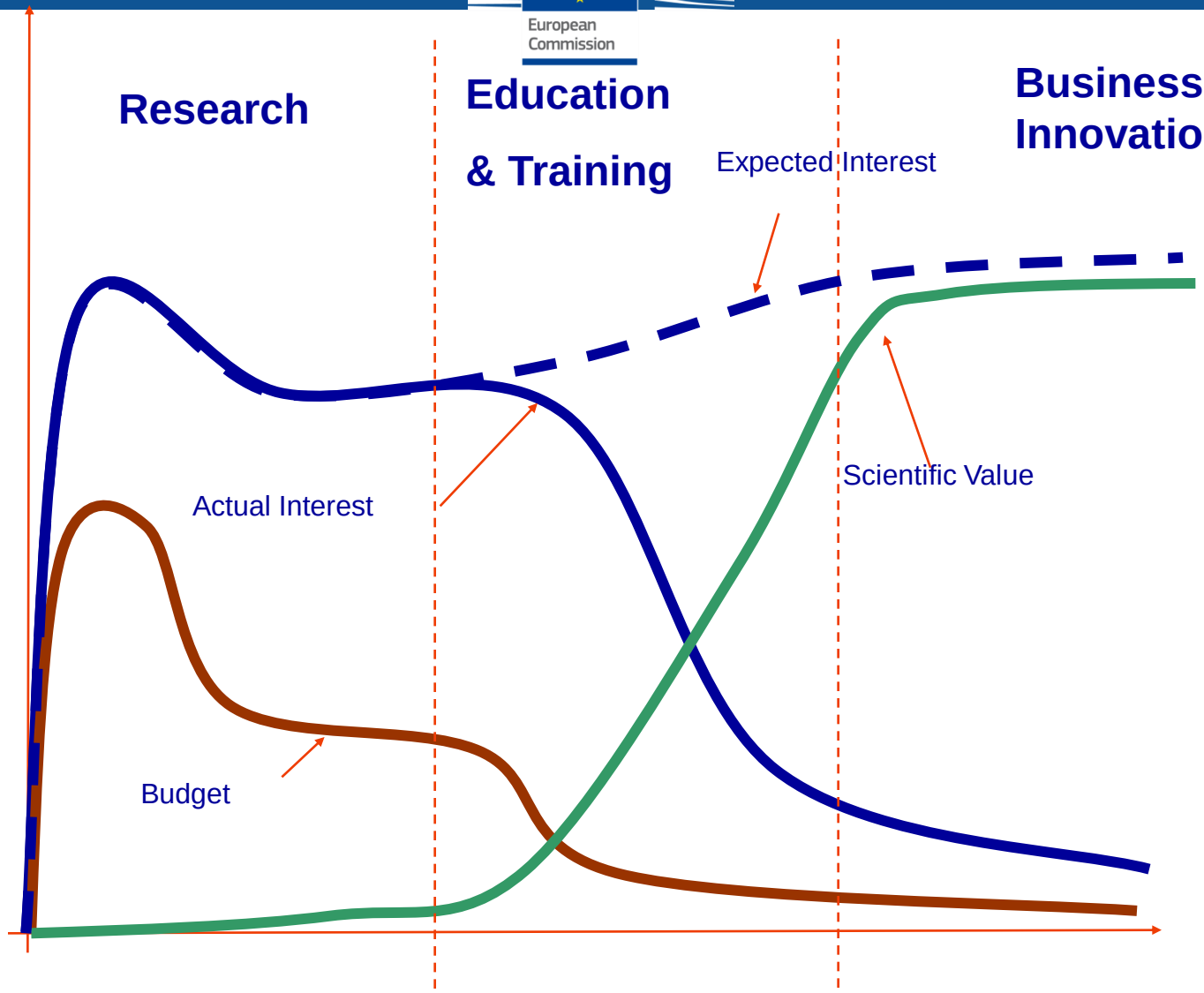
The remaining 10% are employees that perform support and other activities (e.g. commercial, etc.) and are only nuclear-aware.

Hypothetical graphical representation of the nuclear energy sector in the EU-27 by type of employees



2 - Turning ideas into jobs, green growth and social progress (DG RTD)





Knowledge cycle management

"Innovation Union" (= basis for "Horizon-2020", follow-up of FP-7 (2007 – 2013)) COM(2010) 546 (Brussels, 6.10.2010)

Objective: increase Europe's innovation capacity and generate green growth and social progress

Priorities: …… the highest political level sets a strategic agenda, regularly monitors progress and tackles delays."……..

Funding instruments: EC calls for partnerships (public-public and public-private)

What is partnering? Partnering brings together the public sector at European, national and regional levels in as well as the public and private sector in.

- *Public-public partnerships ("P2Ps"):* example of "European Metrology Research Programme" (EMRP) : value of over €400 million (pooling 44% of overall metrology resources in one initiative)

- *Public-private partnerships ("PPPs"):* examples of Joint Technology Initiative (5 initiatives since 2007); European Industrial Initiatives (EII) under the SET Plan (7 EIIs since 2010, including the ESNII (European Sustainable Nuclear Industrial Initiative)

=> EIIs since 2010, including the ESNII (*European Sustainable Nuclear Industrial Initiative*)

Horizon 2020

= Common Strategic Framework for
research, innovation and technological development

Three main areas, firmly anchored in the Europe 2020 strategy:

- excellence in the science base
- tackling societal challenges
- creating industrial leadership and boosting competitiveness.

⇒ eliminate fragmentation and ensure more coherence,
including with national research programmes

"The budget will invest in Europe's brains by increasing the amounts allocated to education, training, research and innovation. These areas are so crucial for Europe's global competitiveness so that we can create the jobs and ideas of tomorrow."

A Budget for Europe 2020, *Brussels, 29.6.2011 COM(2011) 500*

(= Multiannual Financial Framework /MFF/ 2014 – 2020)

Jose Manuel Durão Barroso, President of the European Commission

Euratom (2014-2018) within Horizon 2020

Budget *TOTAL: € 1788 million,*
including Fission €355m;Fusion € 709m; JRC € 724m.
Funding for ITER outside MFF in a separate supplementary programme: € 2573 million for 2014-2018

Specific objectives for Research & Innovation indirect actions

- support **safe operation** of nuclear systems;
- contribute to efficient solutions for the **management of ultimate waste**;
- Support development and maintain **nuclear competences**;
- foster **radiation protection**;
- ensure availability of **research infrastructures**

http://ec.europa.eu/research/horizon2020/

Perfect link with FP7

What is "Horizon 2020" ?
follow-up of FP-7 (2007 – 2013)

- **Commission proposal for a € 80 billion funding programme for research and innovation (2014-2020), including Euratom programme**

- **A core part of *Europe 2020*, *Innovation Union* and *European Research Area***

<u>What is new ?</u>

- **Coupling research to innovation – from research to retail, all forms of innovation**

- **Focus on societal challenges facing EU society, e.g. health, clean energy and transport**

<u>Three priorities:</u>

- **1 - Excellent science**

- **2 - Industrial leadership**

- **3 - Societal challenges**

Training under Horizon 2020

- *Priority 1 - Excellent science:* a.o. "Marie Curie actions" (Sklodowska)

= opportunities for training and career development (including "co-fund")

(proposed funding = € 5 572 million)

- *Priority 3 - Societal challenges*: a.o. "Secure, clean and efficient energy"

(proposed funding = € 5 782 million)

NB: for nuclear safety and security from the Euratom Treaty activities (2014-2018) = additional € 1 788m - does not include ITER)

- ***European Institute of Innovation and Technology* (EIT) => "*Knowledge and Innovation Communities*" (KIC - proposed funding = € 1360 (+ conditional 1440) million)**
- ***European Research Council* (ERC - proposed funding = € 13 268 million)**

European Commission

The ENEN Association
(*European Nuclear Education Network*)

A non-profit international organization established on September 22, 2003

under the French law of 1901 and located at CEA-INSTN Paris.

Mission

The preservation and further development of higher nuclear education and expertise in all areas of nuclear fission and radiation protection (education and training)

Composition (as of September 2012)

⇒ 64 members (universities, research institutions and industry) from 17 EU Member States, plus Switzerland, Russia, Ukraine, Japan and South Africa

⇒ further international collaboration: partnership agreements with ENS, IAEA / ANENT (Asia), Canada and WNU

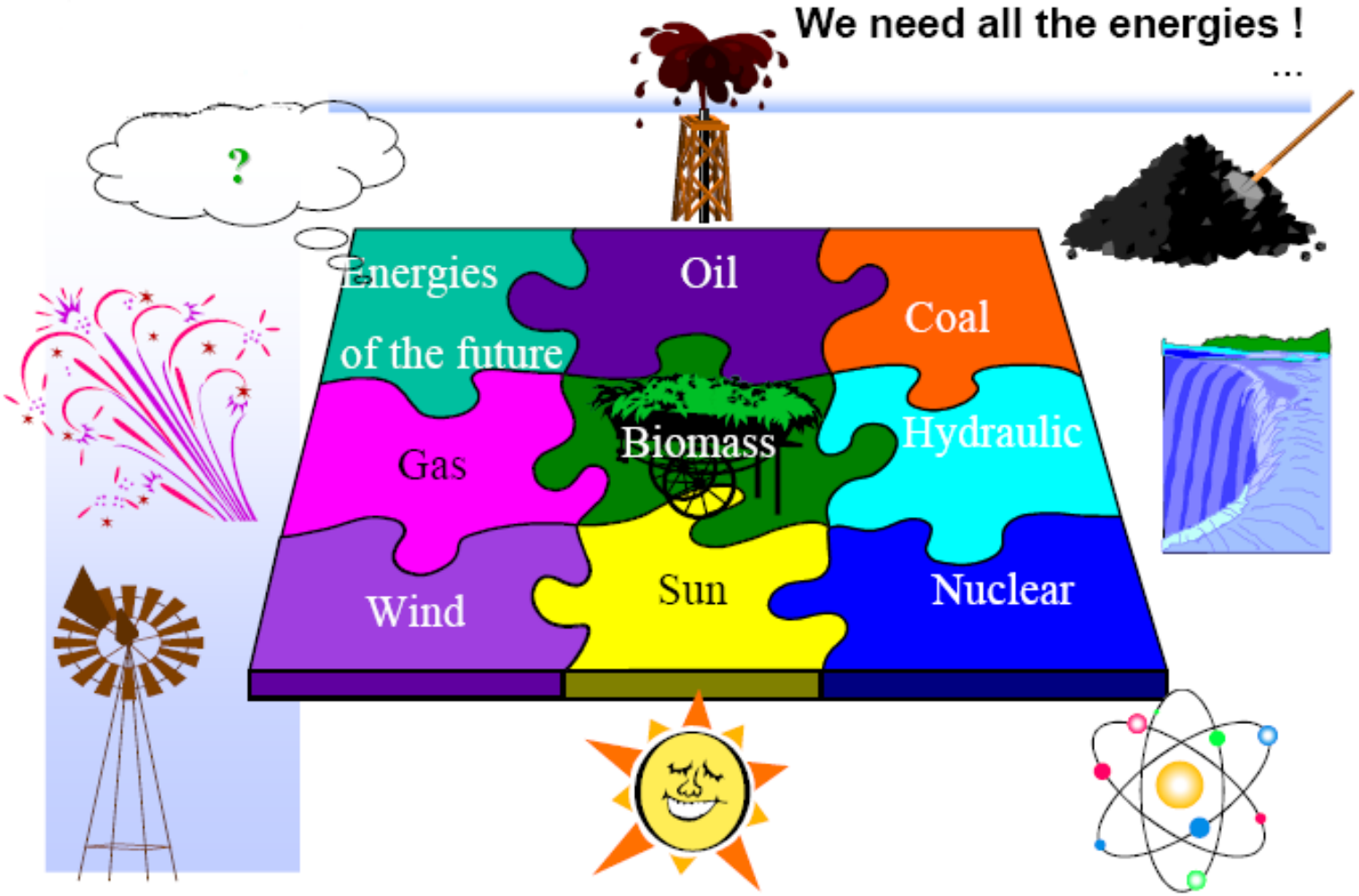
Website = http://www.enen-assoc.org/

enen
european nuclear education network

Reminder: **legal association ENEN = spin-off of Euratom FP-5 coordination action (22 universities, budget of 200 000 Euros) (contract FIR1-CT2001-80127 over period 2002 – 2003 / http://cordis.europa.eu/fp5-euratom/src/lib_finalreports.htm#training)**

European Commission

3 - Towards a resource-efficient, low-carbon economy (DG ENER)



"Resource efficient Europe" (= basis of "Energy Policy for Europe") COM(2011) 21 (Brussels, 26.1.2011)

<u>Objectives</u>: moving towards a low carbon economy (including European policy framework, reinforced financial instruments and technology development pillar / SET-Plan),

in synergy with:

- **The "*climate and energy package*" (January 2008): the EC proposed binding legislation to implement the 20-20-20 targets**
  - **"package" agreed by the EP and Council in Dec. 2008 => became law in June 2009**

- ***Investing in the Development of Low Carbon Technologies (SET-Plan)***
  COM(2009) 519 (Brussels, 7.10.2009)

Long-term European framework:

Energy Roadmap 2050 **(COM(2011) 885 (Brussels, 15.12.2011))**

- **the EU is committed to reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050 in the context of necessary reductions by developed countries as a group**
- **while at the same time ensuring security of energy supply and competitiveness**

Excerpt of SET-Plan related to "European Industrial Initiatives" (EII)

- focus on key challenges and bottlenecks + concrete actions for the period 2010-2020.

- detailed implementation plans and Technology Roadmaps 2010-2020, taking into account priorities and available resources

1 - Wind energy (total public and private investment needed in Europe over the next 10 years is estimated as € 6 bn + creation of 250 000 skilled jobs)

2 - Solar energy, including photovoltaics (PV) and concentrated solar power (CSP)
(total investment needed is estimated as € 16 bn + creation of 200 000 skilled jobs)

3 - Electricity networks (creating a real internal market; integrating a massive increase of intermittent energy sources; and managing complex interactions between suppliers and customers – total investment needed is estimated as € 2 bn)

4 – Sustainable bio-energy (total is estimated as € 9 bn + creation of 200 000 skilled jobs)

5 - CO2 capture, transport and storage /CCS/ (total investment needed is estimated as € 13 bn)

6 – The sustainable nuclear fission initiative: see below

7 - Fuel cells and hydrogen: the Joint Technology Initiative (JTI) on fuel cells and hydrogen was established for 2008-2013 with a budget of 470 M€ of Community funding to be at least matched by industry (total estimated investment needed over the period 2013-2020 is estimated at €5 bn).

"European Industrial Initiative" no 6
The sustainable nuclear fission initiative

Nuclear fission has to move towards long-term sustainability with a new generation of reactor type – the Generation-IV reactor. They will be designed to maximise inherent safety, increase efficiency, produce less radioactive waste and minimise proliferation risks.

Commercial deployment of these reactors is foreseen for 2040, but to achieve that target, work has to start now.

The bulk of the programme up to 2020 will be the design and construction of prototypes and demonstrators, fuel fabrication workshops and experimental facilities and a research programme to develop new materials and components to improve the industrial and economic viability of the reactors.

This effort will build upon a solid basis of competences and experience in current nuclear technology which is contributing to meeting the 2020 SET-Plan objectives.

The total public and private investment needed in Europe over the next 10 years is estimated as €7 bn.

By 2020, the first Generation-IV prototypes should be in operation. The first cogeneration reactors could also appear within the next decade as demonstration projects to test the technology for coupling with industrial processes.

=> *European Sustainable Nuclear Industrial Initiative* (ESNII, November 2010)

Excerpt of SET-Plan related to "European Energy Research Alliance" (EERA)

Objective: elevate cooperation between national research institutes to a new level – from an ad-hoc participation in uncoordinated joint projects to collectively devising and implementing joint programmes.

Priorities:

- taking ideas out of the laboratory and developing them to the point where they can be taken up by industry is a step that needs to be shortened considerably

- involvement of universities in the Alliance through the platform created by the *European University Association* will help ensure that the best brains can be mobilised.

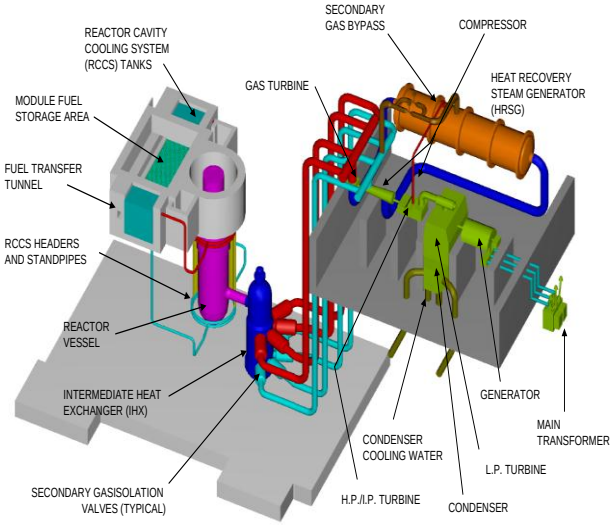
- launch and implementation of 13 "joint programmes" (JP) addressing the key challenges of the SET-Plan (strong links with the Industrial Initiatives to ensure industrial relevance)

  - four JPs launched in June 2010 (Madrid), three in November 2010 (Brussels), six in November 2011 (Warsaw)
  - Joint Programme on "Materials for Nuclear" (November 2010, coordinator = KIT, 4 subprograms: Support to ESNII + ODS + Refractory/composites + Modelling)
  - European Energy "Education and Training" Initiative (Kick-off meeting of the Core Group, Brussels, 08 December 2011) and Working Group 'Nuclear Energy' (kick-off meeting, Brussels, 20 February 2012)

European Commission

4 – Towards lifelong learning and borderless mobility (DG EAC)

From knowledge transfer ..... => ..... to competence building



New governance for education and training in the EU (Bologna 1999 and Copenhagen 2002)

- Bologna Declaration on the European space for higher education (June 1999):
  (29 countries signed => "European Credit Transfer and accumulation System" – ECTS)

- Copenhagen Declaration on enhanced European cooperation in VET (Nov. 2002):
  (all EU Member States signed
  => "European Credit system for Vocational Education and Training" - ECVET)

NB: "Learning outcomes"
= defined in terms of knowledge, skills and competences (KSC)

- *Knowledge* = Learning to know: for example, cognitive domain needed to support operational and technical decisions in power plants

- *Skills* = Learning to do: for example, translation of safety and security culture into practical terms, and *Attitudes* = Learning to live together: sharing values and beliefs)

- *Competence* = e.g. Learning to lead a team: for example, solving problems requiring abstraction by employing simple research methods and communicating efficiently

An agenda for new skills and jobs (= basis for Education and Training policy)
COM(2010) 682, Strasbourg, 23.11.2010

Objective: A European contribution towards full employment

Four key priorities: better functioning labour markets; a more skilled workforce; better job quality and working conditions; stronger policies to promote job creation and demand for labour.

Focus on "*Comprehensive lifelong learning*": ("considerable challenge")

- **Improving access to lifelong learning, to help people move to high-value added sectors and expanding occupations**

  …. More flexible learning pathways can facilitate transitions between the phases of work and learning, including through modularisation of learning programmes.
  These pathways should also allow for the validation of non-formal and informal learning and be based on learning outcomes, as well as the integration of career guidance systems.

- **Enhancing stakeholders' involvement and social dialogue on the implementation of lifelong learning…**

- **Establishing effective incentives and cost sharing arrangements, to enhance public and private investment in the continuing training of the workforce……**

European Commission

What is "Erasmus for all"?

- **Commission proposal for a € 17 billion funding programme for Education, Training, Youth and Sport (2014-2020)**

- **A core part of Europe 2020**
  (in particular, the already mentioned "Europe 2020" flagship initiatives "Innovation Union" and "An agenda for new skills and jobs" + 'Youth on the Move', COM(2010) 477, 15.9.2010))

What is new ?

- **emphasis on innovation, productivity and growth: education and training are now more important than ever, especially in the context of the current economic and financial crisis**

- **emphasis on borderless mobility (increasingly globalised labour market) and lifelong learning (requested by people of all ages): education and training systems must deliver the knowledge and skills requested by the changing society**

Three priorities:

- ***Learning mobility of individuals***
- ***Cooperation for innovation and good practices***
- ***Support for policy reform***

Priority 1 of "Erasmus for all" – *Learning mobility of individuals*

Focus on the quality of mobility : significant share of the increased overall budget (63 %)

=> mobility opportunities to around 5 million learners over the seven-year period, including international expansion outside the EU)

- Specific key activity on *Mobility for higher education students* (including joint/double degrees) :
  building on the success of Erasmus Mundus + need for alternative forms of mobility

- Specific key activity on *vocational education and training students*:
  work-based learning is critical for employability at all education levels

- *Transnational traineeships* in enterprises have a high potential to enhance employability (reinforce the link between education and business, foster entrepreneurship and facilitate the transition from education to the world of work)

- opening up access for learners to methods, practices and technologies used in other countries will help to *improve their employability in a global economy*

Priority 2 "Erasmus for all" – *Cooperation for innovation and good practices*

Focus on strengthening innovative partnerships between educational institutions and business (25 % of overall budget).

For higher education, the emphasis will be on capacity building, concentrating on neighbourhood countries as well as strategic partnerships with developed and emerging economies.

- *Knowledge Alliances for higher education*: see below
- *Sector Skills Alliances:* sectoral projects between businesses and education and training providers to create new sector-specific curricula, to develop innovative ways of vocational teaching and training and to put the EU wide recognition tools into practice.
- *IT support platforms and virtual mobility:* deliver peer learning and exchange of good practices to a greatly enlarged group of potential beneficiaries (e.g. e-courses and virtual mobility, including collaboration with neighbourhood countries.

Focus on "Knowledge Alliances for higher education" (also under "Innovation Union")

Objective: improve the synergy between the world of education and the world of work
+ help universities modernise and enhance quality and innovation

Priorities: structured partnerships between higher education institutions and businesses, which develop innovative ways of producing and sharing knowledge, foster creativity and entrepreneurship and design and deliver new curricula and qualifications

NB:

- "Knowledge Alliances" promotes enhanced cooperation between education and innovation
- "Horizon 2020" promotes stronger links between research and innovation (without covering E&T activities)
- **"European Institute of Innovation and Technology"** (EIT) under "Horizon 2020":
  - full integration of the so-called Knowledge Triangle (research, business/innovation and education)
  - consists of a number of "Knowledge and Innovation Communities" (KIC) in all sectors of industry and society (business creation activities are coupled with Research and Innovation Projects as well as with Education and Training)

Example of KIC in nuclear fission => KIC InnoEnergy / Innovation project no 3 = "Sustainable nuclear & renewable energy convergence" (Colocation Centre Alps Valleys) - http://www.kic-innoenergy.com/
built upon an industrial plan, results oriented, commitment from shareholders for a first period of 7 years, financially sustainable in the medium term, covering all the SET Plan thematics (including nuclear fission)

Priority 3 "Erasmus for all" – Support for policy reform

- Focus on activities which help steer the EU agenda for education, training and youth, in particular through the "open method of coordination" (3 % of overall budget).

(e.g. development of indicators, statistics and benchmarks; monitoring of trends and policy developments; peer learning and reviews; policy analysis).

- Support to the further valorisation and implementation of various EU transparency tools created under the Lifelong Learning Programme, in particular:

  - *EQF*: *European Qualifications Framework*
  - *ECTS*: *European Credit Transfer and Accumulation System*
  - *ECVET*: *European Credit System for Vocational Education and Training*

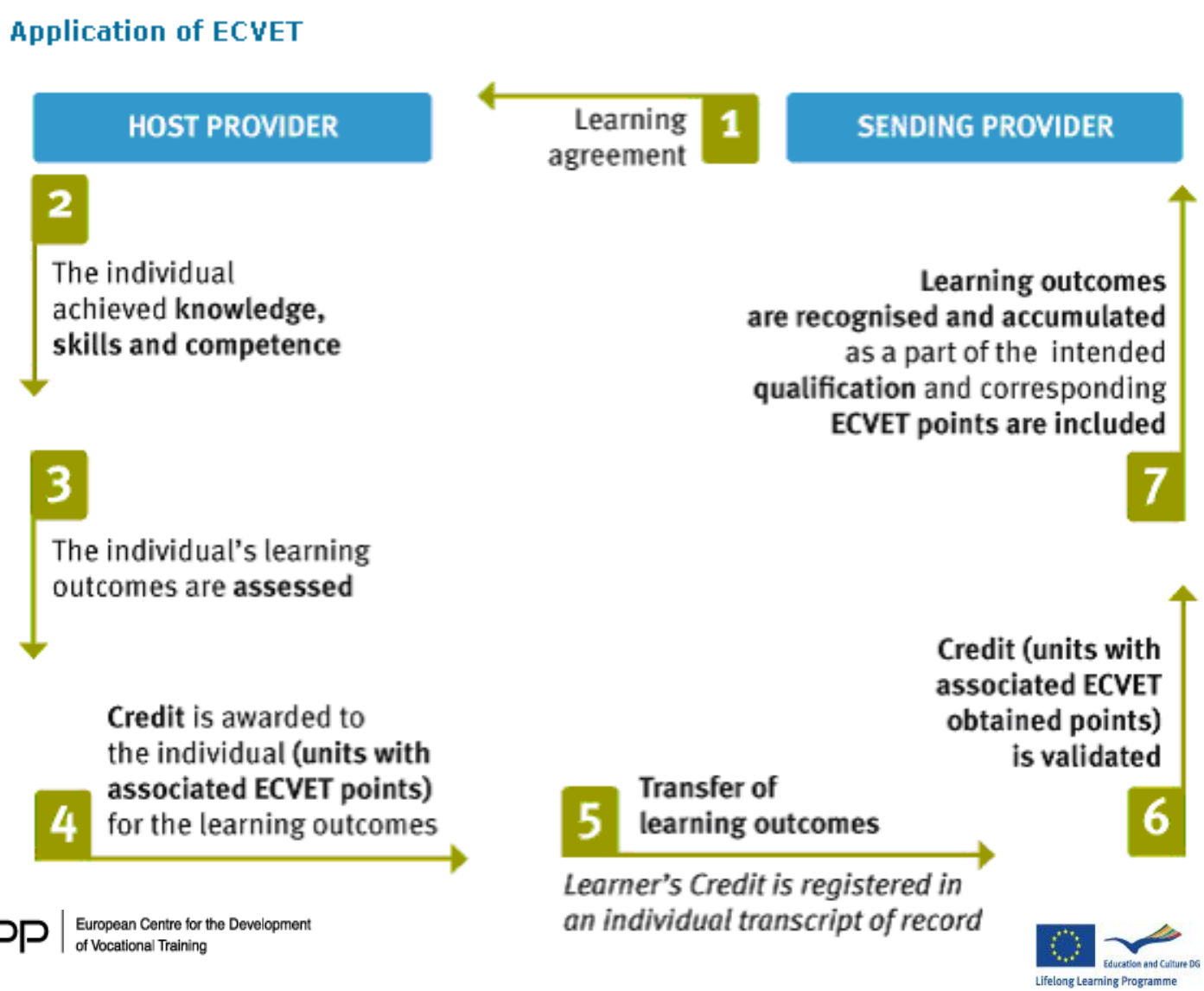
NB: for the implementation of the actions launched by the "Lifelong Learning Programme", please consult
(1) National Agencies operating in the 27 EU Member States + CH + 4 associated countries (e.g. Norway, Turkey)
=> http://ec.europa.eu/education/lifelong-learning-programme/national_en.htm
(2) National Europass Centre in each MemberState (coordination of all activities related to the Europass documents)
=> http://europass.cedefop.europa.eu/en/about/national-europass-centre

5 - Implementation of ECVET in the nuclear sector: Eight FP-7 Euratom coordination actions until now ("Euratom Fission Training Schemes" / EFTS /)

Euratom co-funding of training schemes and qualification processes at EU level, in areas of nuclear fission and radiation protection (each EFTS: Euratom FP-7 "coordination action", 3 years, total budget of circa 1 000 000 Euros)

- (1) TRASNUSAFE: health physics sector (e.g., ALARA principle)
- (2) ENEN III Training schemes: nuclear systems suppliers
- (3) ENETRAP II: nuclear safety authorities (e.g., Radiation Protection Expert)
- (4) PETRUS II: radwaste agencies (e.g., repository and engineered systems)
- (5) CINCH: nuclear and radio-chemistry (e.g., chemistry of nuclear fuel cycle)
- (6) CORONA: Regional Center of Competence for VVER Technology
- (7) EURECA! : Cooperation between EU and Canada on Super-Critical Water Reactors
- (8) GENTLE : Graduate and Executive Nuclear Training and Lifelong Education

http://www.enen-assoc.org/en/training/for-nuclear-community/efts-fp7.html



ENSREG ("European Nuclear Safety Regulators Group") meeting of 24 February 2012, Brussels:
- "new" description of jobs in terms of learning outcomes (knowledge, skills, competences)
- qualification process for higher level education and training schemes (depends of each MS)
- "Europass" whenever needed (= set of documents to describe qualifications of individuals)
=> European harmonization process leading to the free circulation of nuclear experts in the EU

6 - Conclusion:
towards a new generation of highly qualified nuclear experts in a global economy

(1) changes in research & innovation, and in education & training:
from knowledge creation (research) to competence building (training)
=> towards lifelong learning and borderless mobility (new EU governance)

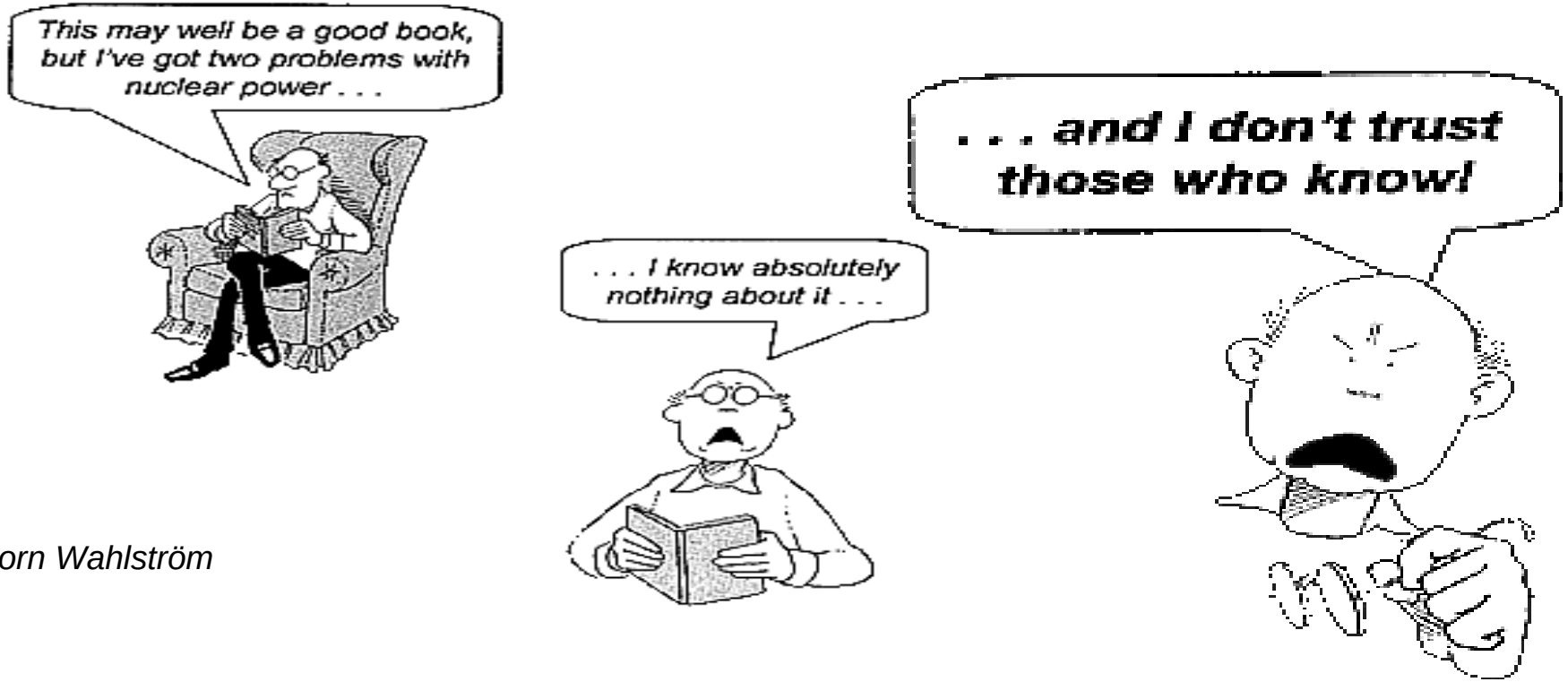
(2) changes in the political and legislative framework in the EU
common strategic framework for research and innovation Horizon-2020
=> "European Strategic Energy Technology Plan"("Europe 2020 strategy")

Main objectives = a beneficial, responsible and sustainable energy mix

- towards a new generation of highly qualified nuclear experts in a global economy, thereby ensuring scientific and technological excellence in all parts of the EU (and of the world)
- towards a robust demonstration that the selected mix of energy technologies is beneficial, responsible and sustainable
(thereby achieving / improving public understanding and acceptance)

Towards (re)building public trust

through openness, communication and teamwork



Bjorn Wahlström

No knowledge, no future

Janez Potočnik, EU Commissioner
for Science and Research (2004 – 2009)

"- Some of our trading partners are competing with primary resources, which we do not have.

- Some compete with cheap labour, which we do not want.

- Some compete on the back of their environment, which we cannot accept,…

Building the knowledge society is probably the best,

and maybe only, way to sustain the European model of society, without having to make a trade-off between economic growth, social cohesion and environmental protection"

Source: ERA News, 2005-02-03

"La technologie au service de l'homme"

Hubert Curien

Manifeste de Grenoble, Octobre 2000
Institut National Polytechnique de Grenoble

"Il est nécessaire de s'expliquer et de s'engager au sein d'une société, qui, certes ne refuse pas le progrès, mais se méfie d'éventuelles diableries.

… Aux deux vocations classiques de l'ingénieur, innover et gérer les industries, il faut en ajouter une troisième: expliquer et éventuellement rassurer. … L' information, le transfert du savoir, ne prend sa pleine ampleur que dans le dialogue. … "

Source: « Charte d'éthique des ingénieurs de l'INP Grenoble »
http://www.grenoble-inp.fr/le-groupe/charte-ethique-des-ingenieurs-de-l-inp-grenoble-23534.kjsp?RH=INP_PRESENTATION

7 – Annex: description of the eight EFTS under Euratom FP-7

(1) TRASNUSAFE : Nuclear Safety Culture

Focus on competences required by the health physics sector (e.g., ALARA principle)

- designing, developing and validating two training schemes on nuclear safety culture, with a common basis: nuclear industry and installations making use of ionising radiation

- target public: professionals, at the managerial level, in charge of health physics control in nuclear power plants and of radiotherapy services in hospitals

19 Participants: UCL (B) as coordinator

- + TECNATOM (E); SCK•CEN (B); ITN (P); JSI (SLO); CEPN (F); EAN (EU); UPB (RO); UNIMAN (UK); STUBA (SK); CIRTEN (I); UPM (E); ND-DACMT (UK); ENEN association (INSTN, TKK, BME); CNCAN (RO); TRACTEBEL ENG. (B); EITA (EU); SNN (RO); SEAS (SK)

(2) ENEN III Training schemes : Generation III and IV engineering

Focus on competences required by nuclear system suppliers

➢four training schemes:

- **Basic Nuclear Topics for Non-Nuclear Engineers**
- **Design Challenges for Generation III NPP (2 professional profiles)**
- **Construction Challenges for Generation III NPP (2 professional profiles)**
- **Design Challenges for Generation IV Reactors**

Special attention to the following competences: System and Process Engineering, Safety Analysis Evaluation, HVAC Project Implementation, digital I&C Engineering

19 Participants: ENEN Association as coordinator

+ SCK-CEN, UCL, TKK, LUT, INSTN, AREVA, ISAR, BME, CIRTEN (POLITO, UNIPI), DUT, UPB, UL, JSI, TECNATOM, UNED, UPM, UPC, SULTAN

(3) ENETRAP II :

European Network on E&T in Radiological Protection

Focus on competences required by nuclear safety authorities

- legal basis = Euratom legislation on *Basic Safety Standards* (96/29/EURATOM) and forthcoming revision (including "RPE Recognition")

- EU standards for initial education and continuous professional development for radiation protection experts (RPEs) and radiation protection officers (RPOs)

- development of the "European radiation protection training scheme" (ERPTS) for RPE training

12 Participants: SCK•CEN, BELGIUM as coordinator

+ CEA-INSTN, FRANCE; KIT-FTU, GERMANY; BfS, GERMANY; ENEA, ITALY; NRG, THE NETHERLANDS; CIEMAT, SPAIN; HPA-CRCE, UK; ENEN Association (TKK, ISAR), FRANCE; ITN, PORTUGAL; BME-NTI, HUNGARY; UPB, ROMANIA

Council Directive 96/29/Euratom sets up a framework for the control of exposure of workers and members of the public to ionising radiation (http://ec.europa.eu/energy/nuclear/radiation_protection/publications_en.htm)

(4) PETRUS II :
Program for Education, Training, Research on Underground Storage

Focus on competences required by radwaste agencies (e.g., repository and engineered systems design)

- development of a *Science and Technology Passport*, related to the following competences:

  Site Investigation Design and Management; Underground Construction; Repository and Engineered Systems Design; Above Ground Waste Handling Facility Design/Operation; Underground Systems Engineering (Waste Handling); Operational and Post-Closure Safety

Survey of the "market": use existing courses (in France, Switzerland, Germany, United Kingdom, Sweden, Finland and Slovenia) + add new courses to fill in the gaps

14 Participants: Institut National Polytechnique de Lorraine, FR, as coordinator

+ ANDRA, FR; ARAO, SI; Cardiff University, UK; ENRESA, ES; ENEN Association (UPM, CTU, TKK, BME), FR; GRS, DE;ITN, PT; ITC School of Underground Waste Storage and Disposal, CH; Microbial Analytics Sweden AB, SE; NDA, UK; Posiva Oy, FI; RAWRA, CZ; Universitaet Clausthal, DE

(5) CINCH:
Cooperation in education In Nuclear Chemistry

Focus on competences required by nuclear and radio-chemistry
(e.g., chemistry of nuclear fuel cycle, separation chemistry, chemistry of actinides, radio-analytical chemistry, low-level radionuclide detection, radio-pharmaceutical chemistry, etc.)

- a set of compact joint modular courses (including internships) will be produced - the EU experience will be faced with the Russian expertise
- e-learning platform with pilot topics in the chemistry of the nuclear fuel cycle, that is: nuclear fuel and chemistry of the front-end of the nuclear fuel cycle; nuclear spent fuel recycling; waste conditioning; chemical problems in radioactive waste management and repository design)
- a set of common qualification criteria and a mutual recognition system in view of a "European training Passport" will be developed following the guidelines of ENEN
- A long term sustainable strategy for the nuclear chemistry education will be established, including a roadmap for its implementation

7 participants: CESKE VYSOKE UCENI TECHNICKE V PRAZE (CTU, Czech Republic) as coordinator

- + CHALMERS TEKNISKA HOEGSKOLA AB (Sweden); HELSINGIN YLIOPISTO (UH, Finland); Moscow State University (Russia); Ecole Nationale Supérieure de Chimie de Paris (France); USTAV JADERNEHO VYZKUMU REZ A.S (NRI, Czech Republic); NATIONAL NUCLEAR LABORATORY LTD (United Kingdom)

(6) CORONA:
"Establishment of a Regional Center of Competence for VVER Technology and Nuclear Applications"

Focus on competences required by VVER personnel

unify existing VVER related training schemes according to IAEA standards and commonly accepted criteria recognized in EU.

1)Training schemes for VVER nuclear professionals; for non-nuclear specialists and subcontractors, involved in nuclear sector; and for students

2) VVER related knowledge management system, which will accumulate information regarding design data, operational experience, training materials, etc.

3)Specialized regional training center for supporting VVER customers with theoretical and practical training sessions, training materials and general and special assignment training tools and facilities……

11 Participants: KOZLODUY NPP PLC, Bulgaria, as coordinator (lipironkov@npp.bg)

+ AEKI Hungary, FORTUM Finland, INRNE Bulgaria, JRC-IET Netherlands, MEPHI Russian Federation, CVREZ Czech Republic, PM Dimensions GmbH Austria, RISK ENGINEERING LTD Bulgaria, TECNATOM S.A. Spain, INTELLECTUAL TECHNOLOGY-SLAVUTICH Ukraine

(7) EURECA!
"Cooperation between EU and Canada in Education, Training and Knowledge Management on Super-Critical Water Reactors"

Focus on competences required by Generation IV research and training experts (RTD of the Super-Critical Water-cooled Reactor /SCWR/ in Europe and Canada)

-definition of an international education & training program which

(i) enhances the skills of current professionals in the nuclear sector,

(ii) attracts young graduates and professionals in other sectors to work in the nuclear field

(iii) enhances the mobility of professionals in the EU and Canada

*** 6 EU Participants: TECHNISCHE UNIVERSITEIT DELFT Netherlands, as coordinator**

+ UNIVERSITAET STUTTGART Germany, KUNGLIGA TEKNISKA HOEGSKOLAN Sweden, CVREZ Czech Republic, ENEN France, UNIVERSITA DI PISA Italy

* ***Canadian participants***: the "University Network of Excellence in Nuclear Engineering" (UNENE) is a Canadian based alliance of universities, nuclear power utilities, research and regulatory agencies for the support and development of nuclear education, research and development capability in Canadian universities - http://www.unene.ca/index.htm

(8) GENTLE :

Graduate and Executive Nuclear Training and Lifelong Education

Focus on: Theory and Simulations; Nuclear Energy systems; Nuclear Fuel Cycle; Economics and Operation

Specifically, the project aims at the implementation of the following joint E&T tools:

- Student research projects to facilitate students to get hands-on experience in Europe's unique and specialised laboratories and student internships in research and industry
- Intersemester courses for graduate and post graduate students on industry related topics, which will be provided by academics and specialists from research and industry.

=> executive European Master of Science, for young professionals

The stakeholders ("employers" supporting the project) are: AREVA (France), Compania Nationala a Uraniului (Romania), Eesti Energia (Estonia), ENEN (Int'l), Foratom (Int'l), NNL (UK), NRG (Netherlands), RWE (Germany), SNE-TP (Int'l), TVO (Finland).

12 Participants : Delft University of Technology (Netherlands) as coordinator

+ BME (Hungary), CIRTEN (Italy), I2EN (France), JRC (EU), KIT (Germany), SCK•CEN (Belgium), UPM (Spain), UMAN (UK), UT (Estonia), PSI (Switzerland), LUT (Finland)

Available Links

EC DG Research and Innovation *http://ec.europa.eu/research/home.cfm*
EU Energy research: *http://ec.europa.eu/research/energy/index_en.htm*
Euratom Seventh Framework Programme: *http://cordis.europa.eu/fp7/euratom/home_en.html*
And http://ec.europa.eu/research/participants/portal/
Euratom Seventh Framework Programme funded projects
http://cordis.europa.eu/fp7/euratom-fission/library_en.html

CORDIS publications
http://cordis.europa.eu/fp6-euratom/library_en.html
http://cordis.europa.eu/fp7/euratom-fission/library_en.html

Euratom FP6 Research Projects and Training Activities, Volume I-II and III (PDF)
Volume I ftp://ftp.cordis.europa.eu/pub/fp6-euratom/docs/nuclear_fission_eur21228_en.pdf
Volume II ftp://ftp.cordis.europa.eu/pub/fp6-euratom/docs/nuclear_fission_eur21229_en.pdf
Volume III ftp://ftp.cordis.europa.eu/pub/fp7/docs/euratom-fission_eur22385_en.pdf

Euratom FP7 Research Projects and Training Activities, Volume I-II (PDF)
Volume I ftp://ftp.cordis.europa.eu/pub/fp7/docs/fin-266-euratom-web-jun09v02_en.pdf
Volume II http://ec.europa.eu/research/energy/pdf/euratom-fp7-vol-2.pdf

Horizon 2020 *http://ec.europa.eu/research/horizon2020*

SET-Plan *http://ec.europa.eu/energy/technology/set_plan/set_plan_en.htm*
FISA 2009 *http://cordis.europa.eu/fp7/euratom-fission/fisa2009_en.html*
TPs : *http://www.snetp.eu/ http://www.igdtp.eu http://www.melodi-online.eu http://www.nugenia.org*

Knowledge, Skills and Attitudes in Terms of Learning Outcomes

Description of two Job Profiles based on ECVET (AREVA NP GmbH - Training Center Offenbach)

Design Engineers of GEN III NPPs

Job 1 - System and Process Engineering

Job 2 - Safety Analysis Evaluation Engineer

under the current FP-7 project ENEN III

1 - Training Scheme for Design Engineers of GEN III NPPs

ToC of FP-7 project ENEN III Deliverable D1.3 **(PPT 1-2)**
Job 1 - System and Process Engineering
Job 2 - Safety Analysis Evaluation Engineer

Job Profile / Description / job 1 (PPT 3-5) and job 2 (PPT 6-8)

Knowledge, Skills and Attitudes in Terms of Learning Outcomes

*** knowledge (Learning to know)** **(PPT 9-11)**

*** skills (Learning to do)** **(PPT 12-14)**

*** attitudes (Learning to live together / Learning to be) (PPT 15-16)**

2 - Training Scheme for Construction and Commissioning Engineers of GEN III

ToC of FP-7 project ENEN III Deliverable D1.4 **(PPT 17-18)**
Job 1 - HVAC Project Implementation Engineer
Job 2 - Fluid System Construction and Commissioning Engineer

3 – Conclusions and recommendations **(PPT 19-21)**

http://www.enen-assoc.org/en/training/for-nuclear-community/efts-fp7/enen-iii.html

1 - Training Scheme for Design Engineers of GEN III Nuclear Power Plants

ToC of FP-7 project ENEN III Deliverable D1.3 (1/2)

3. Job Profile / Description

3.1 System and Process Engineering
- 3.1.1 Main function of the job
- 3.1.2 Detailed Tasks
- 3.1.3 Knowledge, skills and attitudes required for the job tasks

3.2 Safety Analysis Evaluation Engineer
- 3.2.1 Main function of the job
- 3.2.2 Detailed Tasks
- 3.2.3 Knowledge, skills and attitudes required for the job tasks

ToC of FP-7 project ENEN III Deliverable D1.3 (2/2)

4. Knowledge, Skills and Attitudes in Terms of Learning Outcomes

- 4.1 Learning outcomes in the knowledge area (Learning to know)
  - 4.1.1 Nuclear Power Plant Knowledge
  - 4.1.2 Nuclear Safety Knowledge
  - 4.1.3 Flow, Thermodynamics and Th.-hydraulics Knowledge
  - 4.1.4 Nuclear Engineering Design Knowledge
  - 4.1.5 Nuclear Power Plant Systems Knowledge
- 4.2 Learning outcomes in the skills area (Learning to do)
  - 4.2.1 Skills for Job profile "Syst. and Process Design Eng."
  - 4.2.2 Skills for Job profile "Safety Evaluation Engineer"
- 4.3 Learning outcomes in the attitude area (Learning to live together and/or Learning to be)

Job 1 - System and Process Engineer (1/3)

Main function of the job

The future employee will be responsible for the development of system and process functional specifications for nuclear power plant systems (planning, design and operation) within specified rules and guidelines. The work essentially consists of process engineering requirements regarding mechanical components as well as electrical and instrumentation & control.

Job 1 - System and Process Engineering (2/3)

Detailed Job Tasks

A person occupying this position within the future nuclear engineering organization (research or industrial) should be able to perform the following tasks:

- Concept development with respect to system configuration of the nuclear reactor plant (development within the scope of the contract)
- Design of systems/system parts with appropriate validation /analysis through evaluation or plausibility inspection
- Requirement specifications of other assembly sections and/or project phases (e.g. control and regulatory functions, loading capacity, system operation mode, mechanical component specifications, commissioning)
- Technical bid development with cost and time schedule for scope of supply and services for the specific engineering activities. Activities are coordinated with the executive manager
- Documentation of work results and development of presentation material and interview with customers as well as appropriate authorities where necessary
- Additional duties: Technical coordination in teams

Job 1 - System and Process Engineering (3/3)

Knowledge, skills and attitudes required for the fulfillment of the job tasks

Knowledge

- **Nuclear Power Plant Knowledge**
- **Basic Nuclear Safety Knowledge (more details further down)**
- **System/System Group Knowledge**
- **Nuclear Engineering Design Knowledge**
- **Flow and Thermo Dynamics Knowledge**

Skills

- **Working with Self-developed Engineering Tools or Off-the-Shelf Tools**
- **Cost Estimates (costs, time) for the Engineering Work**
- **Order Processing (Project Management)**

Attitudes

- **Formal Quality Control of Result Reports**
- **Individual, Critical Examination of the Tasks**
- **Presentation and Documentation of Work Results**
- **Teamwork/Communication**

Job 2 - Safety Analysis Evaluation Engineer (1/3)

Main function of the job:

The future employee will be responsible for the qualified implementation of safety analyses (e.g. transient analyses, emergency coolant analyses, probabilistic and deterministic analyses, fluid dynamics analyses, accident analyses, analyses concerning radiation protection and neutron flux). The main focus is on routine implementation and analyses evaluation.

Job 2 - Safety Analysis Evaluation Engineer (2/3)

Detailed Job Tasks

- Compilation of relevant input data for the construction of safety analyses (transient analyses, probabilistic analyses, accident severity, radiation protection, ZEDB etc…) for nuclear power plants
- Implementation, evaluation, appraisal and documentation of the appropriate analyses using complex computer programs (e.g. NLOOP, S-RELAP-5, MELCOR, GASFLOW, MCNP, Risk spectrum, S-TRAC etc...), including separate handling of utilized programs in coordination with experienced colleagues
- Maintenance and redevelopment resp. verification and validation of computer programs, evaluation and simulator models
- Development of technical measures, methods and concepts (e.g. determination of program uncertainties, mitigation of severe accidents, radiation protection and neutron fluency)
- Examination of result reports, documentations etc…on formal regulations and plausibility (quality check), and where necessary implementing corrections
- Compilation of licensing documentation for submitting to regulators and expert organizations
- Development of presentation material and interviews with customers, experts, regulators and external auditors for the individual task assignment

Job 2 - Safety Analysis Evaluation Engineer (3/3)

Knowledge, skills and attitudes required for the fulfillment of the job tasks:

Knowledge

- Extended Nuclear Safety Knowledge **(more details further down)**
- Thermo hydraulic Knowledge
- Basic Knowledge of Power Plant Engineering
- Basic Knowledge of Plant, System and Component Engineering

Skills

- Working with Self-developed Engineering Tools or Off-the-Shelf Tools
- Order Processing (Project Management)
- Formal Quality Control of Result Reports
- Presentation and Documentation of Work Results
- Teamwork/Communication

Attitudes

- Individual, Critical Examination of the Tasks

Section 4.1 "Learning outcomes in the knowledge area" (Learning to know)

Item 4.1.2 Nuclear Safety Knowledge (1/3)
Job 1 - System and Process Engineering
Job 2 - Safety Analysis Evaluation Engineer

The nuclear safety knowledge module is separated into two main topics:

(1) "fundamentals of nuclear safety" addressing both types of nuclear engineers profiles

(2) "methods of nuclear safety" addressing in principal the job profile n° 2.

It is clear that the achievement of learning outcomes of the second module can not be done before the achievement of learning outcomes of first module.

(1) Area of knowledge : TSB.K08
Fundamentals of Nuclear Safety **(more details further down)**

(2) Area of knowledge : TSB.K09
Methods of Nuclear Safety

- - Deterministic Safety Analysis
- - Probabilistic Risk Assessment
- - Categories of initiating events
- - External and Internal Hazards
- - Classification of SSC

Nuclear Safety Knowledge (2/3)

TSB.K08 / Fundamentals of Nuclear Safety

Learning Outcomes

1. Repeat the fundamental nuclear safety objective
2. List the three fundamental safety functions.
3. Name the three main physical barriers participating in the fulfillment of the 3rd fundamental safety function.
4. Use another words for explaining the term “defense in depth”.
5. Recognize in the frame of the defense in depth concept the importance of the integrity of each single barrier (comprehension and attitude)
6. Asses the possible consequences for the first physical barrier in case of violation of the 1st and 2nd fundamental safety function (evaluation)
7. List together with examples the INES Accident Scale as defined by the IAEA.
8. Recall the two mechanisms responsible for damaging the 1st physical barrier: DNBR from outer and PCI from the interior of the fuel.

Nuclear Safety Knowledge (3/3)

TSB.K08 / Fundamentals of Nuclear Safety

Learning Outcomes (cont'd)

9. Arrange the safety requirements arriving from different responsible entities in order of priority
10. Differentiate between mandatory nuclear requirements and recommendations applicable during all phase of a NPP
11. Recognize the importance of ALARA principle relying on the admissible doses value drawn from the radiation protection requirements
12. List the main modes for failure of a system (Single Failure, Common Case Failure)
13. Explain the two reasons for the existence of redundant systems or components
14. Prove that due to a common case failure in the absence of diverse system the fundamental safety functions can not be assure/guarantee.
15. Show how fail-safe systems can contribute to the fulfillment of the fundamental safety functions.
16. Asses the need of performing the deterministic analysis for the confirmation of the fundamental safety functions
17. List all the applicable operation modes taken into account under the deterministic safety analysis frame (normal, abnormal, incidents, accidents, etc)
18. Recall the main reasons for the introduction of the probabilistic safety analysis
19. Enumerate the 3 possible Levels of a complete PRA
20. Explain the following terms: Core Damage Frequency (CDF), Large Radioactive Frequency Release (LRFR)
21. List the main systems responsible for the fulfillment of the fundamental safety functions
22. Describe the fail-safe mechanisms of the reactor trip function.
23. List the main requirements necessary for the achievement of a strong fundamental safety culture
24. Give the definition of the safety culture as derived from the IAEA Documents.

Section 4.2 "Learning outcomes in the skills area" (Learning to do) (skills 1/3)

Item 4.2.1 - Job 1 - System and Process Engineering
Item 4.2.2 - Job 2 - Safety Analysis Evaluation Engineer

The definition of skills in terms of learning outcomes is rather a difficult task. Looking at the definition of term, Skills can be seen as a combination of capabilities and correct application of knowledge. The accumulation of knowledge can be relatively easily achieved through a structured description of different areas of interest. The second component, the capability of doing, relates more to the behavioural comportment of each individual.

The number of required skills for fulfillment of the condition of a job description can vary greatly from case to case. That is why we propose for the description of the job profiles targeted by this training scheme to summarize the following skills categories or areas:

- Analytical Skills
- "Hands On" (Manufacturing) Skills **(more details for job 1 further down)**
- Communication and Organizational Skills **(more details for jobs 1 and 2 further down)**

Skills (2/3)
Job 1 - "System and Process Design Engineer"

Area of skills:

TSB.S02 / "Hands On" (Manufacturing)

Learning Outcomes

1. Use effectively tools required for system layout and design.
   Examples: system layout (CATIA), core design codes (ORIGEN-S), core and system thermal- hydraulic codes like (CATHARE) etc

2. Perform operations related to a test scale reactor.
   Examples: calibrate nuclear instrumentation (e.g. neutron detectors)

3. Perform operations at a small scale test loop.
   Examples: calibrate closed control loops by adjusting deviation parameters, calibrate non-nuclear instrumentation (e.g. temperature and flow rate sensors)

4. Use effectively tools required for communication purposes.
   Examples: MS Office tools, content management tools, modern e-mail features

5. Use valid data bases of regulations, standards, components etc.

Skills (3/3)

Job 2 - "Safety Evaluation Engineer"

Area of skills :

TSB.S05 (= TSB.S03) / Communication and Organizational

Learning Outcomes

1. Organize small teams of engineers of different disciplines in an effective way according with the project or internal procedures.
2. Communicate effectively the needs for fulfilling the work requirements.
3. Get in contact with the cross-cutting disciplines, e.g. I&C or Electrical Power Supply.
4. Document technically the work done.
5. Communicate internally according to the employers procedures
6. Communicate externally with the client according to the contractual procedures
7. Communicate externally with the nuclear regulatory or safety authorities according to regulatory procedures
8. Show innovative and creative behavior……

19. Present with confidence and conviction to an unfamiliar & large audience (internal or external)

Section 4.3 "Learning outcomes in the attitude area" (Learning to live together and/or Learning to be) (attitude 1/2)

Job 1 - System and Process Engineering
Job 2 - Safety Analysis Evaluation Engineer

It is one of the most difficult tasks to change the behavior of an individual. This training scheme should provide a number of learning outcomes to be achieved especially during the internship or on the job training period.

=> simple separation in two categories based on the actions of the individual

- Passive attitude

In this context passive means not the absence of any kind of response but rather reactions related directly with his personality. Verbs like value, accept, be aware, have confidence, listen or embrace would be most appropriate to describe ones association with a positive attitude toward nuclear domain

- Active Attitude

As a result of firm beliefs and convictions, an individual will not only accept and value the necessary attitude for his field but (s)he will act on changing the others attitude. Again a number of verbs can help understand the actions of such individuals: act, ask, answer, defend, justify ,share or question.

Attitude 2/2
Job 1 - System and Process Engineering
Job 2 - Safety Analysis Evaluation Engineer

Area of attitudes :
TSB.A02 / Active (Human Performance)

Learning Outcomes

1. Promote information transmission within the project

2. Questioning attitude toward nuclear safety and safety culture

3. Act solution oriented based on principal "What is right and not who is right?"

4. Express interest in reduction of radiation exposure through crossover disciplines design

…….

6. List the main requirements necessary for the achievement of a strong fundamental safety culture

……..

9. Manifest interest for the changes induced by modification of safety standards and norm application

10. Respect the protocols and procedures but keep a questioning attitude

……

12. Point out mistakes or violation of safety rules and protocols

13. Make safety culture a daily priority by the beginning of the work

2 - Training Scheme for Construction and Commissioning Engineers of GEN III Nuclear Power Plants

ToC of FP-7 project ENEN III Deliverable D1.4 (1/2)

3. Job Profile / Description

3.1 HVAC Project Implementation Engineer
- **3.1.1 Main Function of the Job**
- **3.1.2 Detailed Tasks**
- **3.1.3 Knowledge, Skills and Attitudes Required for the Job Tasks**

3.2 Fluid System Construction and Commissioning Engineer
- **3.2.1 Main Function of the Job**
- **3.2.2 Detailed Tasks**
- **3.2.3 Knowledge, Skills and Attitudes Required for the Job Tasks**

Reminder: HVAC = Heating, Ventilation and Air Conditioning

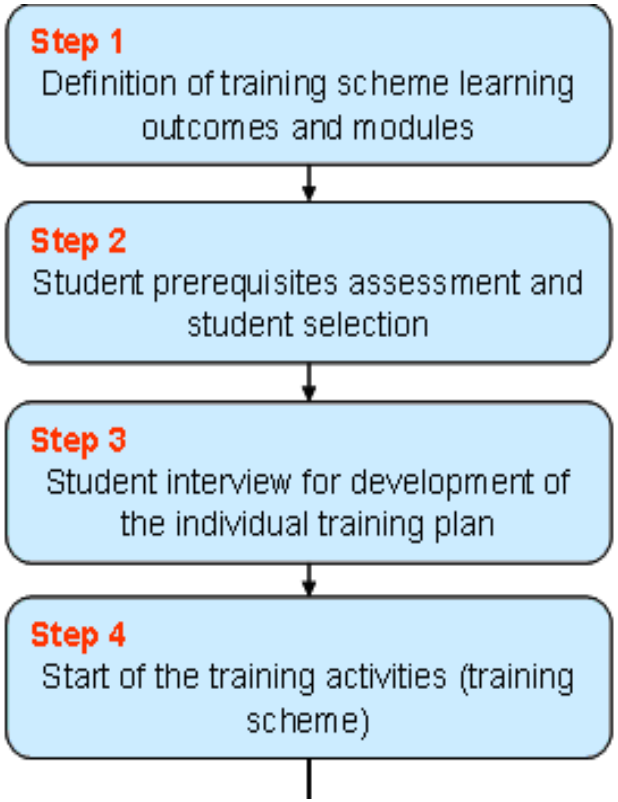
ToC of FP-7 project ENEN III Deliverable D1.4 (2/2)

3 - Conclusion and recommendations

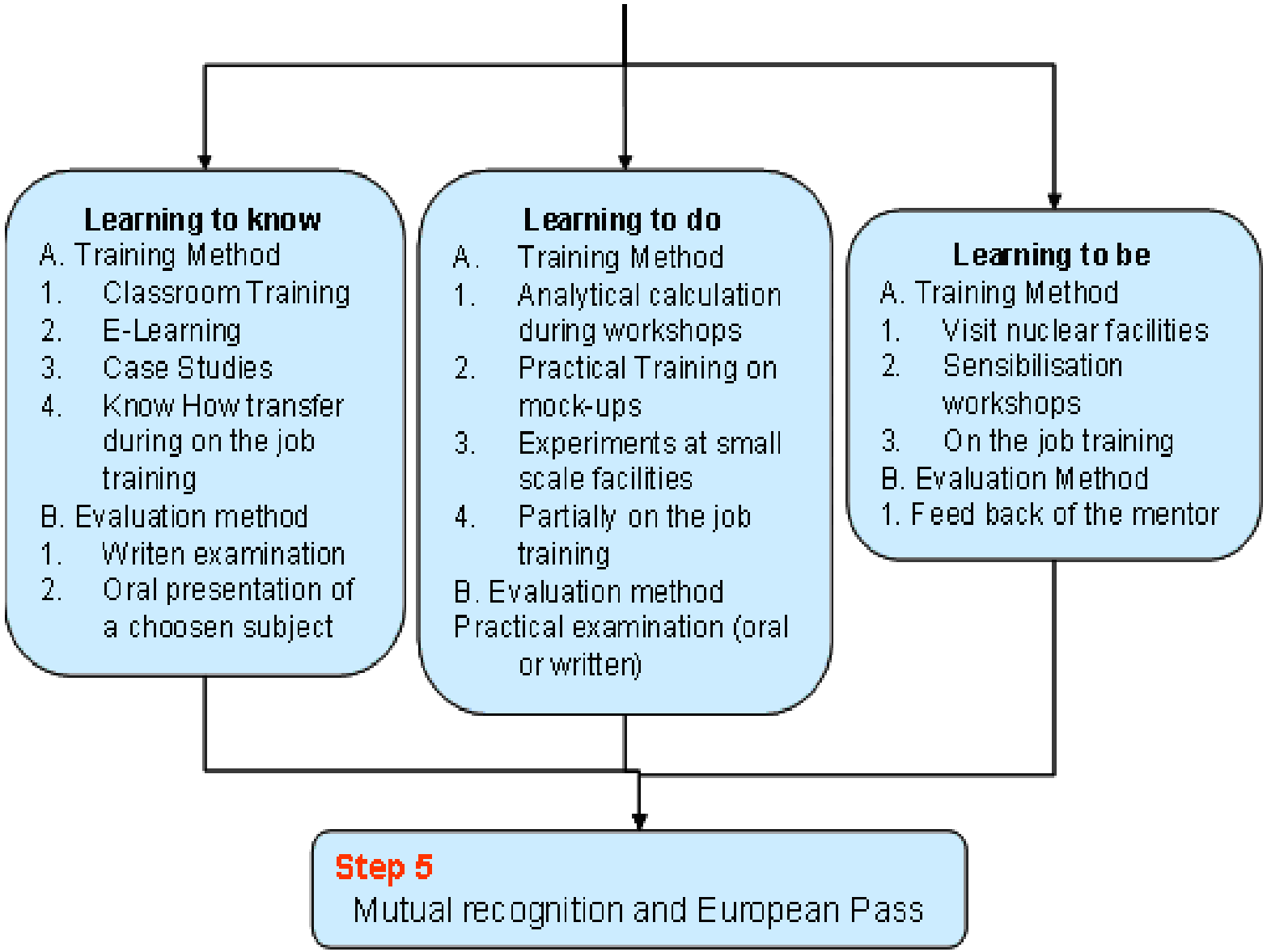
Each Training Scheme should follow a similar path for the achievement of the designed learning outcomes knowledge, skills, attitudes).
- The complete Training Scheme is presented in this Figure (1/2 and 2/2).
- **Step no 1 was defined above – steps no 2 to 5 are still to be done !**

= = = = = = = = =

Steps of Training Scheme Implementation in ENEN III (1/2)



Steps of Training Scheme Implementation in ENEN III (2/2)



Recommendations in ENEN III

.....

▪ The acquisition of the knowledge in all cognitive areas (knowledge, comprehension, application, analysis, evaluation) is clearly a challenging objective and should be not seen as an exclusive task of this training scheme. Further training and overall refreshment of the knowledge should be encouraged in the continuous development programs.

▪ In comparison with the area of knowledge, the skills and attitudes area are more demanding. Knowledge can be easily structured and transferred to the interested person. Skills and Attitudes have to do with the psychological and emotional profile of each trainee. ..... Pure theoretical training courses should have at least one learning outcome in area of skills and attitudes.
.....

▪ An individual profile should be documented for each participant in the training scheme, where the need and choice of training activities will be investigated. In short: Not everyone takes part in all training activities but rather with a very well defined target. Such document should be the result of an interview with the work package coordinator and if possible with representative of Human Resources. This step should be taken before the "Learning Agreement" is signed by the (counter) parts.