

**Beyond ITER –  
Skills Development  
Fusion Industry Innovation Forum**

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**Technology transfer**

**Developing skills**

**Roadmap to fusion power**

- Research and industry – ***building a stronger relationship***
- Skills – ***a prime asset***
- Skills Development – ***experiences from the fission community***
- Skills Development – ***next steps in fusion***
- Conclusions

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**The fusion programme is entering a transition period from science to application.**

**To do this, it is important that industry take a more active role in defining and developing fusion technologies. To assist in this:**

## **the Fusion Industry Innovation Forum**

**has been formed with three main objectives:**

- to promote and assist the fusion research community in the realisation of a DEMO design including industrial constraints**
- to promote and assist in technology transfer and spin off generation**
- to promote and assist in the development of skills in industry to position European industry at the forefront of fusion technology and therefore anticipate any future fusion commercial opportunities**

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- EFDA has initiated a programme on Power Plant Physics and Technology (PPP&T)
- The next two years will deliver a pre-conceptual design for a Demonstration fusion power plant
- To guide the EFDA activities, a PPP&T Advisory Board has been formed with an industrial representative
- Over these two years the Forum will work closely with EFDA to define DEMO and a technology roadmap for the realisation
- In the period 2014 to 2020 (the new Commission Horizon 2020 programme), and with adequate funding, industry will work close with research to implement this roadmap with the target of delivering a comprehensive conceptual design report by 2020
- The forum has already made a preliminary contribution to the Commission proposals for Horizon 2020

**Even though work has just started, industry is getting closer to research and is already contributing.**

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# Review of present situation

- **Education and training actions have been, up to now, mainly focused on basic education**
- **Very few training is proposed for professional engineers in fusion-related industrial activities**
- **The actions are not, in most cases, job driven and the contents mainly deal with fundamental topics**
- **Plant design, construction, operation, safety issues ... are only considered in some exceptional cases**

**There is thus a need to address short falls in fusion industrial competences**

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## From a quick survey of industry (39 companies)

- No specific competences reported in the area of civil design, nuclear licensing, and nuclear grade qualification and control
- Experiences reported mainly in engineering support, quality assurance and project management, diagnostics, electrical power supplies and material development
- Job positions of system engineers, process engineers and procurement engineers did not yet exist for this specific field
- In contrast, the following job positions are considered important for the future industry: system engineers, I&C engineers, electrical, mechanical, quality management engineers, interface and configuration management, project and procurement engineers, project and engineering managers
- Nearly all agreed that a professional training passport, recognized EU wide, would be advantageous

**Current initiatives insufficiently satisfy the emerging training requirements. Fusion needs adaptation of conventional disciplines (technical process and systems but also management, procurement, quality assurance ... ).**

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# Skills Development in Fission

- **Continuous worldwide growth of workforce from the 50s to the 80s**
- **No major new build of nuclear power plants in the 90s**
- **Consequently,**
  - **reduction of related education and research / development activities**
  - **size of workforce stagnated or was reduced**
- **Now, for 5 – 7 years new build projects have started or have been planned**
- **However, new requirements for 3rd generation (GEN III) power plants:**
  - **higher demands on safety**
  - **tight schedule, competitive costs**
  - **worldwide teams and supply chain**
- **Consequently, demand for skilled personnel is rising again**

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# Job Positions in Fission

- Research centers, universities, ...
- Nuclear operators (EDF, E.ON, ...)
- Waste management
- Suppliers for nuclear facilities (AREVA, Westinghouse, Bouygues, ...)
- Safety authorities
- Technical safety organizations (IRSN, GRS, TÜV, ...)
- International standards organizations (IAEA, ... )

including

- technicians / academics / ...

for diverse activities like

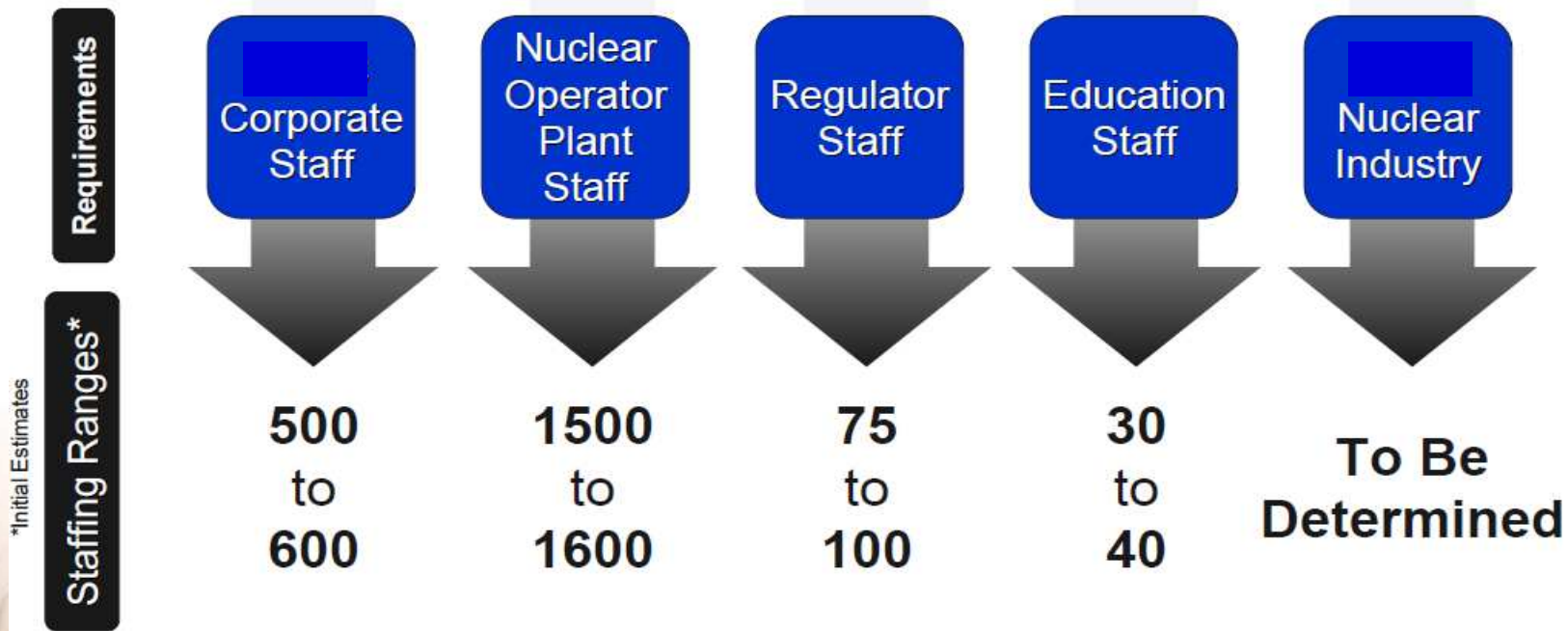
- engineering, operation, maintenance, licensing, safety, security, ...

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# Example: Building up a Nuclear Fleet (4 units, 1 site)



**An Initial Opportunity Estimate of 2100 to 2300 Staff by 2020**

IAEA Meeting  
on Workforce  
Planning  
March 2009

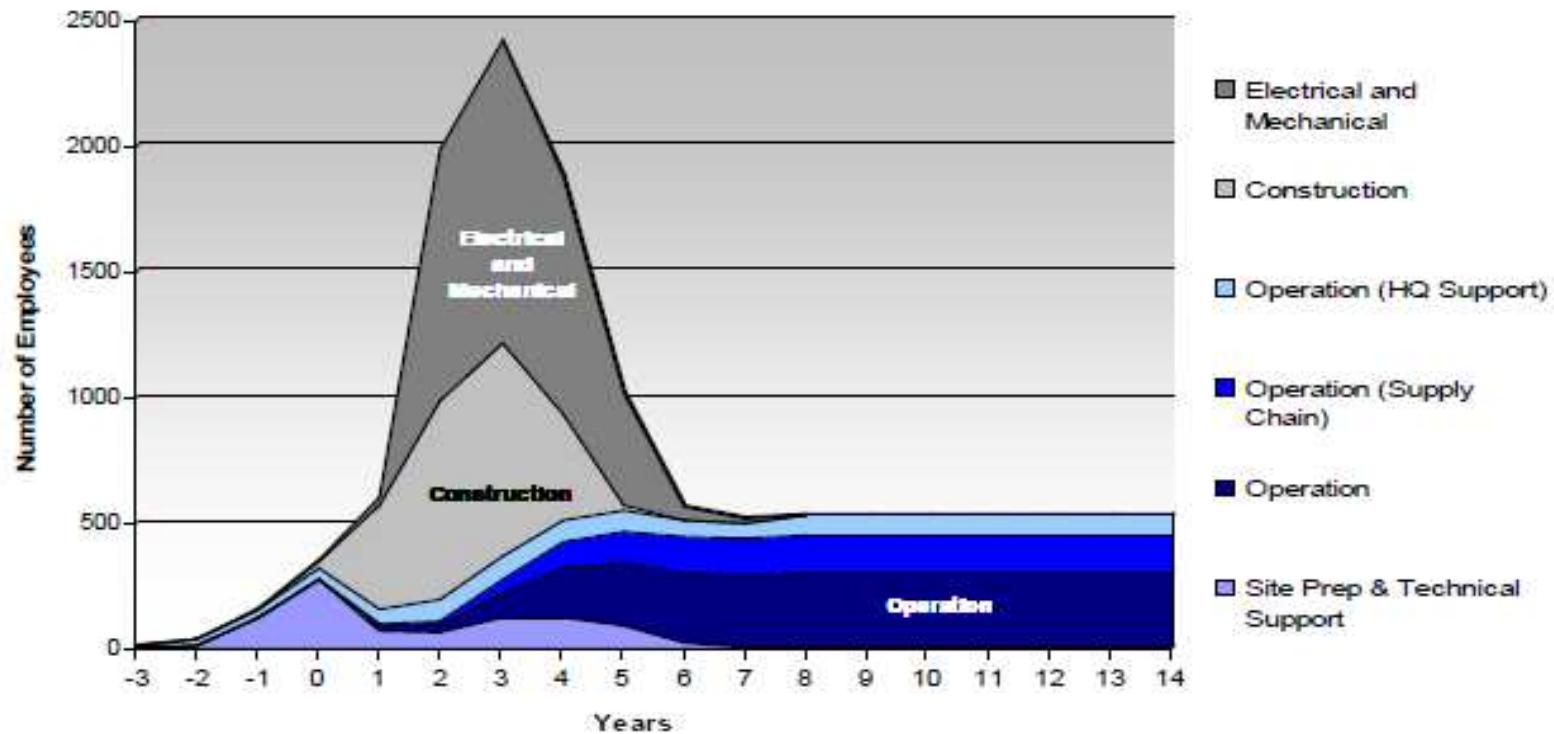
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# Resource Development during New Build (NB) Projects

Workforce Model for a Single-Unit Station



EUNET Meeting UK, 2011-12-14

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# Some NB Project Figures

- 5000+ resource mobilization
- 10+ locations around the world - numerous interfaces with partners
- 100+ / 200+ Project Team
- 5.000.000+ engineering hours for a turnkey
- 100.000+ engineering documents
- 1.000.000+ parts
- ~ 170 systems
- 15.000 lines on level 3 time schedule
- 50.000+ communication letters
- €3-5 - XX billion
- (6 or 7)+ years

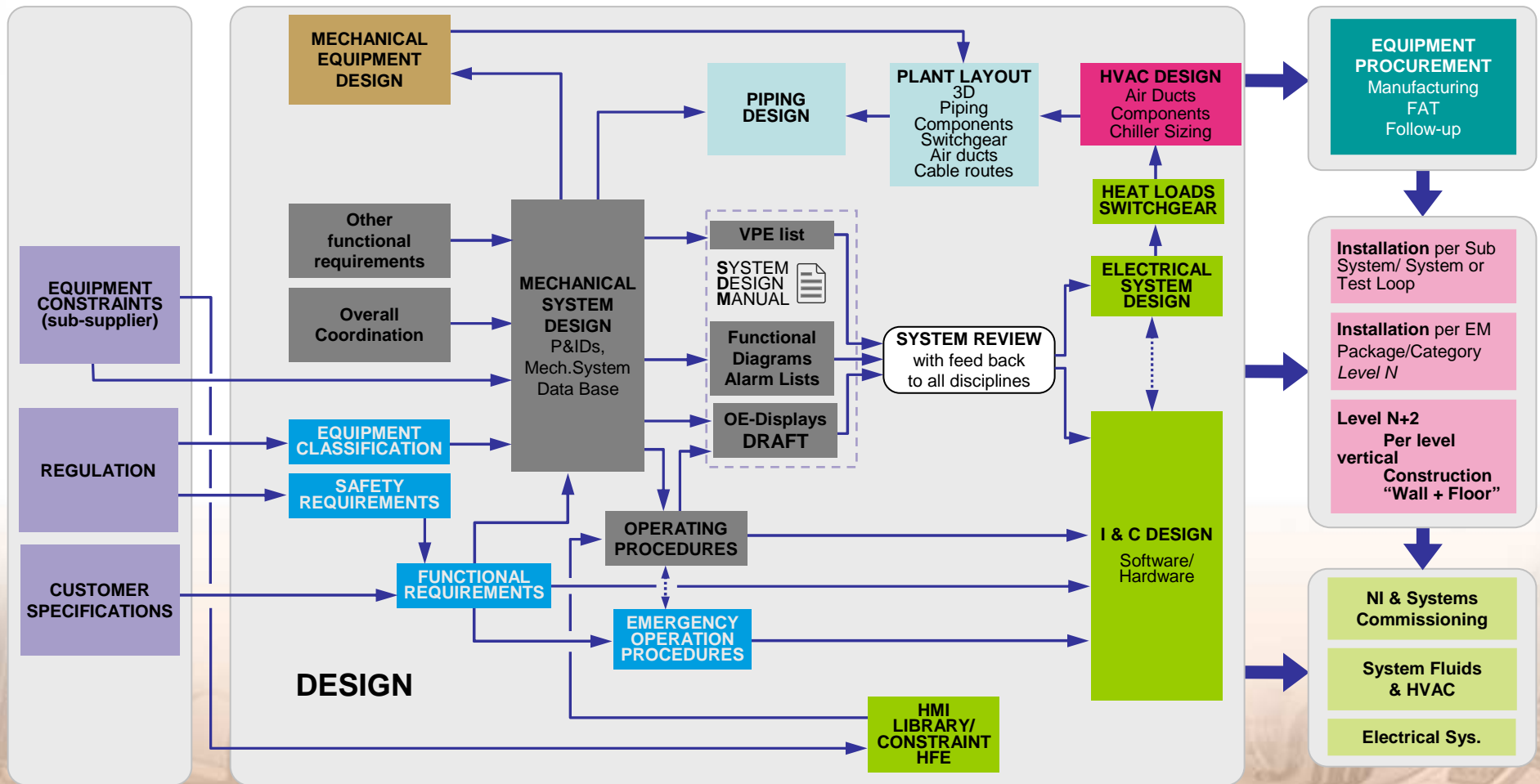
Photo AREVA

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# Engineering a NB Project



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# First Summary – Fission Skills Development

- Demand of hiring skilled employees is rising again
  - when existing workforce is ageing and in retirement phase
- Although production of nuclear (fission) energy is a mature technology, now further competences are asked for:
  - comprehensive safety culture
  - international working environment
  - diverse scope of licensing conditions
  - interface and configuration management (contractually / technically)
  - process management
  - project management

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# How to Meet these Emerging Resource Needs?

- Internal qualification programs  
(AREVA, EDF, **short term**, GDF-Suez, ...)
- National or international programs  
(NSAN, ENEN, **medium term**)
- Adaptation of academic education  
**long term**


NSAN: National Skills Academy Nuclear  
ENEN: European Nuclear Education Network

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# European Initiatives

- EURATOM Education & Training initiatives supported by the EC DG Research and Innovation / Energy (fission) e.g. under the current Seventh Framework Programme 
- Assisting in post-graduate and professional training
- Main objectives:
  - contribute to continuous EU-wide improvement of nuclear safety culture
  - support borderless mobility (mutual recognition)
  - support lifelong learning (continuous professional development)
- Currently 7 Euratom Fission Training Schemes under development dealing with competences required by stakeholders concerned with specific societal and industrial challenges
  - health physics / system suppliers / safety authorities / radwaste agencies / nuclear and radio-chemistry / CoC for VVER technology / EU-Canada coop.

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# European Nuclear Education Network

- non profit international organization established in 2003 under support by FP5 project, 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:
  - 60 members from 17 EU Member States, plus Switzerland
  - + further international collaboration: external MoUs, partnership arrangements, special agreement with DG JRC
- now also coordinating some Euratom projects, e.g. ENEN III

<http://www.enen-assoc.org/>

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# Some Conclusions for Fusion

- Lessons learned from the transition conceptual/basic design to detailed design / construction might have a positive impact on fusion power plant design / procurement / construction / project management
- Lessons learned from on-going fission skills development activities will help to plan, develop and implement fusion skills development programs on all levels
- There is an apparent need to develop programs
  - on different time lines (short / medium / long)
  - for different organizations (research & education, industry, regulators, ...)
  - for different job positions (system / process / I&C engineer, ...)

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## **The Forum has made some initial recommendations:**

- **Implement a pilot scheme for training industrial professional engineers including**
  - **dedicated fusion courses provided by the fusion community,**
  - **practical on-the-job training with internships and**
  - **creating recognisable centres of excellence for academic and vocational training in the different needs of the future fusion industry.**
- **Establish a pilot European Master of Nuclear Engineering / Fusion**
- **Embed training actions in the power plant conceptual design activities**
- **Involve experienced personnel from professional training institutions, dedicated to the design, development, coordination and implementation of training actions for all stakeholders in fusion research.**
- **Include basic industry related job positions in the FUSENET mission**
- **Contribute to a European Skills Passport**

# Conclusions

- **With the correct level of support, Industry can join a research programme to realise a DEMO design including industrial goals**
- **Industrial competitiveness must be supported by effective IPR management**
- **The fusion programme should maximise the added value from research and implement, for nearer term, a sound technology transfer programme**
- **Industry must set up programmes to address the specific skills needed to take, in time, leadership in any future fusion markets**

**The FIIF is now here to help in all of the above**

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**Thank you  
for your attention**

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