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Strategy for nuclear technology education at Uppsala University

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Outline

Nuclear power in Sweden

A brief background
Surviving the “dark age”

The need for nuclear technology education

In Sweden and world-wide

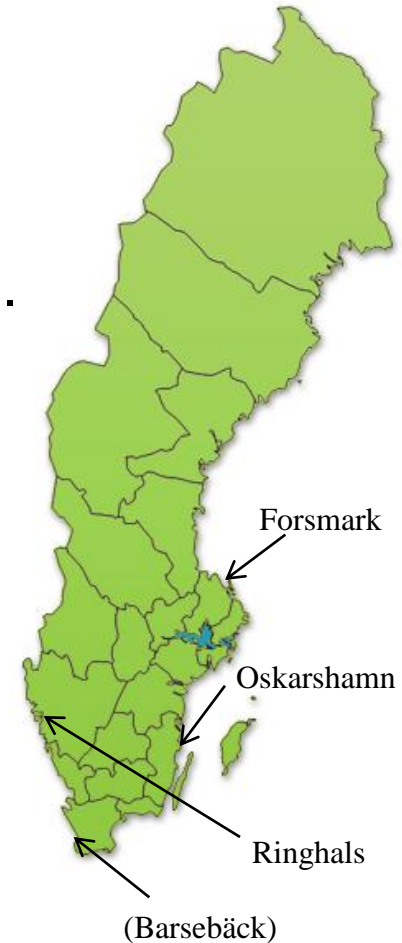
Nuclear technology education in Sweden

The Uppsala U. strategy for nuclear education
Current educational efforts at Swedish universities



Nuclear power in Sweden

- 9M inhabitants with a huge demand for electricity (≈ 17 MWh/person/year)
- Electricity production is mainly by hydroelectric and nuclear power. Fossil fuels are not used for electricity production.
- Currently 10 NPPs provide approximately 45% of the electricity.
- Some local history:
 - 1980 referendum: All reactors should be shut down by 2010.
 - 1997 legislation: NPPs should be phased out, but with no fixed time limit. Barsebäck NPPs shut down in 1999 and 2005.
 - 2010 legislation: Old NPPs may be replaced by new ones, but no more than 10 NPPs at any time.





Huge need for nuclear education

In the foreseeable future there will be a big demand for engineers with knowledge and training in the nuclear area from industry, authorities and universities.

- Many professionals are currently retiring (generation gap),
 - Life-time extensions and power upgrades of current plants,
 - Emerging technologies, e.g. Gen IV, require additional competence on various levels and functions,
 - New countries are embarking on nuclear power programmes,
Also, old NPPs are considered for replacement
- ⇒ Increased need for education and training, which in turn requires personnel.

The need is common for all actors:

- **Authorities** (supervision, inspection and licensing)
 - **Industry** (operation, maintenance and construction)
 - **Universities** (teaching and research)
-



The situation is similar world-wide

There are several national and international ‘platforms’ for sharing knowledge and expertise in nuclear education and training (WNU, ANENT, ENEN, ANSN, UNENE and others)

Some personal reflections:

- To a large extent the aim of competence is often set too high (Master, Ph.D.). The bulk of engineers needed at the NPPs is on Bachelor’s level or even lower.
- Courses are predominantly utility-oriented.
- Industry and where possible, national authorities, need to get involved in education and training.
- While international collaboration is essential, the requirements and conditions of each country are unique.



Swedish recruitment needs

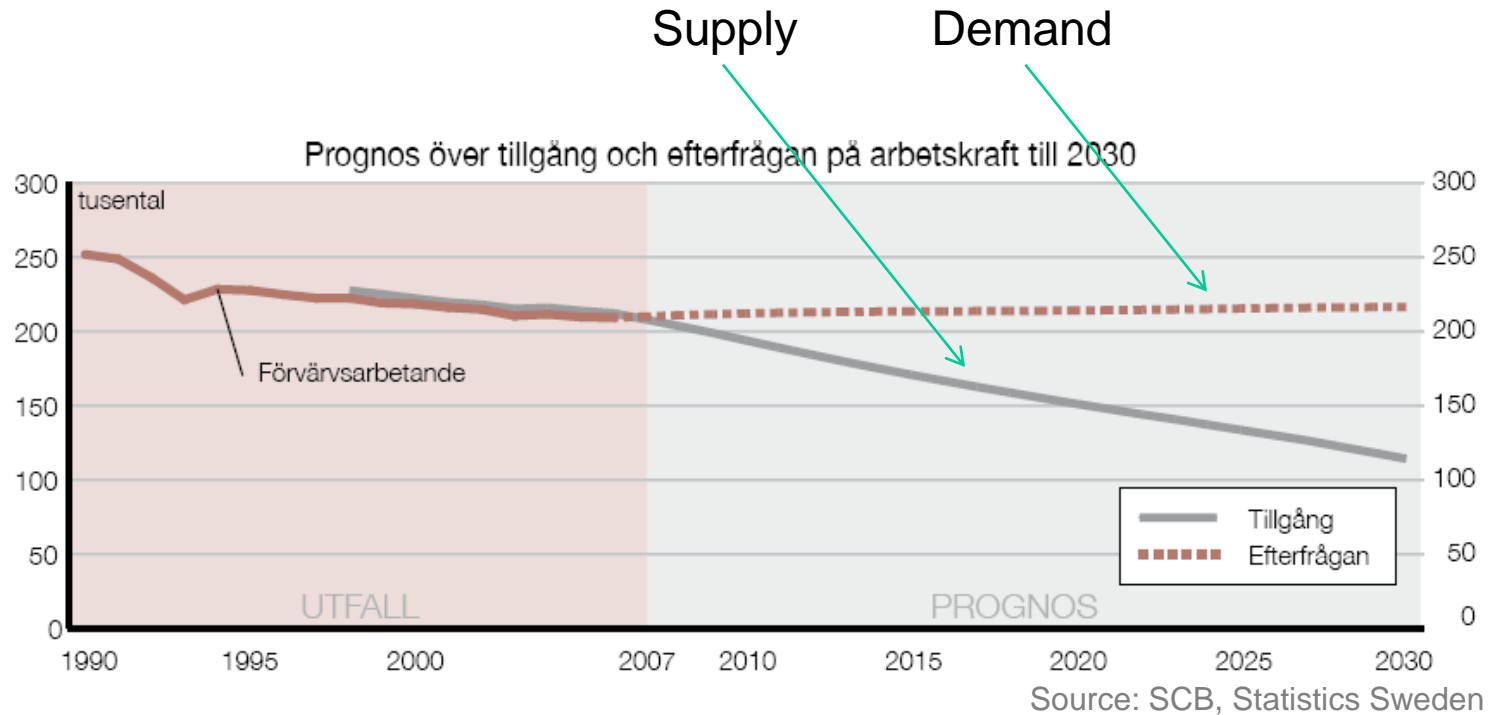
- In Sweden there is a big ($>10^2$ /year), long-term demand for engineers with a solid grasp of nuclear engineering on all levels.
- The biggest demand is for engineers on the Bachelor's level (primarily for NPP O&M).
- Previous educational initiatives, in Sweden (and abroad), have been focused on educating nuclear engineers on the Master's level.



Source: Young Generation, Sweden



B.Eng. supply and demand



The nuclear sector will face stiff competition from industry operating in other fields of engineering when recruiting new staff.



The dark age (Sweden 15 years ago)

50 % from nuclear power
12 nuclear power plants
Retirements \Rightarrow recruitment

No government funding of R&D
Reactors shutting down in 2010
Phasing out professorships etc.

Pros

Cons

\Rightarrow Very little student interest



Saving the day

Authority

Academy



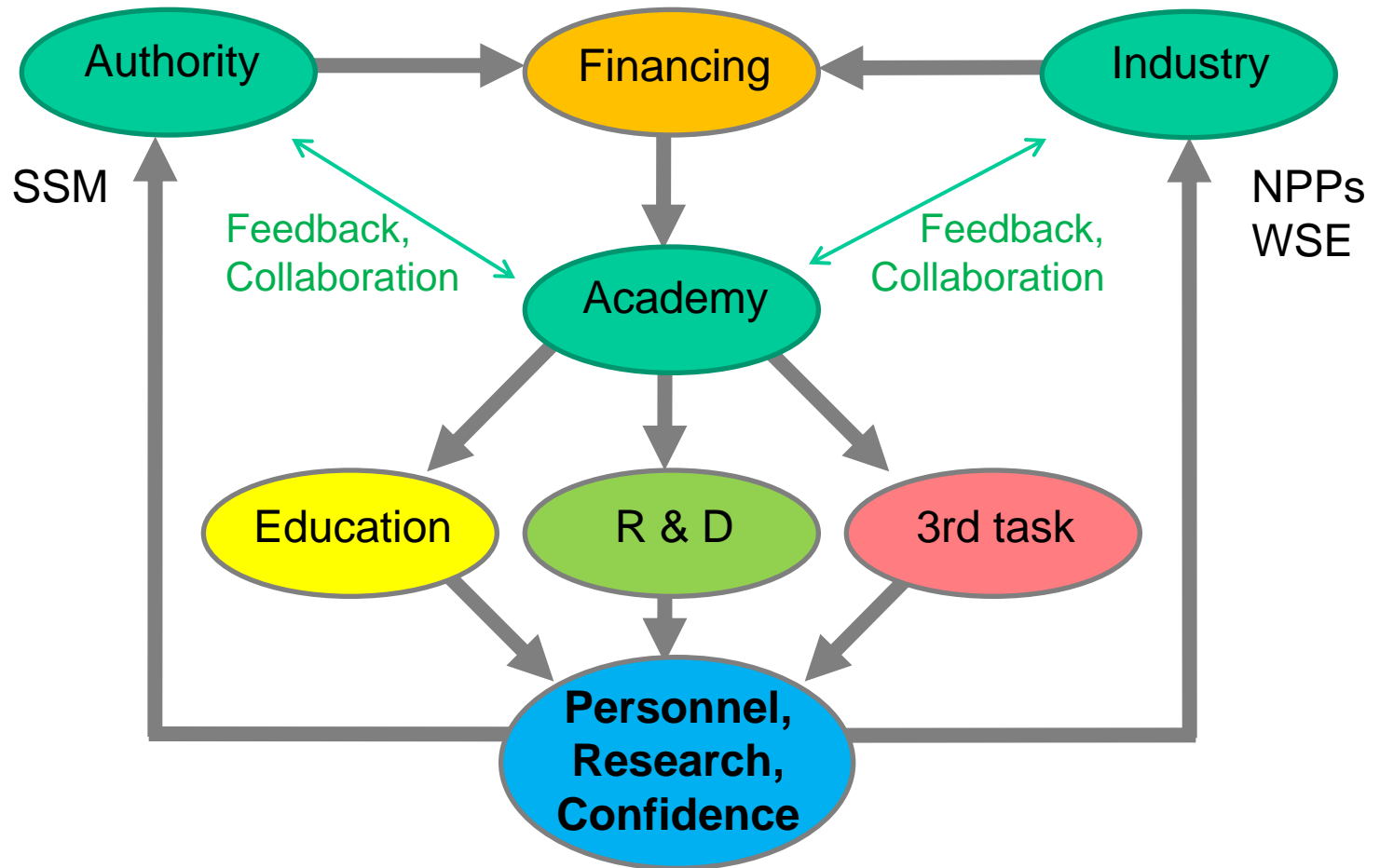
Industry

The nuclear industry teamed up with the Swedish Radiation Safety Authority and the universities to form the Swedish Centre for Nuclear Technology (SKC)

Objective : Define a financial platform for reconstructing research and education at Swedish universities.



The Swedish institutional system



SSM: Swedish Radiation Safety Authority
NPPs: Oskarshamn, Forsmark, Ringhals
WSE: Westinghouse Electric Sweden AB



Some comments on “The Swedish Model”

- No national Technical Support Organization
– advantage or disadvantage?
- The model may be most suitable for small countries
- The model facilitates contacts between students, and industry/authority staff
 - Guest lecturers
 - Study visits
 - Project courses
 - Diploma works outside the universities



Current situation in Sweden

Government funding of R&D
Academy is hiring new staff

45 % from nuclear power
10 power reactors (long term)
Retirements of personnel

Political decisions uncertain

Pros

Cons

⇒ Large student interest



Situation at UU a decade ago

- No university interest in supporting nuclear energy related research and education.
- Strong focus on renewable energy sources

Major master's programs:

• Energy Systems Engineering	Approx. annual intake 75 students
• Engineering Physics (+materials)	130 students
• Systems in Technology and Society	70 students

Dark horse:

The research program *Applied nuclear physics* had managed to stay alive partly due to funding provided by SKC. Research in fundamental nuclear physics with applications in electronic industry, medicine and safeguards.



Strategy for Uppsala U.

Objective:

- Establish UU as one of the largest providers of future staff for the Swedish nuclear power industry.
- Increase the volume and scope of nuclear energy related research at UU (not part of this talk).

Strategy:

- Adopt a “bottom-up perspective”, i.e., initially, do not strive to establish a nuclear engineering program.
- Instead, expose as many students as possible to nuclear energy within the framework of existing education programs.
- Establish a close cooperation with nuclear industry concerning NPP staff training in the form of contract education, e.g., reactor physics, thermal hydraulics, radiation protection & safety etc.



Outcome of the educational strategy

Starting from essentially zero ten years ago the UU experience is very encouraging:

About 100 Swedish-speaking students take at least one basic nuclear technology course annually.

About 20 students graduate each year with nuclear technology relevant diploma theses. Almost 50% female students. These engineers are to a major part employed in the nuclear industry.

The contract education directed towards NPP personnel increases every year. From a humble start in 2003 with 9 weeks of courses, during 2009 about 150 persons attended the contract education which comprised 29 weeks of teaching.

Students are allowed to participate “for free” in some of the contracted courses.



Phase two

- With the volume goal being met, introduce electable in-depth nuclear engineering courses within existing engineering programs.
- Develop a nuclear track within one of the existing programs, i.e., Energy Systems Engineering, in order to allow students to have a significant part of their education within the field of nuclear energy.
- Develop a B.Sc. in nuclear engineering program (Swedish: högskoleingenjörprogram i kärnkraftteknik)





The B.Sc. in nuclear engineering program

Prerequisite: At least two years of studies, primarily in electrical or mechanical engineering, at any Swedish university.

The third year is in Uppsala, covering the following topics:

- Introduction to nuclear power
- Reactor physics
- Thermal hydraulics and steam turbine technology
- Light-water reactor technology
- Chemistry, materials and fuel
- Electrical power technology
- Nuclear power safety
- Nuclear power operation
- Future nuclear energy systems – Gen IV, fusion
- Diploma work (half-semester, primarily performed within industry)



Unique aspects of the program

- The Swedish NPP operators, jointly support the education in a large and long-term sponsorship program. This is without precedent in Sweden.
 - Currently, 4/5 of the cost for operating the program is covered by the sponsorship program.
 - The sponsorship is mainly used to finance faculty positions, and includes resources for staff competence development, i.e. research.
 - The university retains the right to decide about the syllabus, admission to the program and examination. This is not contract education.
 - Industry and authorities participate in courses
 - Experts from industry and authority serve as teachers in many courses
 - Mentorship program. Each student has a personal mentor from the "Women in Nuclear" network.
 - Access to industrial training facilities (e.g. simulators and the Barsebäck NPP training facility).
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Nuclear technology education in Sweden

KTH



A Master's program in nuclear energy engineering was started in 2007.
All teaching in English.

Chalmers



A Master's program in nuclear engineering was started in 2009.
All teaching in English

UU



A “Högskoleingenjör” program in nuclear engineering was started in August 2010
All teaching in Swedish.

N.B. The Swedish “Högskoleingenjör” is roughly equivalent to a B.Sc. in engineering degree, but without the possibility of directly proceeding to a Master's program



In conclusion

- The collaboration between university, industry and authority has been essential to the success of the UU educational effort.
 - Industry and authority can provide expertise and training facilities not otherwise available to the university.
 - Nuclear engineering education tend to be more expensive than other engineering educations (e.g. reactor laboration).
 - The financial support includes resources for competence development for the teaching staff.
- Marketing is of vital importance.
Student interest \neq career in nuclear engineering
- The bachelor program as developed in Uppsala may serve as a template for deeper integration of authority and industry into the academic teaching, and for a larger involvement of academic staff into industry and authority competence development.



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Thank you for your attention!