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Challenges and Solutions in Successful Management of a Nuclear Business

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Last year the world population passed the 6 billion mark, and every year another 80 million are being born. Of course all of these people require not just food but also energy. Global energy consumption is currently increasing each year by nearly 2%, or roughly 250 million tonnes of coal equivalent.

The question of how this growing hunger for energy can be satisfied is becoming increasingly urgent, for the consequences of the destructive exploitation of our natural resources are becoming more and more apparent: forests in developing countries are being cut or burned down, exposing huge tracts of land to erosion; deserts are steadily expanding; and fossil energy sources will become scarce within a foreseeable period of time, leading to significant price increases. Also, the carbon dioxide (CO_2) emissions resulting from their utilisation continue to endanger our global climate.

Although this disturbing situation is now known to all, the necessary determination is still lacking to take far-reaching actions. It is simply not enough to define comparatively short-term goals for climate protection. Instead, what is involved here are fundamental, long-term problems such as future climatic living conditions on our planet as a whole and the timely implementation of steps to prevent international disputes, right up to military conflicts for access to natural resources.

In this situation, far-sighted common sense dictates that we base the generation of electrical power on as many energy sources as possible and thus at the same time avoid being dependent on the resources of only a small number of countries. All energy sources that can be exploited economically are therefore needed to meet the demand for energy. In this context nuclear energy plays a special role because it enables power to be generated without CO_2 emissions.

Nuclear power also contributes in two ways to the long-term stabilisation of electricity prices:

- Since the cost of nuclear fuel constitutes only a relatively small fraction of total nuclear power plant generating cost, it remains largely unaffected by developments in energy prices.
- Nuclear power exerts competitive pressure on the development of natural gas and oil prices. A phase out of nuclear power would remove this pressure, allowing the prices for fossil energy sources to rise — and the subsequent sharp increase in demand would push these prices up even further.

In view of these inescapable facts, the political opposition of some governments to nuclear energy is outdated and short-sighted. The significant

contribution made by nuclear energy to global power production will have to continue. In this context I would like to state my firm conviction that it is therefore only a matter of time before careers in the nuclear power industry regain their attractiveness, for highly-qualified university graduates as well.

There are already encouraging signs of this in the USA, in some European countries and especially in the Far East. In the USA, nuclear power plants are lining up to renew their licences which will otherwise expire after 40 years of operation. Baltimore Gas and Electric became the first company to seek licence renewal in April 1998 when it applied to the Nuclear Regulatory Commission for a 20-year extension for its two-unit Calvert Cliffs plant. At the moment, five reactors have received 20-year extensions to their licences, three reactors have filed for licence renewal, and 22 reactors are expected to apply for licence renewal in the next five years.[1]

Furthermore, a study of energy economics in Finland has shown the cost benefits of nuclear power, saying that "a new nuclear power plant would be the least-cost option for fresh generating capacity".[2] In Japan, International Trade and Industry minister Takeo Hiranuma, speaking after the first cabinet meeting of Japan's new coalition government, commented on Japan's national review of energy supply and demand. Concerning nuclear energy Mr Hiranuma said: "...Japan, with its shortage of natural resources, could not survive without it".[3]

Siemens Fuel Assemblies Offer Potential for Cost Savings

Bearing these foreseeable developments in mind, the present situation can be characterised as a period of time in which the main challenge for nuclear power generation is to prove its sustainable economic competitiveness within the deregulated power markets. For us at Siemens, price competition among the various energy sources and power generating technologies — triggered by power market liberalisation — has already been a driving force for many years for enhancing the economic viability of nuclear power.

Like all large branches of industry in this age of globalisation, the nuclear power sector perceives the present competitive environment as a completely normal situation. In fact, it could even be said that globalisation is nothing new to vendors of nuclear technology since they have always had to face competition on a global scale. Exploiting potential cost savings while at the same time improving productivity and quality is a long-standing tradition in this field. Siemens has also been following this course with great success in the nuclear fuel market. By continuously introducing new innovative products we have maintained our status as a technological leader.

At this point I should like to mention that when I speak of "Siemens" I actually mean Siemens Nuclear Power GmbH, a subsidiary of Siemens AG which came into being on 1 July 2000 as the result of the spin-off of Siemens' Nuclear Power Generation Division in Germany and Siemens Power Corporation (SPC) in the USA. Both will shortly become part of a joint venture with Framatome, pending approval by the European antitrust authorities.

Now, what are the success factors for business in the nuclear fuel sector within today's challenging economic and political environment? What does a strict

orientation of business towards the needs of the market — i.e. customer orientation — really mean? What steps has Siemens been taking?

Resources: Think Globally, Act Locally

The first success factor I would like to mention is our orientation towards global markets. To date, our fuel fabrication plants in Germany and in the USA have manufactured more than 78 500 fuel assemblies which are or have been in service in 120 reactors built by all leading suppliers in 16 countries. We recently manufactured our ten-millionth fuel rod.

This global orientation with its widely distributed network of customer relations ensures a stable volume of orders and also, in particular, makes our operations largely independent of current political pressures from local markets (see Figure 1). This, in turn, permits longer-term planning of all manufacturing processes as an *external* basis for successful quality management, sustainable reliability of supply and overall cost competitiveness.

Supporting this is the *internal* strength of our presence in Europe and the USA and the way these business units are interconnected. In keeping with the motto "think globally, act locally", Siemens' Nuclear Fuel Business consists of two business units, based in Germany and the USA. Headed by a single Chief Executive Officer and an international management team, the two business units serve the European and US markets as well as the Far East (see Figure 2).

The global R&D programme implemented by the Market Research and Development department is likewise oriented towards the needs of the global market. Centres of Competence located in Germany and the USA work closely together to develop new fuel assemblies, materials and programmes, thus ensuring efficient utilisation of resources.

While product development for the global market is managed by a central organisational unit, using internal and external resources available in Europe and the USA as well, all other functions exist in duplicate in both Germany and the USA, including the manufacturing plants which operate within a network that we had to carefully restructure following the abandonment of uranium and MOX fuel processing in Hanau. Within this manufacturing network, for example, cladding tubes are made for both business units at just one location — our German plant in Duisburg — while gadolinium-bearing pellets are fabricated only at Richland in the US state of Washington.

This fuel fabrication network promotes efficient, reliable and cost-effective order processing marked by a consistently high level of quality, while the duplication of key manufacturing steps avoids bottlenecks in fuel supply. Whereas our in-house fabrication plants currently focus exclusively on manufacturing uranium fuel assemblies, various partner companies fabricate our MOX fuel assemblies as well as fuel assemblies from enriched recycled uranium (ERU) to our design and under our supervision. The quality of this latter group of products is assured through the use of cladding tubes and structural components made at our own fabrication plants as well as through strict observance of our fuel assembly design specifications.

Thanks to this carefully coordinated network of fabrication capabilities, Siemens has succeeded in maintaining and expanding its status as a technological leader so that we can continue to serve our customers proficiently and with attractive prices.

Processes: Simple, Efficient and Monitored

The second success factor which I would like to mention in connection with our nuclear fuel business is methodical process management. We have divided our overall business process, i.e. the entire "Economic Value Added" chain, into four sequential steps called core processes (see Figure 3). These consist of product development, order acquisition, order processing and nuclear fuel services. Each of these steps is largely standardised, i.e. follows a clearly defined process procedure. The business process is defined and controlled by management processes and is accompanied by supporting processes such as quality management audits and employee development.

The process chain starts with the definition of products oriented towards customer needs. Although the business process is then oriented towards achieving direct benefits for our customers, it must also ensure an appropriate business profit. These two goals — customer benefit and business profit — can only be realised through partnerships with our customers. A key element of the way in which we interpret this cooperation between partners is by doing everything in our power to support our customers in responding to the changes of the liberalised power markets. This is also clearly set out in our "Strategy 2000" in which we committed ourselves to the following value proposition: "We are the most responsive source of solutions to improve customer operating plant competitiveness and profitability."

Consequently, we have made our customers' objectives our own; in other words, shared objectives. With the ulterior motive, of course, of becoming successful ourselves through this customer-oriented strategy and of remaining a reliable partner in the long term for our customers. All process steps are optimised in terms of productivity and product quality as part of a continuous improvement process. A single process manager is responsible, across all organisational units involved, for regularly monitoring and updating process indicators as well as for process reviews.

The successes achieved with this process management approach which are most important from the viewpoint of our customers — namely, the reduction in fuel cycle costs obtained from higher fuel burnups and the overall increase in fuel reliability — are illustrated by Figure 4. Discharge burnups have been steadily increased and, at the same time, we have succeeded in reducing fuel failure rates even further — despite declining product prices.

Our process-oriented organisation for order acquisition and order processing as well as for the performance of complex R&D projects is based on a matrix organisation (see Figure 5). The starting points of this structure are the technical Centres of Competence into which we have integrated our engineering capacities. Staff members from these Centres of Competence are assembled into temporary teams for such tasks as product development, the execution of individual projects or the generation of bid proposals. These project teams are assigned overall business responsibility; hence they also include sales and marketing personnel and business administration staff. The

formation of such cross-functional teams not only permits a process-oriented method of working but also guarantees optimum utilisation of human resources and shortens processing time.

Our process management strategy and matrix organisation structure have enabled us to adjust early on to the requirements imposed by the increasingly stiff competition on the global market and have proven to be vital factors for success.

Central Success Factor: Technologically Advanced Products

Of course, global thinking and customer-oriented management processes can only be of benefit to our customers if our products are also excellent. Siemens fabricated its very first fuel rod and very first fuel assembly in 1961 for the experimental nuclear power station Kahl. With the Atrium family of fuel assemblies for BWRs as well as the Focus X5 and HTP X5 fuel assemblies for PWRs, we now offer the broadest spectrum of nuclear fuel products available anywhere in the world (see Figure 6).[4,5]

These three product lines are suitable for deployment in all Western PWRs and BWRs. The prime objective pursued in fuel assembly development is of course to minimise fuel cycle costs (FCC). As regards the fuel assemblies themselves, innovations are mainly focused on:

- extending discharge burnup;
- improving in-core fuel management flexibility;
- increasing fuel reliability and robustness.

Higher discharge burnups can make an especially effective contribution to reducing costs. At a 1300 MWe PWR, for example, increasing the initial fuel enrichment to 5.0 wt.% U-235 and increasing discharge burnup from the current value of 50 MWd/kgU to around 65 MWd/kgU can be expected to lead to annual savings in the range of 10 to 15 million euros (US$9.2 to US$13.9 million), depending on disposal costs (see Figure 7).

However, higher discharge burnups also place severe demands on the fuel assemblies themselves. Many irradiation phenomena can only be properly studied under real reactor operating conditions. Therefore close collaboration with plant operators is the only way in which further improvements in fuel utilisation and operational reliability can continue to be made in the future.

The know-how required for mastering higher enrichments and higher burnups is based at Siemens on the broad experience gained from the operation of standard reload fuel. This is supplemented by extensive lead test and pathfinder programmes in which rod average burnups of up to 90 MWd/kgU and in one case even 100 MWd/kgU have been reached.[6] The additional experience and data gained from these programmes verify that the designs of the fuel assemblies are suitable for operation to high burnups (see Figure 8).

Of course a transition to reloads having an enrichment of 5 wt.% is the medium-term objective, something which could be completed within around 10 years. On the way towards meeting this objective plant operators and Siemens can expand their experience gradually and with a minimum of risk. The irradiation of lead fuel assemblies will provide the basis for design and licensing documents.

A significant contribution to improving nuclear power plant economics can also be made by plant uprating, which likewise poses a technological challenge for fuel assembly development. Here, all-round plant expertise is indispensable. An integral part of this expertise, which is a main prerequisite for such complex tasks, comes from Siemens' Nuclear Fuel Business.

Employee Satisfaction Through Motivation

I would now like to mention a success factor which is easily overlooked: our employees. At the beginning of my presentation I indicated that, despite all present adversities, the future prospects for nuclear power are definitely positive. I am confident that this will also lead to a renaissance of interest on the part of young engineers in our branch of industry. At Siemens we have faith in the old saying that "nothing is more successful than success itself" — or perhaps, to put it somewhat less philosophically, success is the best source of motivation. Not only does our success motivate our employees to remain committed to their tasks and to the quality of their work, but it also motivates new people from outside to join our staff.

We deliberately attach great importance to systematically developing our human resources, to promoting young members of staff, to preserving know-how in the long term and to providing personnel training. We view these as strategic obligations as well as an investment in the future of both our own business and that of our customers. A valuable tool assisting us in these endeavours is job rotation between various fields of activity and company locations, with personnel also being exchanged between both business units and thus also between the USA and Germany.[7] It is precisely this new insight into different cultures as well as different approaches to technical, commercial and marketing problems that broadens the minds of our employees, resulting in a higher degree of flexibility. With this background, the wide variety of complex tasks that our business involves can be solved in a more customer-oriented and more efficient manner.

We also take part in the activities of the Young Generation Network in which young members of our staff come together with their young counterparts from our customers' companies for an exchange of information and further training.[8] These contacts outside of their actual day-to-day work generate an atmosphere of trust between our customers and ourselves. The resulting network of contacts permits a rapid exchange of information among young employees in the nuclear sector throughout Germany and the whole of Europe. This is further supported by the active involvement of our young professionals in the German Nuclear Society (KTG) as well as in the European Nuclear Society (ENS). For example, Dr Astrid Gisbertz held the office of co-chairperson of the Young Generation Network within the ENS.

We are continuously hiring young staff, which is reflected by the age structure of our workforce (see Figure 9). This structure is perfectly normal for a field of business requiring a higher-than-average level of education and training. Therefore the risk of a loss of continuity as regards know-how, a question occasionally raised in public, does not apply to Siemens.

The comprehensive management philosophy of Siemens' Nuclear Fuel Business described earlier largely corresponds to the model of Business Excellence of the European Foundation for Quality Management (EFQM).[9]

Customer satisfaction, employee satisfaction and impact on society are achieved through leadership driving policy and strategy, people management, resources and processes, leading ultimately to excellence in business results (see Figure 10). All success factors mentioned earlier are implemented, regularly evaluated on the basis of self-assessments and continuously improved by senior management. Our experience from more than six years of Total Quality Management (TQM) according to this model and four years of self-assessment has yielded an increasing orientation and focus of our organisation and all its members towards the continuous improvement of our processes (business, management and support) — on the way to a learning organisation.

Further Plans: Joint Venture with Framatome

All of the prerequisites for competitive strength on the global fuel market that I have mentioned here can be fulfilled much better by the planned joint venture between Siemens Nuclear Power and Framatome (which also applies the EFQM model) than was previously possible by the two companies on their own. The joint venture will therefore be nothing other than the logical consequence of the efforts undertaken by both partners to date.

Let me therefore outline a few key dates in the current time schedule:

- Negotiations with Framatome were completed in June 2000 and the definitive agreement was signed on 4 July 2000.
- Founding of the joint venture will take place immediately on completion of the antitrust investigations, hopefully in late 2000.
- The joint venture itself, named Framatome Advanced Nuclear Power, will be entered under French law as a subsidiary of Framatome and Siemens with headquarters in France. Siemens will have a 34% stake in the company, with Framatome, the majority shareholder, holding 66%.
- From this point onwards, Siemens Nuclear Power GmbH will be run as a 100% German subsidiary of the joint venture and will be named Framatome Advanced Nuclear Power GmbH.
- In addition, there will be a US subsidiary of the joint venture which will combine Siemens' and Framatome's present US activities (i.e. SPC, Framatome Cogema Fuels and Framatome Technologies). FBFC International of Belgium will also become an integral part of this company.
- An essential organisational feature is that the entire company will be managed on the basis of four product lines with global responsibilities: new plant business/major backfitting projects, services, large components, and the nuclear fuel cycle.

What are the objectives of this joint venture and how will our customers benefit from it? A successful long-term partnership with our customers will only be possible and, from our customers' point of view, worthwhile if we can continue to provide a reliable and reasonably priced source of all products and services which are essential to the economical operation of nuclear power plants. This demands a solid technical, personnel and economic basis, a basis which is largely immune to national changes in the political arena.

From our point of view the planned joint venture is the best way for us to provide this basis, as it will also allow us to offer our customers the following advantages:

- Preservation of the technological and economic competitiveness of our products and services, and the innovational energy of our research and development departments, through the utilisation of synergies.
- Safeguarding of overall plant expertise because the joint venture's larger personnel base can ensure that know-how is maintained throughout all technical functions.
- Availability of integrated technical know-how from Siemens and Framatome.
- Parallel product lines, which are technically necessary or expressly demanded by customers, e.g. PWR fuel assemblies, will benefit from the exchange of information between Siemens and Framatome.

Through our merger with Framatome we will become a strong European company, the undisputed technology leader in the PWR sector, our constant objective being to bring our customers the best technical and economic solutions. That last statement also applies unreservedly to the BWR sector because we are far from becoming exclusively a PWR company.

Siemens will bring to Framatome the BWR expertise it has been lacking to date:

- Siemens is the present BWR market leader in Europe.
- In the USA, SPC is ranked second behind General Electric and is well placed to increase its market share due to the acknowledged excellent operating performance of our Atrium-10 fuel assemblies.
- Siemens is supplying the expanding Japanese BWR market directly from SPC and has a long-standing technical cooperation with Nuclear Fuel Industries (NFI).
- SPC's recent successes in Taiwan should also not be forgotten, where it now has a contract to supply fuel to the four operating BWR units for the next ten years.

The BWR sector will thus become an important element of the new company. We will expand these activities and in this way remain a global player and a competent partner for our BWR customers.

In our view, the joint venture between Framatome and Siemens is a logical continuation of our successful strategy over the past years and it represents a signal to our customers — nuclear power plant operators throughout the world — of renewed confidence in the continuing development of nuclear power generation.

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6. Sontheimer F & Landskron H, *Puzzling features of EPMA radial fission gas release profiles: the key to realistic modelling of fission gas release up to ultra high burnup of 100 MWd/kgU with CARO-E*. IAEA Technical Committee Meeting, Windermere, UK, June 2000.
7. Schäffler I, *The Siemens Graduate Program*. International Youth Nuclear Congress 2000, Bratislava, April 2000.
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Figure 1. Siemens is globally active in the nuclear fuel business.

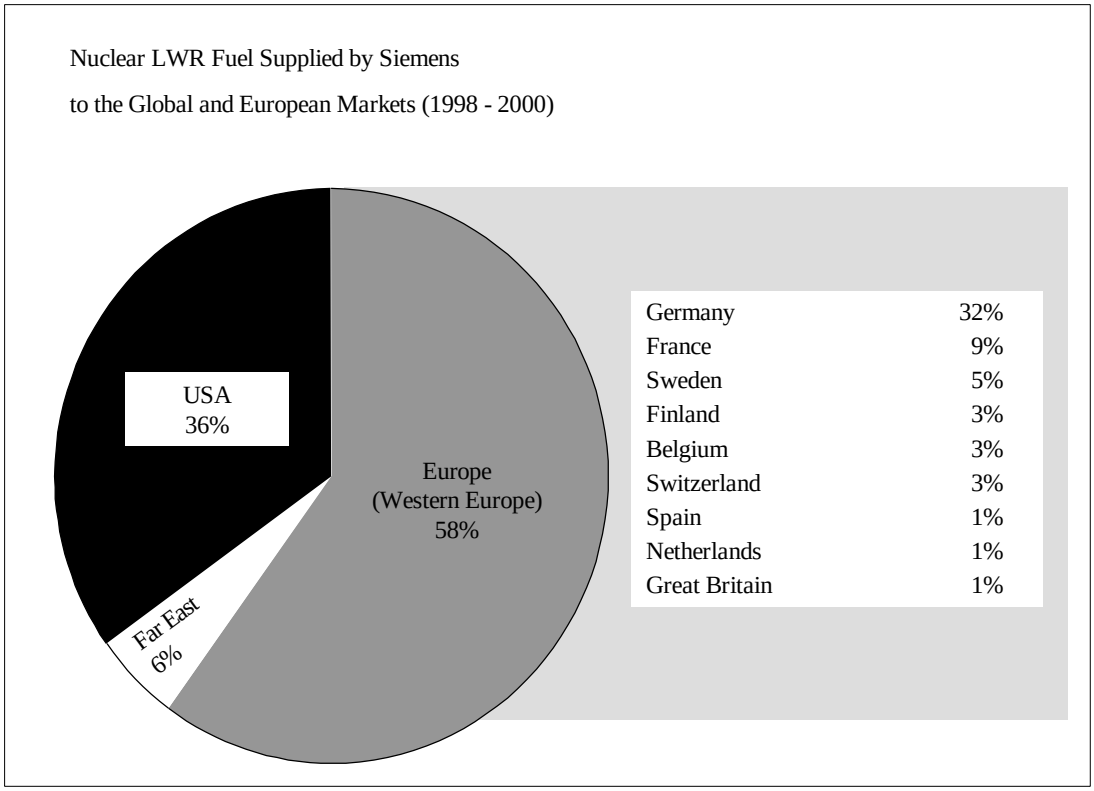

Figure 2. Siemens' organisational structure for its nuclear fuel business.

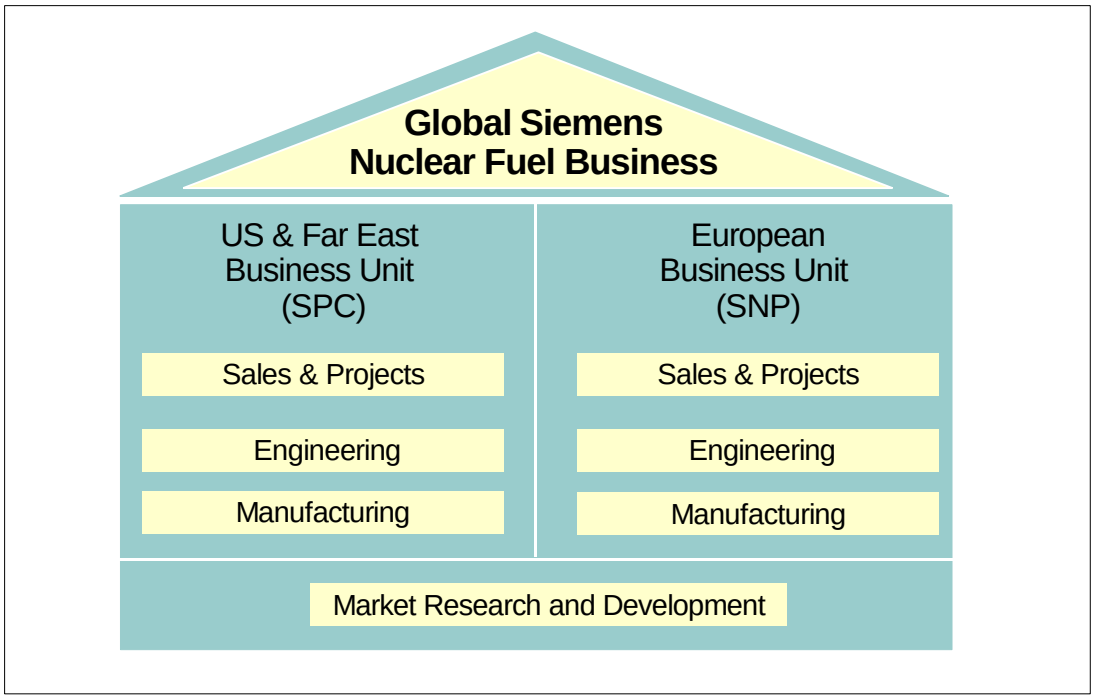

Figure 3. Process management within Siemens Nuclear Power.

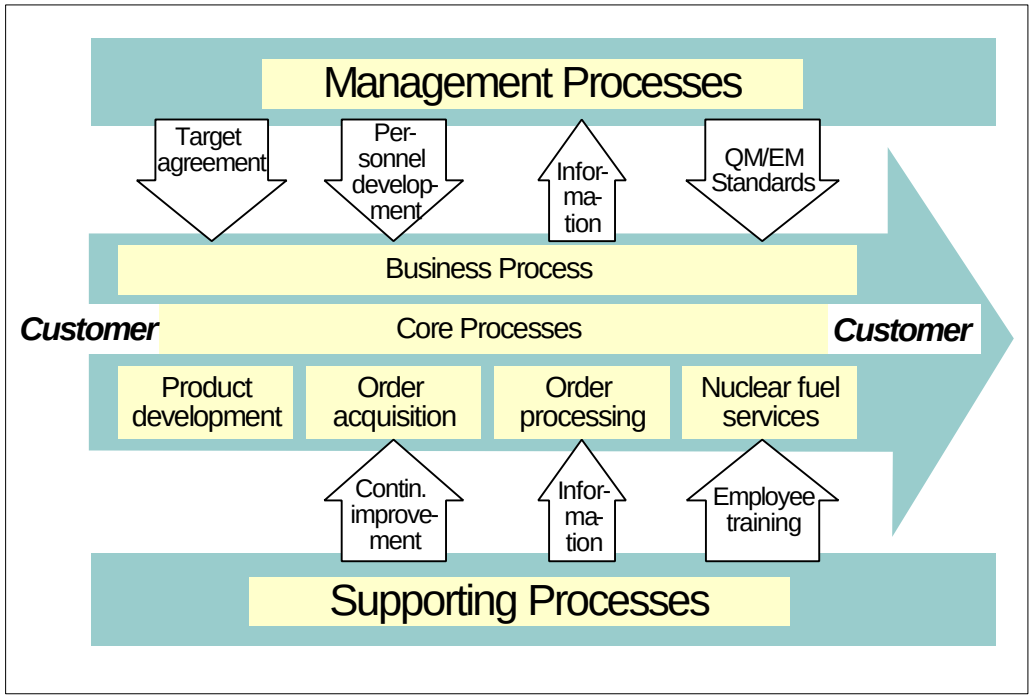

Figure 4. Increases in discharge burnup and reduction in failure rates with Siemens nuclear assemblies.

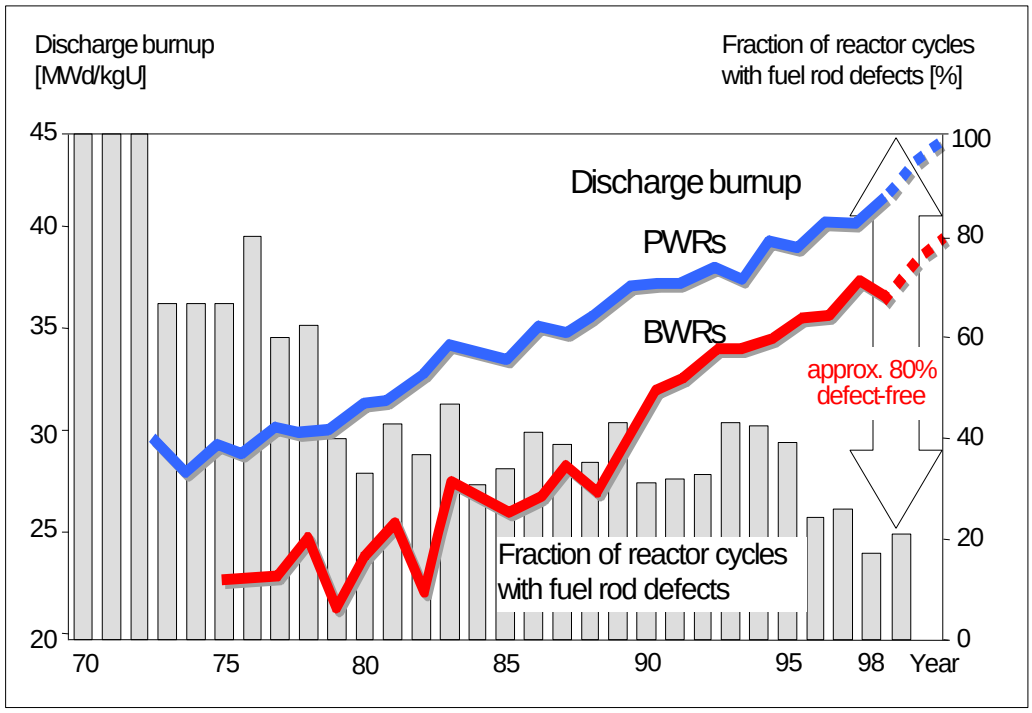

Figure 5. Matrix organisation of the Siemens nuclear fuels business.

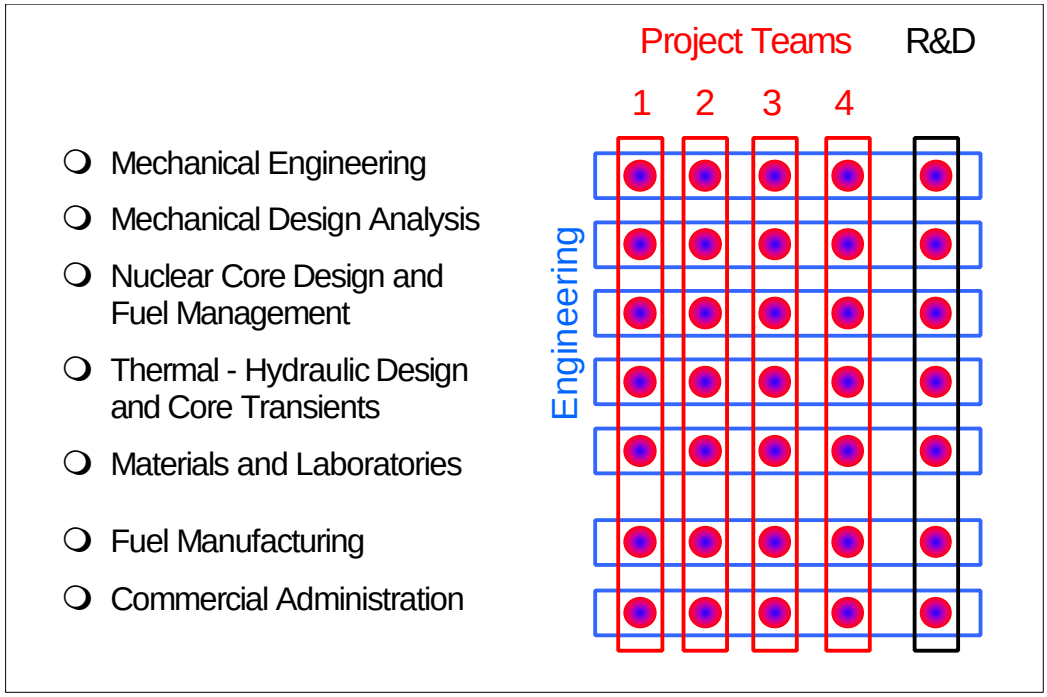

Figure 6. Siemens' range of advanced fuel assemblies is based on 3 product lines.

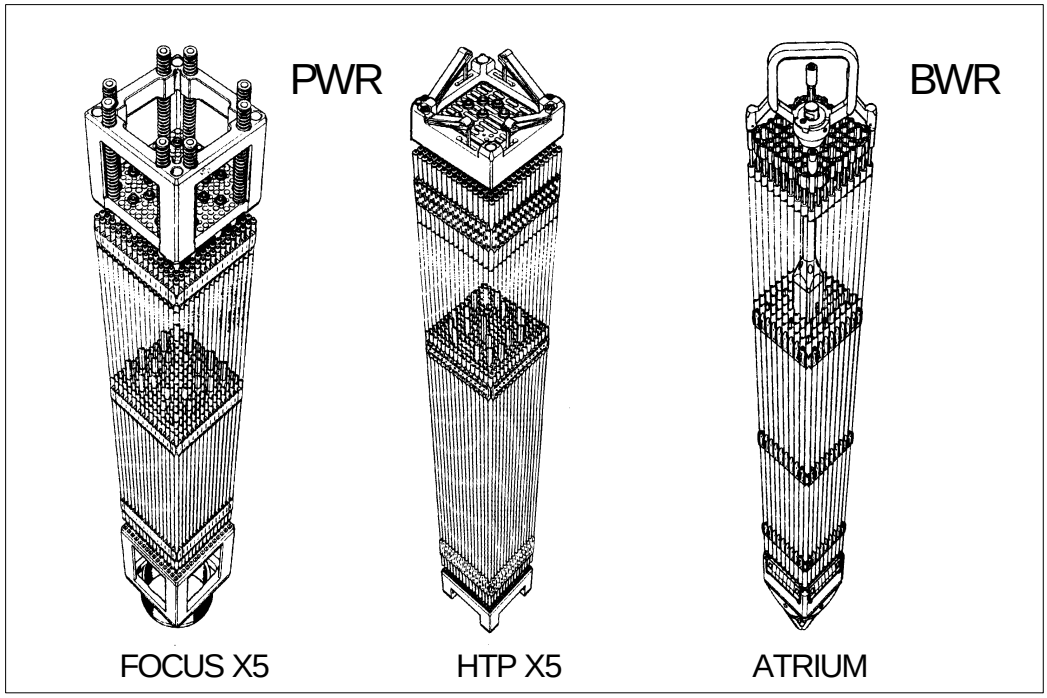

Figure 7. Potential fuel cycle cost (FCC) savings from higher burnups.

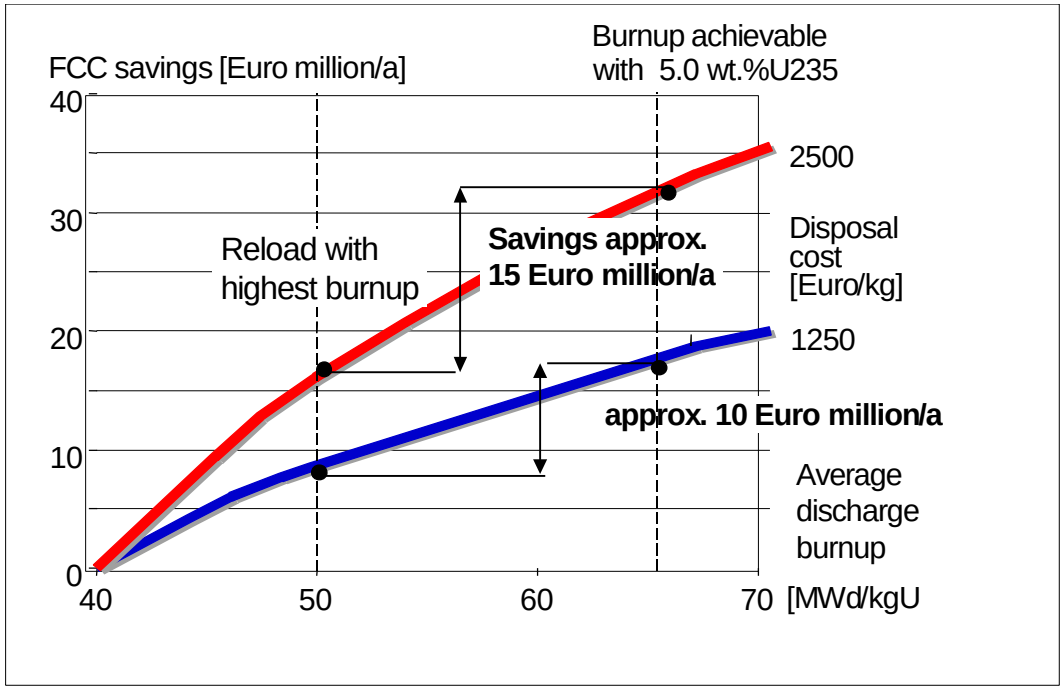

Figure 8. High-burnup experience for BWR and PWR fuel.

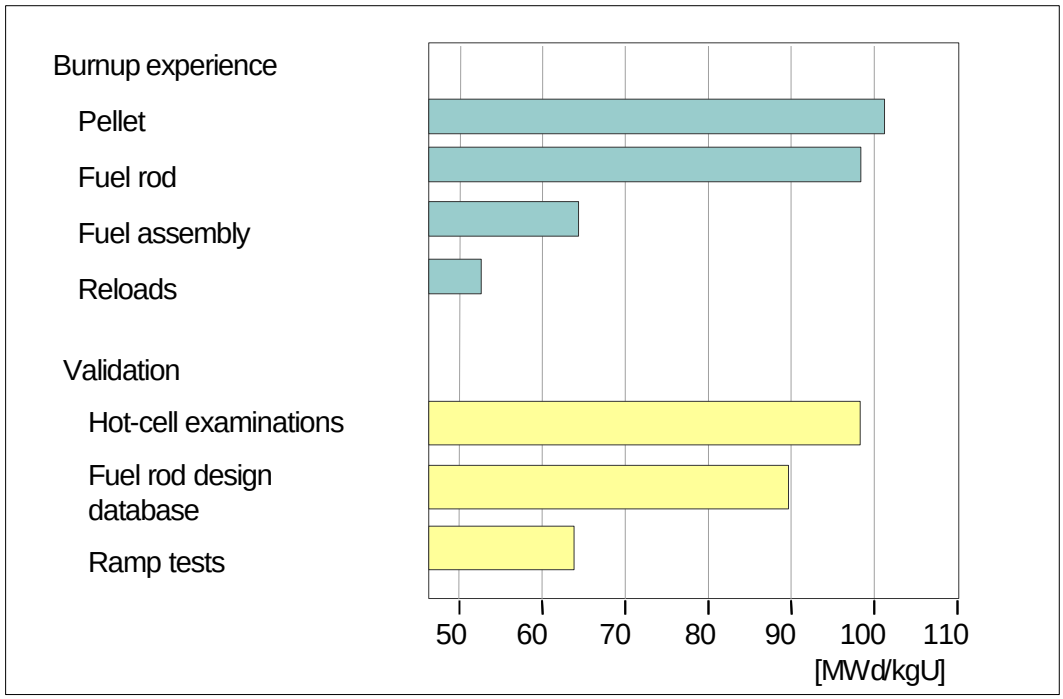

Figure 9. A sound age structure facilitates the build up of experience and retention of know-how.

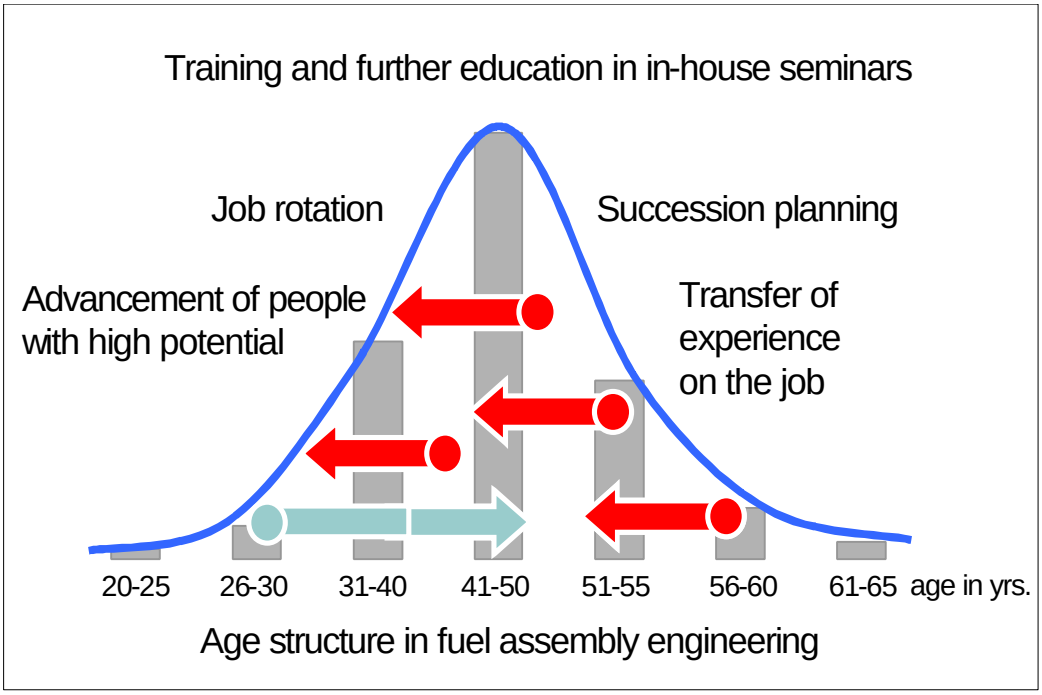

Figure 10. The EFQM model for business excellence.