Nuclear Power: Volume I - The Nuclear Power Industry

An Online Continuing Education Course for Engineers

Course Number: R-3004

Credit: 3 Hours / 3 PDH / 3 CPD

Nuclear Power

Volume I

The Nuclear Power Industry

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Cover photograph: Courtesy U.S. Nuclear Regulatory Commission (NRC).

Preface

This is the first in a series of three courses about the nuclear power industry. The series covers the nuclear industry from the physics of nuclear reactions to the types of plants in operation today as well as the potential of the next generation of nuclear power plants that are likely to appear in the first half of the 21st century.

The complete series includes three courses:

1. Volume I – The Nuclear Power Industry
2. Volume II – Nuclear Power Plants
3. Volume III – The Future of Nuclear Power

The first course, *Volume I – The Nuclear Power Industry*, gives a broad overview of the nuclear power industry. This course goes into the details of nuclear reactions and the physics of nuclear power. The prime fuel source, uranium, is covered too.

The second course, *Volume II – Nuclear Power Plants*, reviews the classifications of nuclear power plants and the basic components of a nuclear power plant. The course covers the design and operation of the current generation of nuclear power plants in operation today.

The third course, *Volume III – The Future of Nuclear Power*, gives an overview of the types of plants that are being considered for the next generation of power plants. Some of the designs covered are already operating in experimental stages, some are modifications of current designs, and others are radical new concepts that have not been commercially validated.

It is not necessary to take the courses in sequence. However, for the best comprehensive it is suggested that the courses be taken in the order presented.

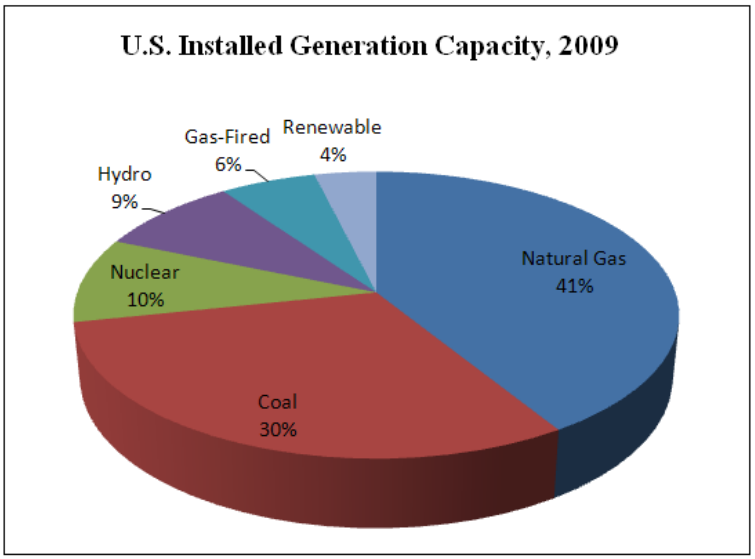
Introduction

A modern technological society requires substantial use of energy to function. While there is currently a lot of talk about energy conservation and renewable energy, the fact is energy consumption is growing and – for electrical base load power – the only practical alternatives are coal, gas, and nuclear energy. Each of these has issues; Coal has environmental issues with carbon dioxide, natural gas is subject to price volatility, and nuclear is expensive. As energy consumption continues to grow – and it will – all three of the traditional base load power sources must be considered to meet our energy needs. This course looks at nuclear power and how it is generated and discusses some of the issues facing the nuclear power industry today.

Meeting the future energy demand requires building many large power-plants over the next few years. If we do not do this and our energy demand grows as expected, we will be faced with large scale blackouts. This is not just an issue for the United States. The rest of World's use of energy is rising too, especially in former third-world nations. The inevitable consequence of the development in places like China and India is a tremendous demand for electricity. Almost all Third World countries (and certainly China and India) intend to raise their standard of living to Western levels. Both these Countries have populations of around 1 billion people and such developments will more than double the world demand for energy. Note that this will happen. The developing world will use energy at a rate comparable to what we did before the end of the 21st Century. China has identified nuclear power as an important component of its future energy mix. India has long-term plans to develop a nuclear power program to meet its own vast energy needs.

It is quite possible to utilize nuclear power to provide the vast majority of an entire country's need for electricity. For instance, in France nuclear power provides 77% of the nation's need for electricity. France generates a surplus of electricity which it exports to neighboring countries.

From a *capacity* standpoint, nuclear is only about 10% of the total electrical generation in the U.S. See the chart on the right. Natural gas is the largest segment of the installed generation in the U.S. at 41%, followed by coal at 30%, and nuclear at 10%. Renewables make up less than 4% of installed



capacity (and an even smaller amount of energy consumption.)

From a consumption – or *energy* - standpoint, nuclear power is responsible for approximately 19% of the electrical energy in the United States. The total generation is approximately 3,800 thousand gigawatt-hours. For comparison purposes, nuclear generation accounts for the following of the total electrical production in some other countries: 77% in France, 46% in Sweden, 43% in Ukraine, 39% in South Korea, 30% in Germany, and 30% in Japan. There are currently 104 licensed commercial nuclear power plants in the United States and 439 worldwide.

The current electrical energy consumption for the entir roximately 1517 gigawatts (GW) of continuous power. The in which provides 16% of the electrical power ces the most nuclear energy, with nuclear es, while France produces the highest percentag 7% as of 2006.

Unlike the coal and o the United States, a nuclear power plant, l the right, releases virtu greenhouse gases into atmosphere, and theref contribute to global wa stuff puffing out of this radioactive water vapor. power plants generate lo waste, this waste arguab of a threat to the biosphe greenhouse gases would.

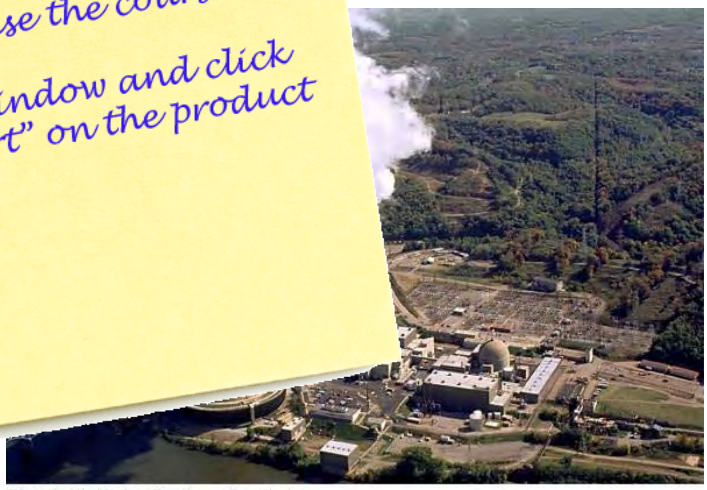


Photo Credit: Nuclear Regulatory Commission

Nuclear power is power produced from controlled nuclear reactions. Commercial plants use nuclear fission reactions. Electric utility reactors heat water to produce steam, which is then used to generate electricity. When an atom undergoes fission it splits into smaller atoms, other particles, and releases energy. It turns out that it is possible to harness the energy of this process on a large enough scale for it to be a viable way of producing energy.

The fundamental point about nuclear energy is that the energy content of one gram of Uranium is equivalent to approximately three tons of coal. This means that we need to consume about three million times less material with nuclear power compared to using coal or any other fossil fuel. This substantially reduces the volumes of fuel and waste of nuclear power compared to fossil fuels.