

Nuclear Energy Economics and Policy Analysis

February 3, 2004

2/4/04

22.812 Nuclear Energy Economics
and Policy Analysis

1

Nuclear Energy Economics and Policy Analysis Course Webpage
22.812J (Same subject as ESD.163J)
(3-0-9 H-Level Grad Credit, open to advanced undergraduates)

COURSE DESCRIPTION

SPRING 2004 ANNOUNCEMENTS:

Prerequisites: No formal prerequisites.

The subject is addressed to advanced undergraduate students and graduate students in science and engineering.

COURSE EQUIVALENTS

The class regularly meets MW 11:00 a.m. - 12:30 p.m.

COURSE HANDOUTS

Course readings will be made available at the [Reserve Reading Room \(14N-132\)](#) (under the course number 22.812) and at the [Dewey Reserve Desk \(E53-100\)](#) (under the course number ESD.163).

READING LIST & ADDITIONAL REFERENCES

Readings from previous years can also be found at the NED Library over at the [Nuclear Reactor \(NW12\)](#).

COURSE ASSIGNMENTS

Class notes (handouts) will be distributed in class and will be available on-line at the handouts page after each class session. Many of the handouts are available for printing or downloading in PDF format.

TEAM PROJECT LINKS AND REFERENCE MATERIAL

Last updated February 3, 2004

NOTE

Grading Information:

2 Quizzes.....50%

Homework.....20%

Team Project30%

Text: Park and Sharp-Bette, *Advanced Engineering Economics*, Wiley, New York, 1990, xeroxed classnotes, and MIT Nuclear Study Group, *The Future of Nuclear Power*, 2003

Instructor:

Professor Richard Lester

2/4/04

22.812 Nuclear Energy Economics
and Policy Analysis

3

World Primary Energy Production

World Primary Energy Production (commercial)	1992 (Quads = 10 ¹⁵ BTU)	2001 (Quads = 10 ¹⁵ BTU)
Petroleum	136.5 (39%)	155.3 (38%)
Coal	89.3 (25%)	96.0 (24%)
Natural gas	76.9 (22%)	93.5 (23%)
Hydro	22.9 (6.5%)	26.7 (6.6%)
Nuclear	21.2 (6.0%)	26.4 (6.5%)
Wind, geothermal, solar, wood, and waste	2.01 (<1%)	3.1 (<1%)
TOTAL	351.1 (100%)	403.4 (100%)

U.S. Energy Information Administration: <http://www.eia.doe.gov/emeu/iea/table29.html>

2/4/04

22.812 Nuclear Energy Economics
and Policy Analysis

4

World net electricity generation by fuel type, 2000

Billions of kilowatt hours (2000)	
Thermal	9318.4 (63.8%)
Hydro	2625.8 (18.0%)
Nuclear	2434.2 (16.7%)
Geothermal	238.7 (1.6%)
TOTAL	14617.0 (100%)

U.S. Energy Information Administration: <http://www.eia.doe.gov/emeu/iea/table63.htm>

About 440 nuclear plants provide nearly 17% of world's electricity.

2/4/04

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and Policy Analysis

5

Countries with highest dependence on nuclear power (2000)

Source: International Atomic
Energy Agency

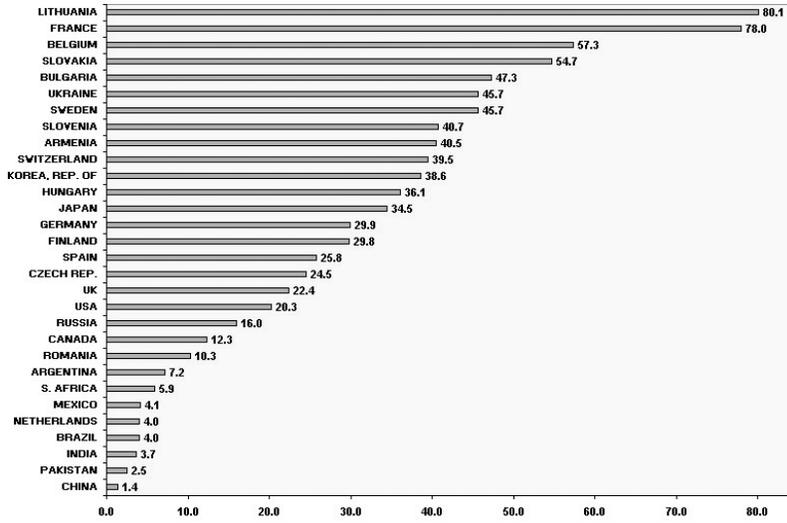
Country	Number of nuclear plants	Nuclear percentage of electricity generation
France	59	76.4
Lithuania	2	73.7
Belgium	7	56.8
Slovakia	6	53.4
Ukraine	13	47.3
Bulgaria	6	45.0
South Korea	16	40.7
Hungary	4	40.6
Sweden	11	39.0
Switzerland	5	38.2
Slovenia	1	37.4
Japan	53	33.8
Finland	4	32.1
Germany	19	30.6
Spain	9	27.6
United Kingdom	35	21.9
Czech Republic	5	20.1
United States	104	19.8
Russian Federation	23	14.9
Canada	14	11.8
WORLD TOTAL	438	16.0

2/4/04

22.812 Nuclear Energy Economics
and Policy Analysis

6

Nuclear Share in Electricity Generation in 2002



Source: International Atomic Energy Agency

2/4/04

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7

- Relatively few new nuclear plants are under construction

Construction began on 6 new plants in 2002 (5 in India, one in DPRK)

4 plants were shut down in 2002

NUCLEAR POWER PLANTS INFORMATION Operational & Under construction Reactors by Country

Country	Operational		Under Construction	
	No. of Units	Total MW(e)	No. of Units	Total MW(e)
ARGENTINA	2	935	1	692
ARMENIA	1	376	0	0
BELGIUM	7	5760	0	0
BRAZIL	2	1901	0	0
BULGARIA	4	2722	0	0
CANADA	16	11323	0	0
CHINA	8	5983	3	2610
CZECH REPUBLIC	6	3468	0	0
DEM. P.R. KOREA	0	0	1	1040
FINLAND	4	2856	0	0
FRANCE	59	63073	0	0
GERMANY	19	21283	0	0
HUNGARY	4	1755	0	0
INDIA	14	2503	8	3622
IRAN, ISLAMIC REPUBLIC OF	0	0	2	2111
JAPAN	54	44287	3	3696
KOREA, REPUBLIC OF	18	14890	2	1920
LITHUANIA, REPUBLIC OF	2	2370	0	0
MEXICO	2	1360	0	0
NETHERLANDS	1	450	0	0
PAKISTAN	2	425	0	0
ROMANIA	1	655	1	655
RUSSIAN FEDERATION	30	20793	3	2625
SLOVAK REPUBLIC	6	2408	2	776
SLOVENIA	1	676	0	0
SOUTH AFRICA	2	1800	0	0
SPAIN	9	7574	0	0
SWEDEN	11	9432	0	0
SWITZERLAND	5	3200	0	0
UKRAINE	13	11207	4	3800
UNITED KINGDOM	27	12052	0	0
UNITED STATES OF AMERICA	104	98230	0	0
Total:	440	360431	32	26447

The following data from Taiwan, China is included in the totals

Operational		Under Construction	
No. of Units	Total MW(e)	No. of Units	Total MW(e)
6	4884	2	2700

Source: International Atomic Energy Agency

2/4/04

22.812 Nuclear Energy Economics and Policy Analysis

8

EIA Projection of World Nuclear Power Growth through 2025

Table 20. Historical and Projected Operable Nuclear Capacities by Region, 2001-2025
(Net Gigawatts)

Region	2001 ^a	2005	2010	2015	2020	2025
Reference Case						
Industrialized	278.7	283.9	290.7	288.5	279.4	260.9
United States	98.2	100.2	99.3	99.5	99.6	99.6
Other North America	11.4	14.6	15.9	15.9	15.9	13.0
Japan	43.2	45.0	49.4	52.2	52.2	51.9
France	63.1	63.5	66.6	66.6	66.6	64.7
United Kingdom	12.5	11.0	11.1	7.0	6.0	5.4
Other Western Europe	50.3	49.7	48.4	47.3	39.1	26.3
EE/FSU	46.3	46.6	46.4	45.0	39.9	34.7
Eastern Europe	11.6	11.8	10.7	10.7	11.3	11.3
Russia	20.8	22.0	23.5	22.5	16.7	14.5
Ukraine	11.2	11.3	11.9	11.9	11.9	8.9
Other FSU	2.7	1.6	0.4	0.0	0.0	0.0
Developing	27.6	37.9	44.7	59.6	63.2	70.4
China	2.2	7.6	8.6	16.6	16.6	19.6
South Korea	13.0	16.9	18.0	20.9	23.6	27.6
Other	12.4	13.3	18.1	22.2	23.1	23.2
Total World	352.6	368.4	381.8	393.1	382.5	366.0

2/4/04

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9

How did we get to this point?

- Some hypotheses:

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2/4/04

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10

Key obstacles to future nuclear power development

- High costs and financial risks of nuclear power plants
- Public concerns over nuclear power plant safety and siting
- Nuclear waste disposal
- Nuclear proliferation and nuclear terrorism

2/4/04

22.812 Nuclear Energy Economics
and Policy Analysis

11

22.812/ESD.163J Nuclear Energy Economics and Policy Analysis (S'04): Preliminary Schedule

Class	Date	Topic
1	Wed Feb 3	Introduction.
2	Mon Feb 9	Balance sheets and income statements. The time value of money. Discrete and continuous compounding.
3	Wed Feb 11	Time value of money mechanics (contd.)
	Mon Feb 16	VACATION
4	Tue Feb 17	No Class
	Wed Feb 18	The effects of inflation. Calculation of capital costs
5	Mon Feb 23	Depreciation, capital recovery, and taxes
6	Wed Feb. 25	Depreciation, capital recovery, and taxes (II)
7	Mon Mar 1	Levelized cost of product. Carrying charges
8	Wed Mar 3	Methods for project evaluation
9	Fri Mar 5	(Makeup Class) Methods for project evaluation (II): Nuclear power economics
10	Mon Mar 8	Review session
11	Wed Mar 10	Quiz #1
12	Mon Mar 15	Scale economies. Investing under uncertainty.
13	Wed Mar 17	Nuclear fuel cycles (I)
	Mon Mar 22	VACATION
	Wed Mar 24	VACATION
14	Mon Mar 29	Nuclear fuel cycles (II): Material balances and simple cost models
15	Wed Mar 31	Nuclear fuel cycles (III): Enrichment case study
16	Mon Apr 5	Nuclear fuel cycles (IV): MOX case study
17	Wed Apr 7	Quiz #2
18	Mon Apr 12	Nuclear theft & nuclear sabotage
19	Wed Apr 15	Nuclear safeguards, export controls, and the Non-Proliferation Treaty
	Mon Apr 19	VACATION
20	Wed Apr 21	Managing nuclear safety risks
21	Mon Apr 26	Spent fuel/high level waste management (I)
22	Wed Apr 28	Spent fuel/high level waste management (II): Once-through vs. closed cycles
23	Mon May 3	Risk perceptions, risk communication & public attitudes
24	Wed May 5	Global nuclear growth scenarios
25	Mon May 10	Term Project Presentations
26	Wed May 12	Term Project Presentations

2/4/04

22.812 Nuclear Energy Economics
and Policy Analysis

12

Some important distinctions

- Macroeconomics
 - How national economies work; how the international economy works
- Microeconomics
 - Behavior of firms and markets
-  • Engineering economics (managerial economics)
 - Analyzing the performance of real investments

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and Policy Analysis

13

Investment analysis

- What is an investment?
 - “The act of incurring an immediate cost in the expectation of future rewards.”
 - Examples:
 - Purchasing equipment
 - Building a plant
 - Laying in a stock of goods for later sale
 - Paying tuition
 - A superbowl ad
 - R&D
 - Two essential features of any investment
 - Time
 - Risk

2/4/04

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and Policy Analysis

14

Another important distinction

- Engineering economics
 - Predicting the consequences of alternative future courses of action
- Accounting
 - Establishing a precise historical record of past economic activity

2/4/04

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and Policy Analysis

15

Key concepts for next class

- Balance sheet
 - Assets, liabilities, net worth
- Income statement (profit-and-loss statement)
 - Revenues, cost of goods sold, operating expenses, operating income, net income, etc.
- Cash flow statement
- Financial ratios
 - Return on assets
 - Return on investment
 - Liquidity ratios

2/4/04

22.812 Nuclear Energy Economics
and Policy Analysis

16