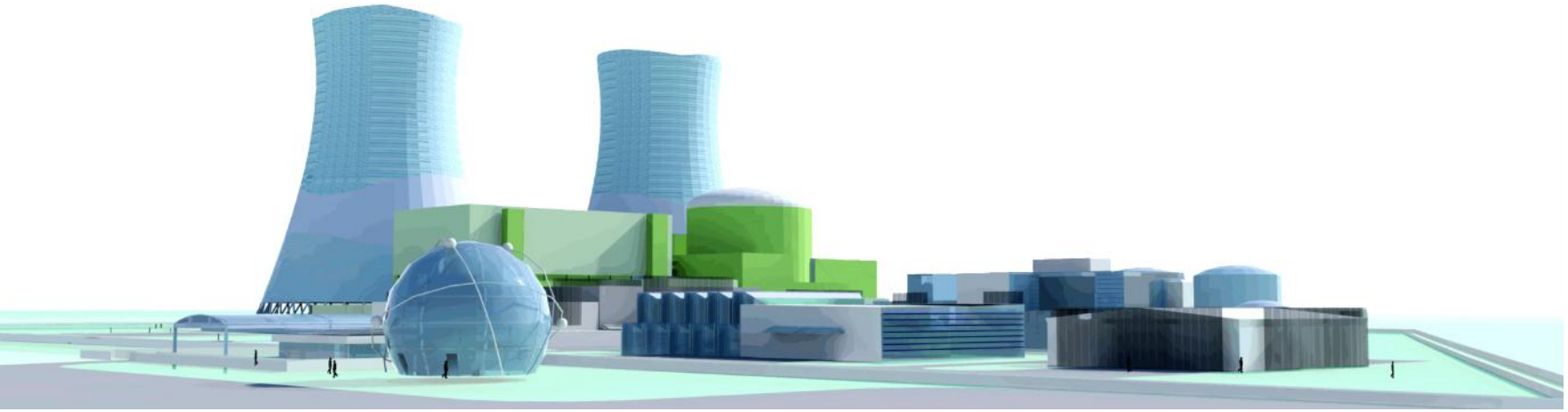


Status nuklearne energetike, Obrazovanje iz NukE na MF UB

Vladimir STEVANOVIĆ
Univerzitet u Beogradu
Mašinski fakultet

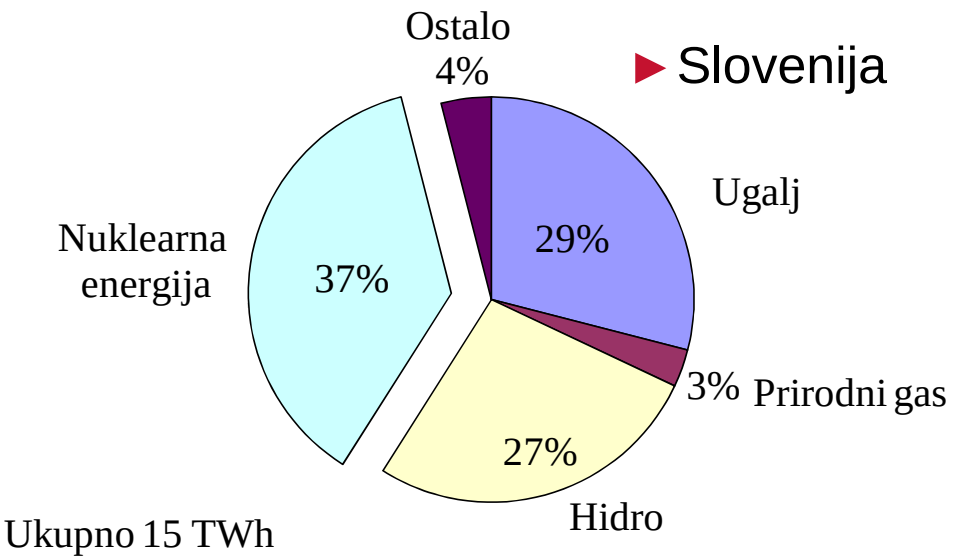
Skup: Trebaju li Srbiji nuklearke, Balkanmagazin, Beograd, 8. mart 2018.

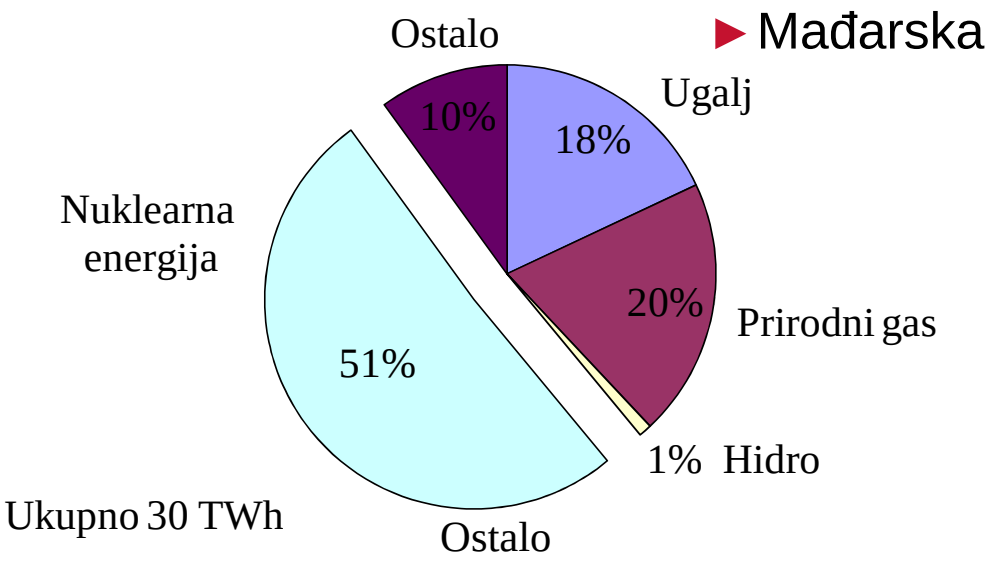
NUKLEARNI ENERGETSKI REAKTORI U SVETU

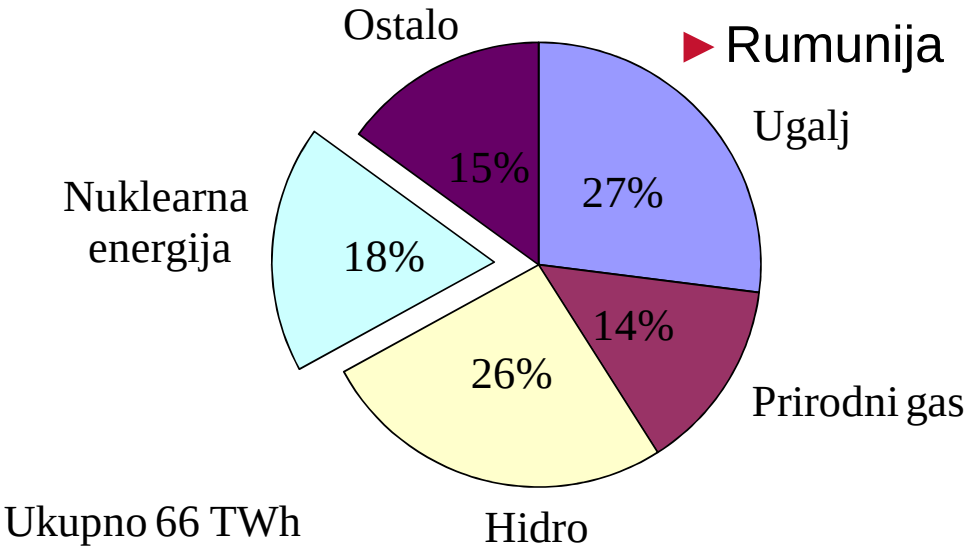
	Zemlja	Br. NR	MWe	Planirano	
				Broj	MWe
1	Argentina	3 PHWR	1627	1	25
2	Bangladeš	2 PWR	-	2	2400
3	Belorusija	2 PWR	-	2	2218
4	Belgija	7 PWR	5913	-	-
5	Brazil	2 PWR	1884	1	1245
6	Bugarska	2 PWR	1906	-	-
7	Finska	2 PWR 2 BWR	2758	2	2800
8	Francuska	58 PWR	63130	1	1600
9	Holandija	1 PWR	482	-	-
10	Indija	18 PHWR 2PWR 2 BWR	6225	7	4340
11	Iran	1 PWR	915	-	-
12	Japan	19 PWR 23 BWR	39752	2	2650
13	Jermenija	1 PWR	375	-	-
14	Kanada	19 PHWR	13524	-	.-
15	Kina	35 PWR 2PHWR	33400	28	28720
16	Mađarska	4 PWR	1889	2	2400
17	Meksiko	2 BWR	1552	-	-
18	Nemačka	6 PWR 2 BWR	10799	-	-
19	Pakistan	4 PWR 1 PHWR	1320	3	2028

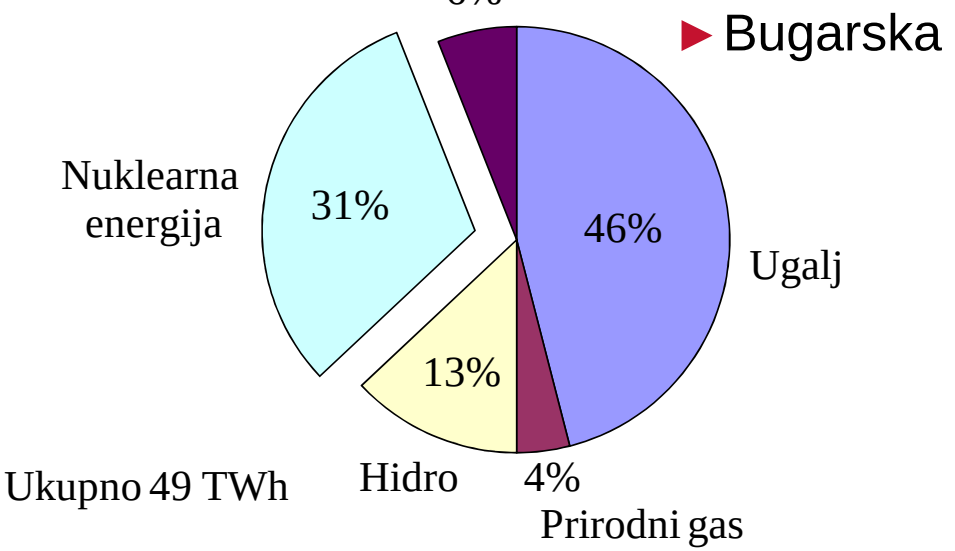
	Zemlja	Br. NR	MWe	Planirano	
				Broj	MWe
20	Rumunija	2 PHWR	1300	2	1440
21	Rusija	18PWR 15RBMK 2LMFBR	26172	9	6718
22	Slovačka	4 PWR	1816	2	880
23	Slovenija	1 PWR	688	-	-
24	Južna Afrika	2 PWR	1860	-	-
25	Južna Koreja	21 PWR 4 PHWR	23044	5	6820
26	Španija	6 PWR 1BWR	7121	-	-
27	Švedska	3 PWR 7 BWR	9740	-	-
28	Švajcarska	3 PWR 2 BWR	3333	-	-
29	Tajvan	2 PWR 4 BWR	5052	2	2600
30	Turska	-	-	4	4800
31	Ukrajina	15 PWR	13107	3	2850
32	UA Emirati	-	-	4	5380
33	UK	1PWR 14 AGR	8888	2	3200
34	USA	65 PWR 34 BWR	102198	6	7100
35	Češka	6 PWR	3930	0	0
	UKUPNO	**450**	**299805**	**90**	**92214**

UDEO NUKLEARNE U PROIZVODNJI ELEKTRIČNE ENERGIJE

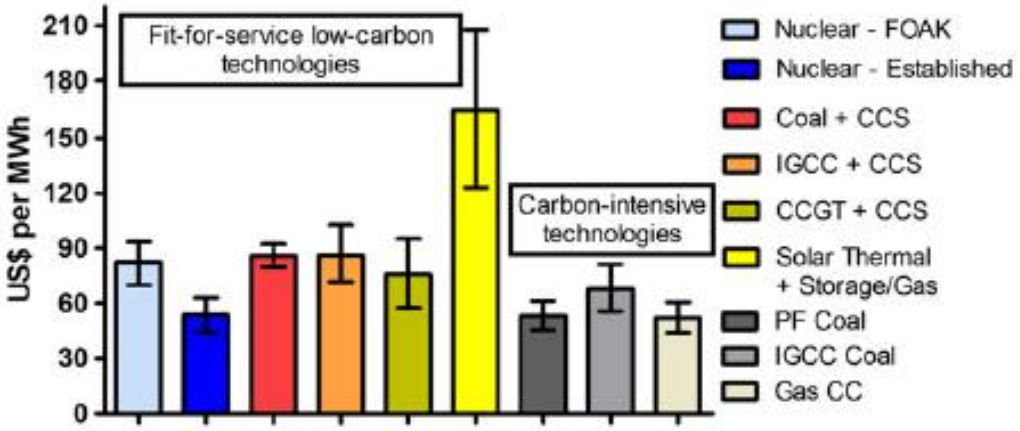




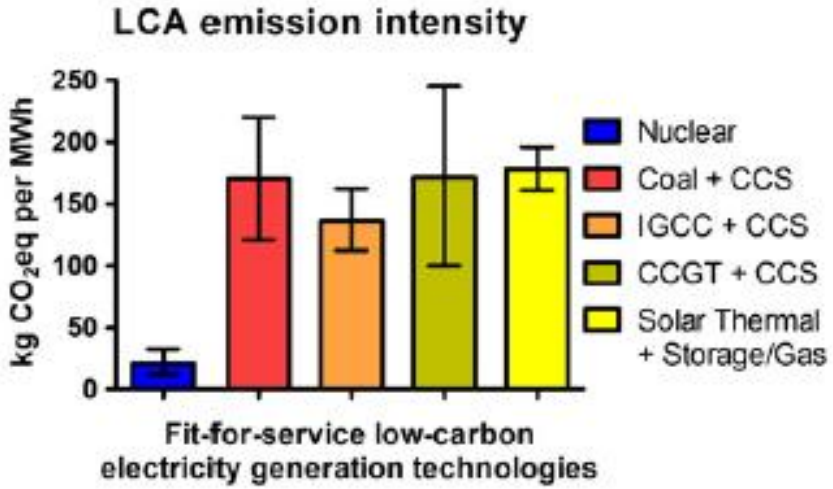




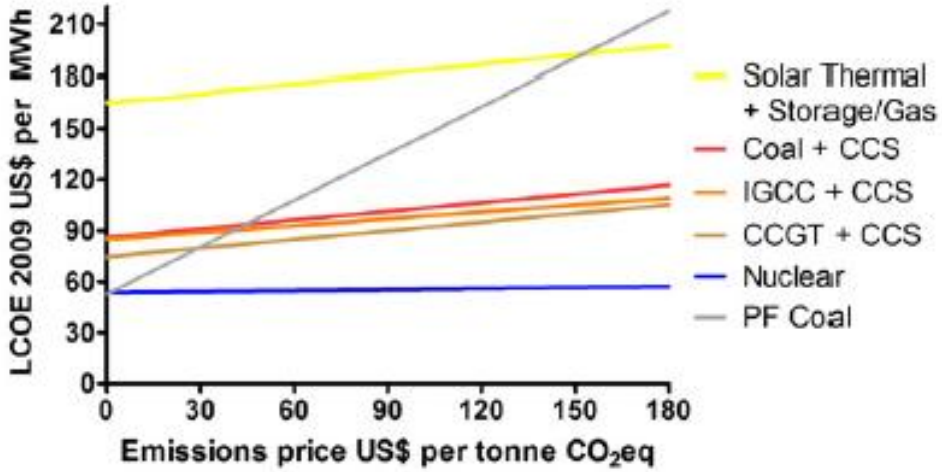
Economic Aspects of Energy Sources – Based on US, OECD, EU data



Levelised cost of electricity for baseload electricity generating technologies. Error bars represent 90% confidence intervals for the mean (bar height)



Emission intensity for fit-for-service baseload electricity generating technologies



Impact of carbon pricing on levelised cost of electricity

CCS – Carbon capture and storage

FFS – Fit-for-service

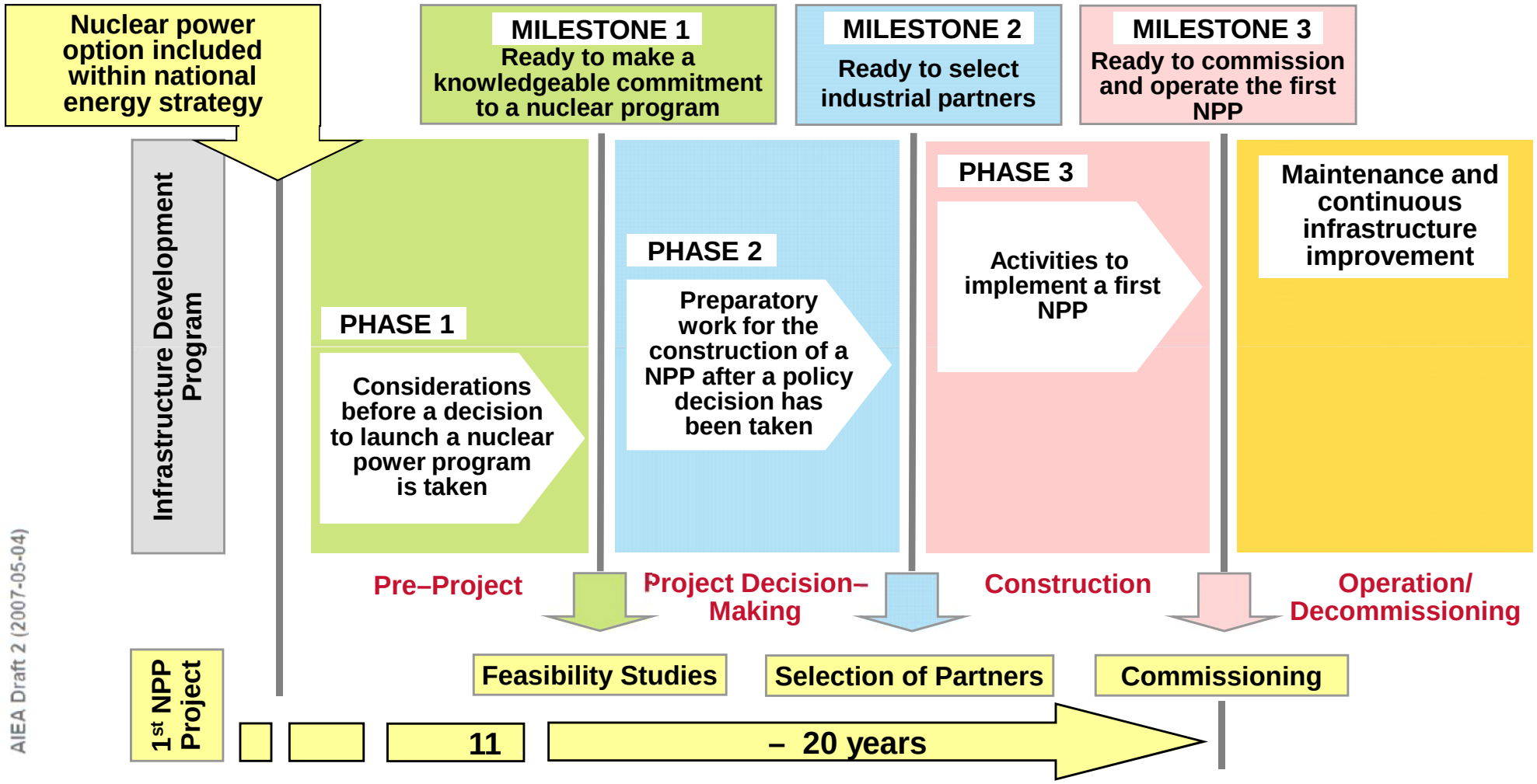
IGCC – Integrated gasification combined cycle

CCGT – Combined cycle gas turbine

PF Coal – Pulverised fuel coal

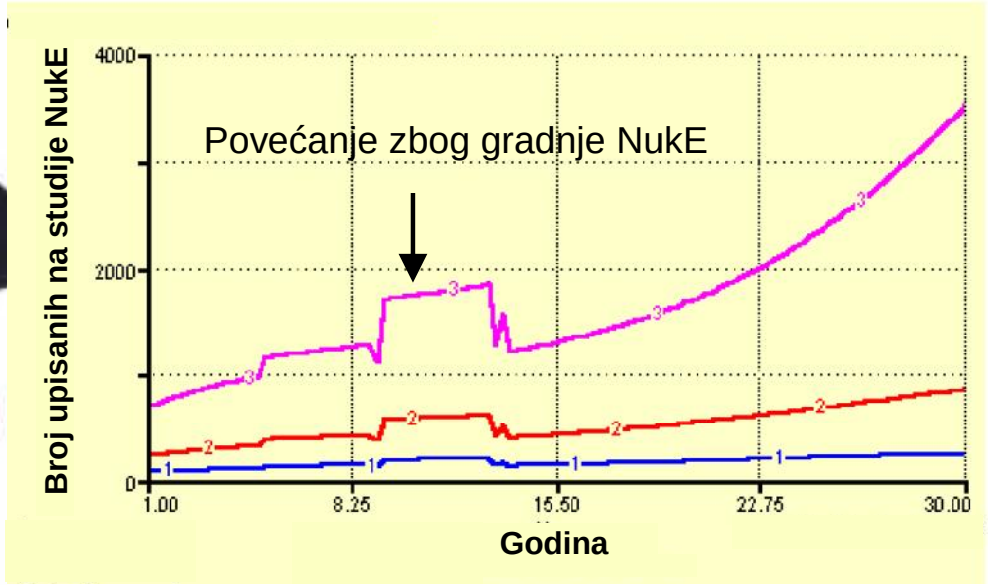
Source: M. Nicholsno, T. Biegler, B.W. Brook, How carbon pricing changes the relative competitiveness of low-carbon baseload generating technologies, Energy 36 (2011) 305-313

Milestones of Development as Seen from the IAEA



Source: IAEA Nuclear Energy Series No. NG-G-3.1
Milestones in the Development of a National Infrastructure For Nuclear Power
AIEA Draft 2 (2007-05-04)

Obrazovanje u oblasti NukE



Obezbeđuje zdravu konkurenciju

Podrška razvoju NukE i pratećoj industriji

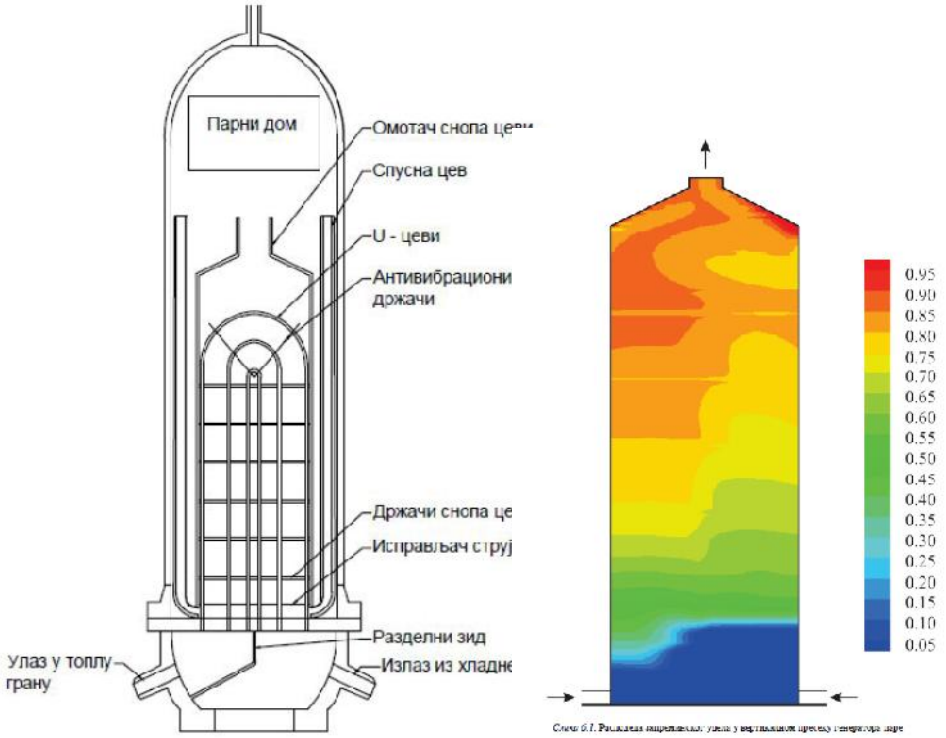
Minimalni broj potrebnih kadrova za kontinuitet profesionalnog znanja u NukE

- **Baza znanja**
  - **Univerzitet**
  - **Istraživački instituti**
  - **Regulatorna tela**
  - **Elektroprivreda**
  - **Kompanije-preduzeća za tehničku podršku**

Source: S.Scott, *Int. Conf. on Human Resource Development for Introducing and Expanding Nuclear Power Programs*, 14–18 March 2010, Abu Dhabi, UAE

Nastava i istraživanje u oblasti nuklearnog inženjerstva na Mašinskom fakultetu Univerziteta u Beogradu (1/2)

- **Nuklearni reaktori, 1. semestar Master akademskih studija**
- **Oko 10 studenata svake školske godine**
- **Sadržaj nastave:**
  - **Procesi i oprema nuklearnih energetskih postrojenja.**
  - **Sigurnost nuklearnih postrojenja i zaštita od jonizujućeg zračenja.**
  - **Pregled nuklearne energetike u svetu i okruženju i njen savremeni razvoj. Uloga i značaj nuklearne energetike u održivom razvoju energetskih sistema.**
- **Termohidraulika nuklearnih sistema za proizvodnju pare u okviru predmeta na Master i Doktorskim studijama: Generatori pare, Numerička mehanika višefaznih strujanja, Modeliranje prelaznih procesa.**

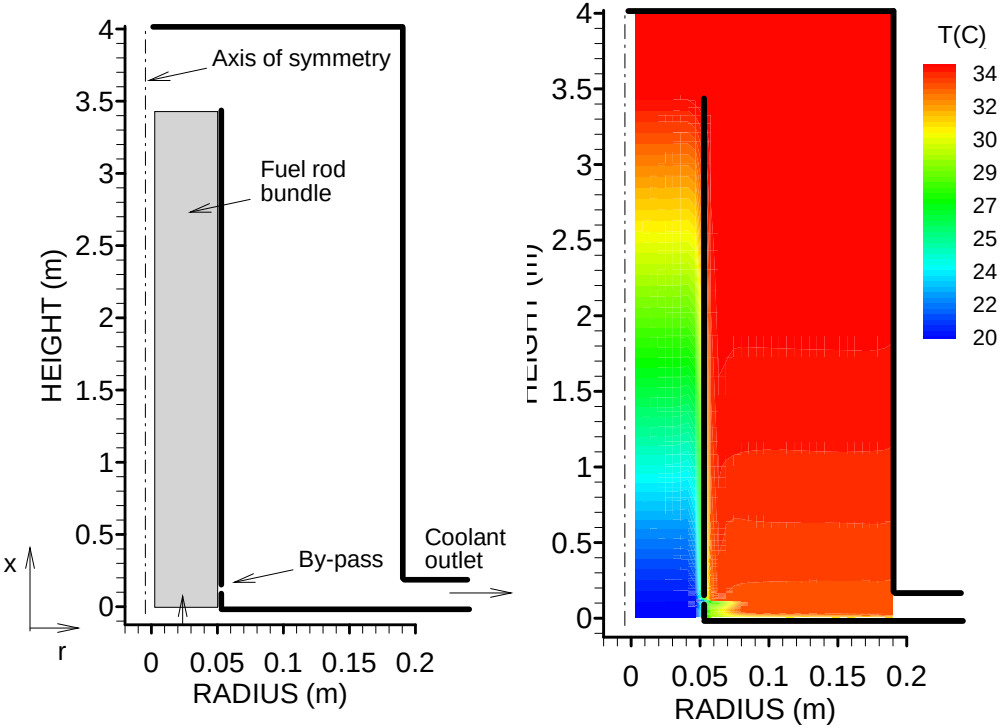


Слика 4.2: Вертикални пресек генератора паре Westinghouse Model F

Nastava i istraživanje u oblasti nuklearnog inženjerstva na Mašinskom fakultetu Univerziteta u Beogradu (2/2)

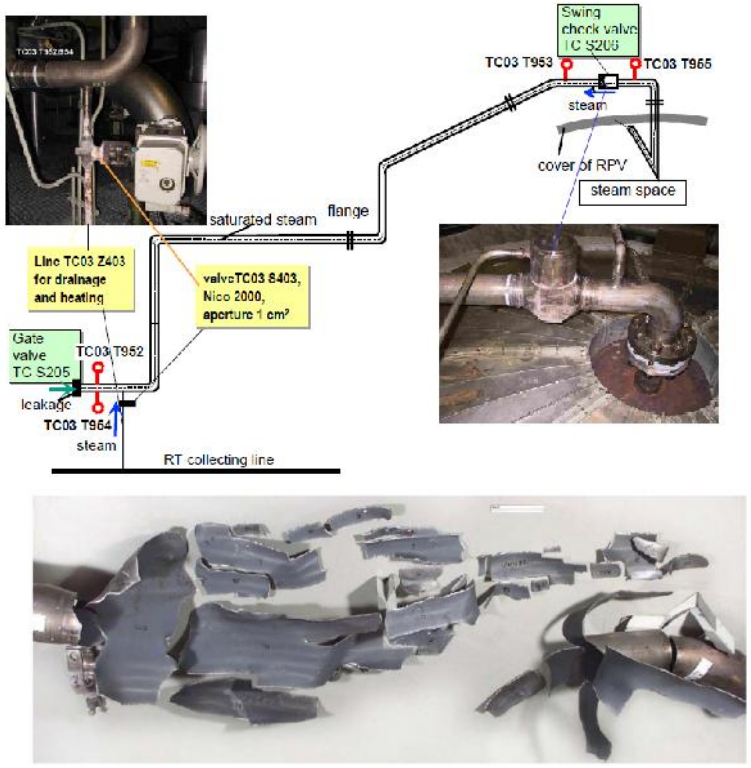
- **Sigurnosne analize NE:**

- **Udes u NE Paks, 10. april 2003. god.**



► **Stevanovic, V.**, Stoll, U., Stosic, Z., Analytical and CFD Investigation of Ex-Core Cooling of the Nuclear Fuel Rod Bundle in a Water Pool, Proc. of the 12th Int. Conf. on Nuclear Engineering, April 25-29, 2004, Arlington, Virginia USA, ICONE12-49530.

- **Udesi u NE Brunsbuettel i Hamaoka, 2001.**



▲ **Stevanovic, V.**, Stosic, Z., Stoll, U., Three-dimensional numerical simulation of non-condensables accumulation induced by steam condensation in a non-vented pipeline, International Journal of Heat and Mass Transfer, Vol. 49, No. 15-16, (2006), pp. 2420-2436.

Hvala na pažnji!

vstevanovic@mas.bg.ac.rs