HEAT DELIVERY FROM BOHUNICE NPP, SLOVAKIA

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Abstract

. Experience with nuclear district heating in the Slovak Republic is reported. The heating system of the town of Trnava is supplied by the Bohunice NPP and conventional sources. Construction of the hot water heating system from the Bohunice NPP began in 1983. Commercial operation began on 10 December 1987. Heat delivery has gradually increased from 478 TJ in 1988, to 1,104 TJ in 1995. The heat cost is low, resulting in an increasing number of consumers

1. COMBINED ELECTRICITY AND HEAT GENERATION

The perspective of energy balance led Slovakia towards heat supply from large energy facilities through regional heating systems with heat transport over relatively long distances. On the basis of governmental decisions, the conversion of existing single purpose power plants to combined electricity and heat generation is taking place and the nuclear power plants in Slovakia will deliver heat energy, in addition to electrical energy. In the Slovak Republic there is only one NPP in operation.. This NPP of Bohunice has four units, out of which units 3 and 4 deliver heat to the centralized heat supply system of the town of Trnava.

In the vicinity of the Bohunice NPP, there is a heat exchanger station with an installed power capacity of 240 MW(th). Heat exchange is achieved through four basic heaters, each supplied with LP steam from one of the turbo-generators of units 3 and 4. In the basic heaters, circulating water is heated from 70 to 130°C by steam from the fifth bleeding stage of the turbo-generator. Behind each pair of basic heaters there is a top heater which heats the circulating water up to 150°C. The circulation of the water is ensured by three pumps, each with a flow rate of 1,200 t/h. The flow can be regulated from 600 to 1,200 t/h by means of hydrodynamic coupling which permits regulation of revolutions from 600 to 1,450 r.p.m. (revolutions per minute).

Construction of the hot water heating system began in 1983. Commercial operation began on 10 December 1987. Heat delivery has gradually increased from 478 TJ in 1988, to 1,104 TJ in 1995. This quantitative increase in delivery is closely connected with the quality of the heat delivered, which resulted in an increasing number of consumers and a steady growth of heat supply.

2. THE MOST CHARACTERISTIC QUALITATIVE PARAMETERS

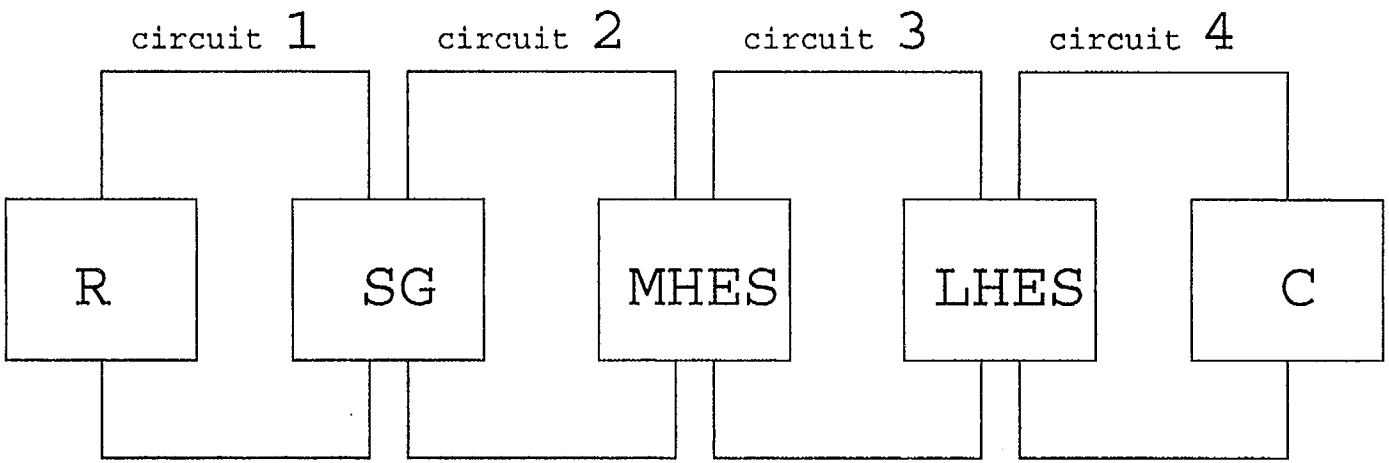
2.1. ACTIVITY (RADIOLOGICAL SITUATION)

The principal scheme of circuits for heat delivery is shown in Fig. 1. To avoid release of radioactivity from circuits 1 and 2 into the circulating water of circuits 3 and 4, several technical measures were taken. In addition to these measures, regular inspection and limiting levels were established for radiological control of working fluids.

For the secondary circuit, the inspection levels were based on the level of values for drinking water. The total activity in the secondary circuit has not yet reached the inspection level of 1 Bq/l.

In the third circuit, total activity of 1 Bq/l is the limiting value and for ^{3}H (tritium) the limiting value specified is lower than the level in the make-up river water.

Neither the limiting values in the third circuit, nor the inspection values in the second circuit, have yet been reached.



R - reactor

SG - steam generator

MHES - main heat exchanger station

LHES - local heat exchanger station

C - consumer

Fig. 1 Scheme of heat circuits in the NPP and district heating system

Source	Share [%]
Fossil source	100
Nuclear source	61
Fuel component of fossil source	27
Fuel component of nuclear source	4

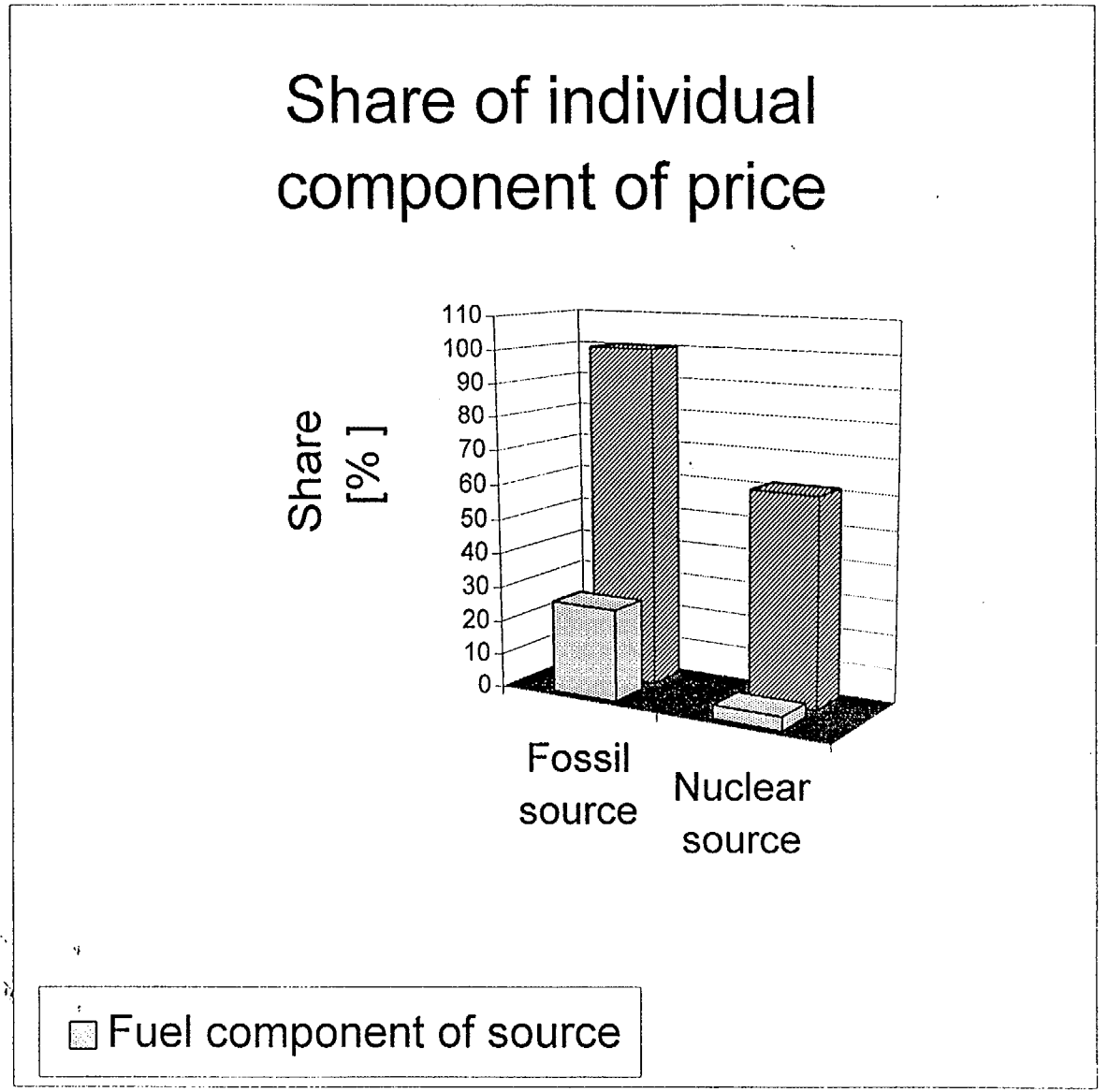


Fig. 2 Relative heat prices

Year	Heat of delivery [GJ]
1987	59 738
1988	478 782
1989	607 786
1990	775 835
1991	850 837
1992	903 172
1993	1 012 399
1994	935 264
1995	1 104 401
Total	**6 728 214**

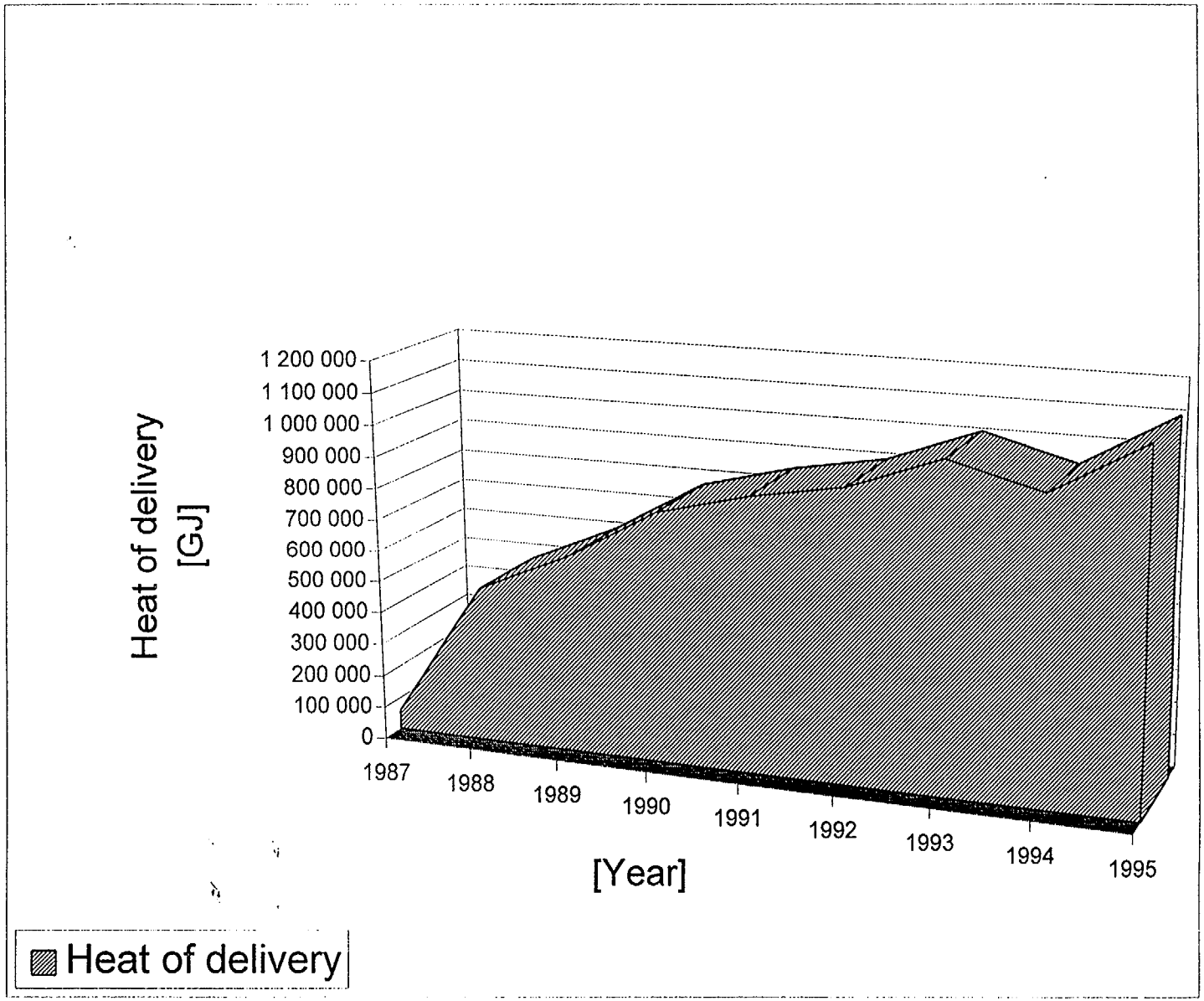


Fig. 3 Heat delivery from the Bohunice NPP

Year	Load Steam [MWt]	Load Hot water [MWt]
1993	126.0	120.0
1994	120.7	125.3
1995	97.4	150.7
1996	93.4	154.3
1997	89.4	157.8
1998	85.4	161.3
1999	81.4	164.9
2000	77.4	168.4
2001	51.4	194.4
2002	45.5	200.2
2003	39.7	206.1
2004	33.8	212.0
2005	30.1	215.7

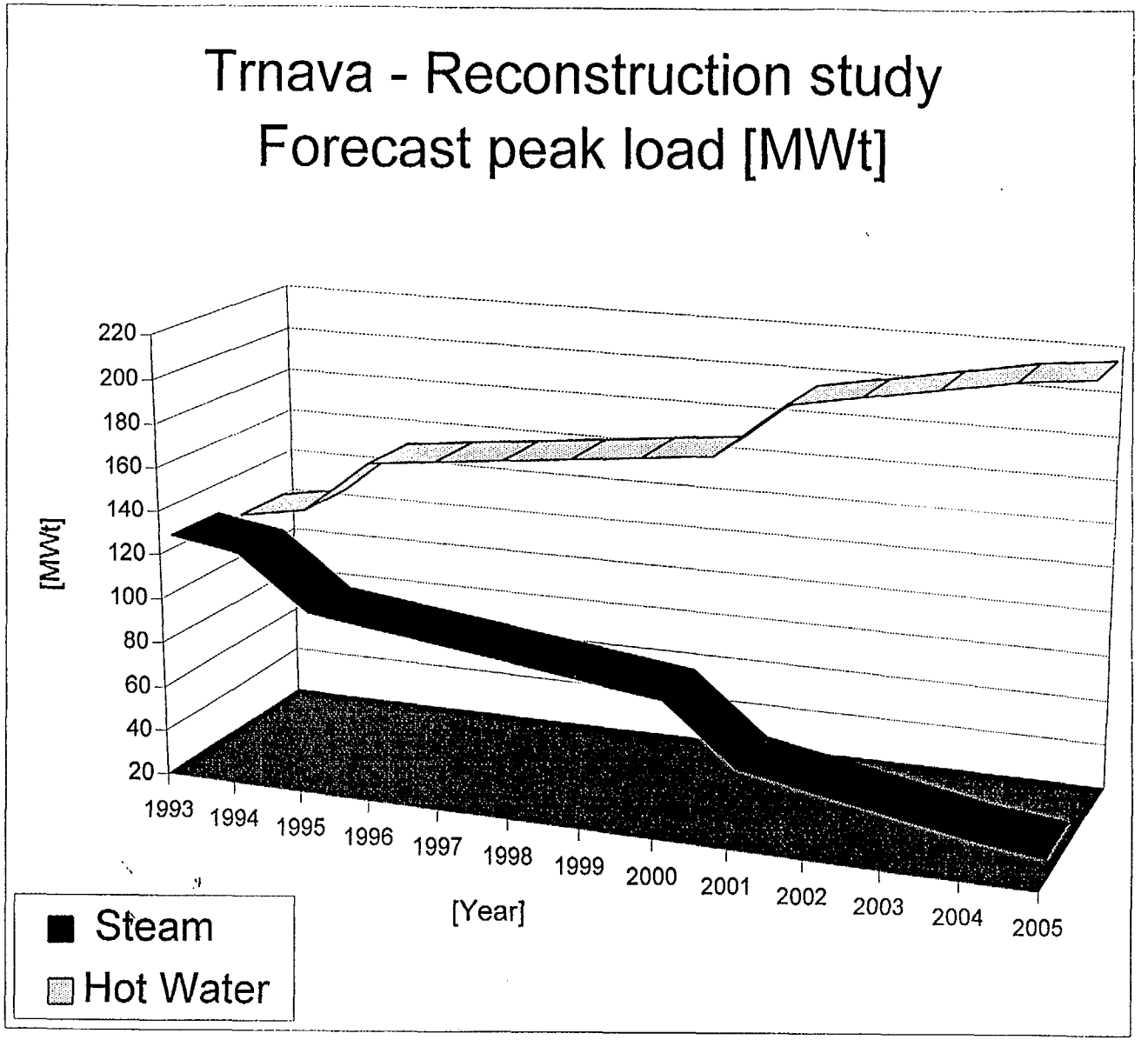


Fig. 4 Forecast of peak heat load

Year	Share [%]
1993	51
1994	49
1995	39
1996	38
1997	36
1998	35
1999	33
2000	31
2001	21
2002	19
2003	16
2004	14
2005	12

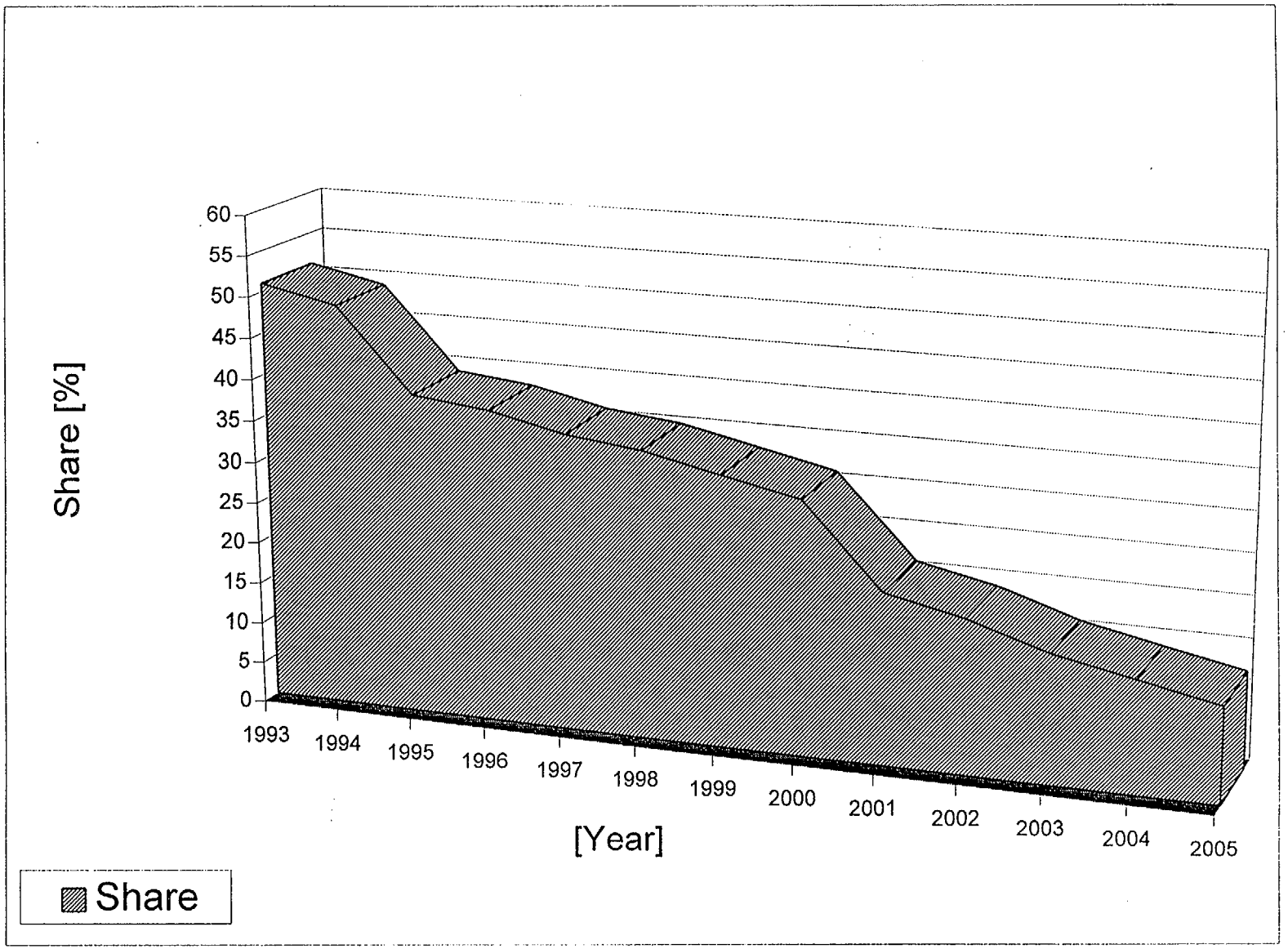


Fig. 5 Forecast of conventional share of heat load

2.2. ECONOMY

Heat supply to Trnava is ensured both from nuclear and conventional sources. In 1995, this relation was approximately 60% nuclear and 40% conventional. In Figure 2, the relative heat prices are shown.

An interesting point is not only the relative cost of heat nuclear heat shown as a percentage of the cost of heat from a conventional source, but also the low nuclear fuel cost. This leads to a lower average heat price as the number of consumers increases and the nuclear heat consumption increases. The specific fixed costs, which constitute the main part of the price, are gradually decreasing.

3. PROJECTIONS OF HEAT CONSUMPTION IN THE TOWN OF TRNAVA

Heat is delivered from conventional sources (steam system) and from nuclear sources (hot water system). The estimated development of energy consumption for heating purposes from different sources is shown in Figs. 3-5.

The data indicate a falling share of heat delivery from conventional sources, from the present 39% to 12% in the year 2005, and a correspondingly increasing share of nuclear heat.