RIJKSUNIVERSITEIT GRONINGEN

INTERACTIVE SIMULATION OF ELECTRICITY DEMAND AND PRODUCTION

Proefschrift

ter verkrijging van het doctoraat in de
Wiskunde en Natuurwetenschappen
aan de Rijksuniversiteit Groningen
op gezag van de
Rector Magnificus Dr F. van der Woude
in het openbaar te verdedigen op
vrijdag 21 juni 1996
des morgens te 11.00 uur precies

door

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geboren op 8 juni 1956

te Helmond

Appendix I: How to use the PowerPlan model

This appendix is intended as an introduction to the user interface of PowerPlan and a brief description on 'how to use' the model. The major options will be shown by means of screen dumps of the interface.
Figure I.1 shows a flow chart of the user interface.

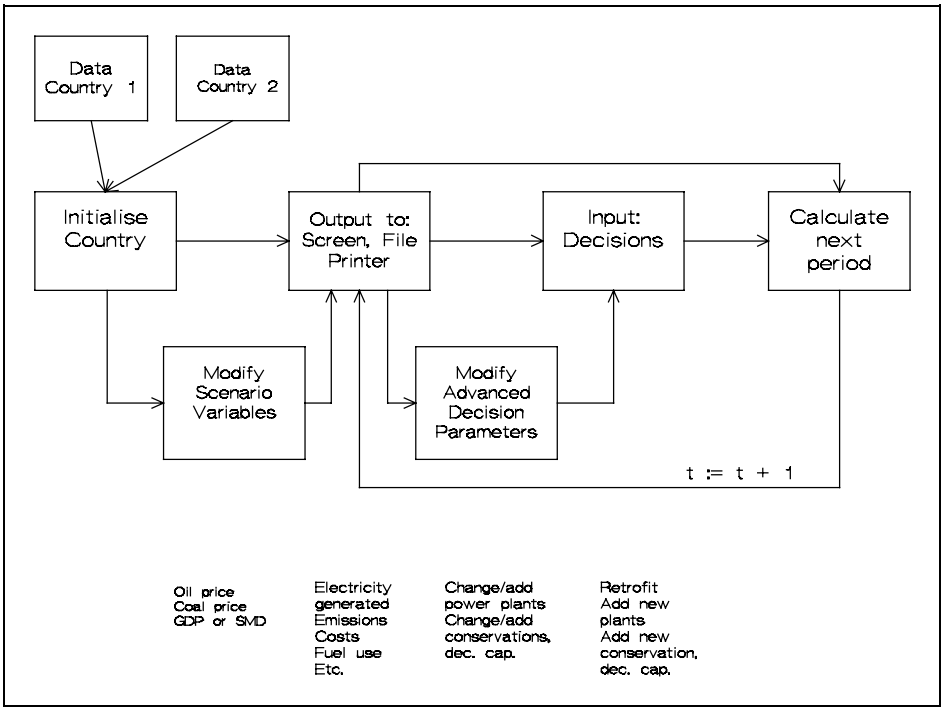
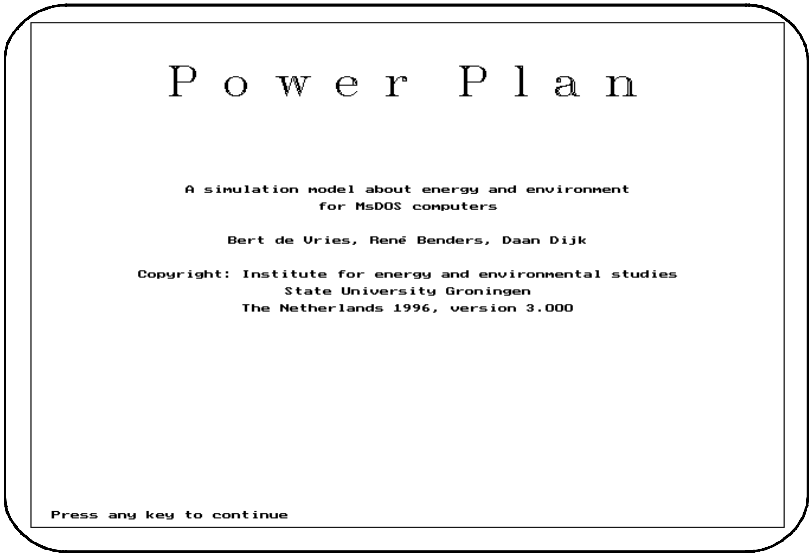
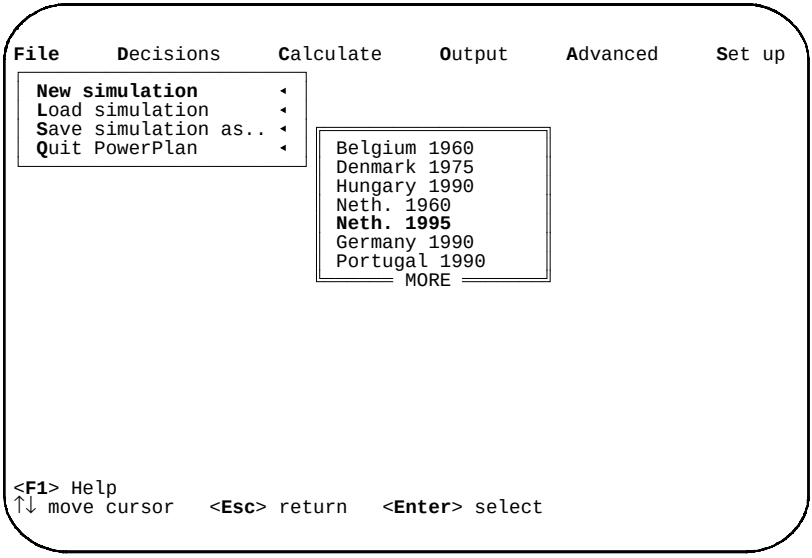


Figure I.1: Structure of the user interface of the PowerPlan software.

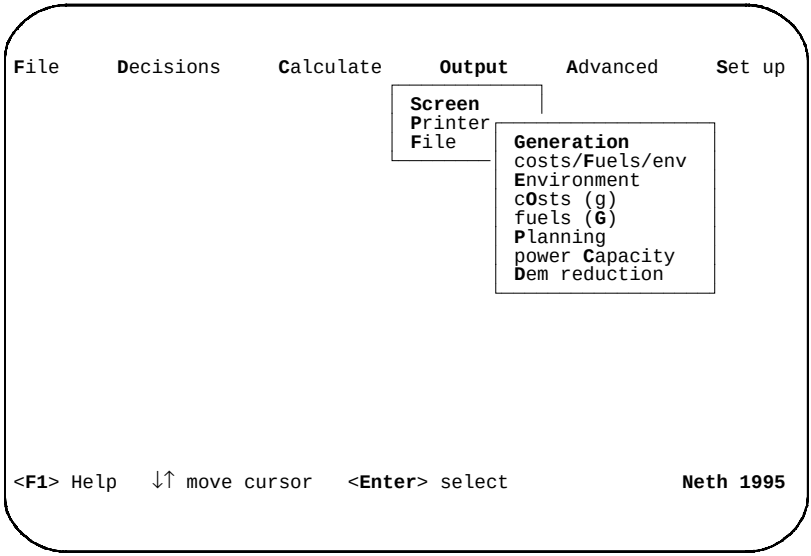
The main sequence in the model use is: initialise, output, input, calculate and back to output again. The two other options are for more experienced users. All default values and initial data are read from a Country data file.
The screen dumps on the following pages are ordered along the lines of *Figure I.1*: initialize, view output, make decisions and for the experienced users: set up scenario and advanced options.



Screen 1: Introduction screen of the interactive computer simulation model PowerPlan.



Screen 2: To simulate the electricity production of a country, one should first load the initial data (e.g. present power plants) and default scenario variables (e.g. GDP growth, Oil price path).



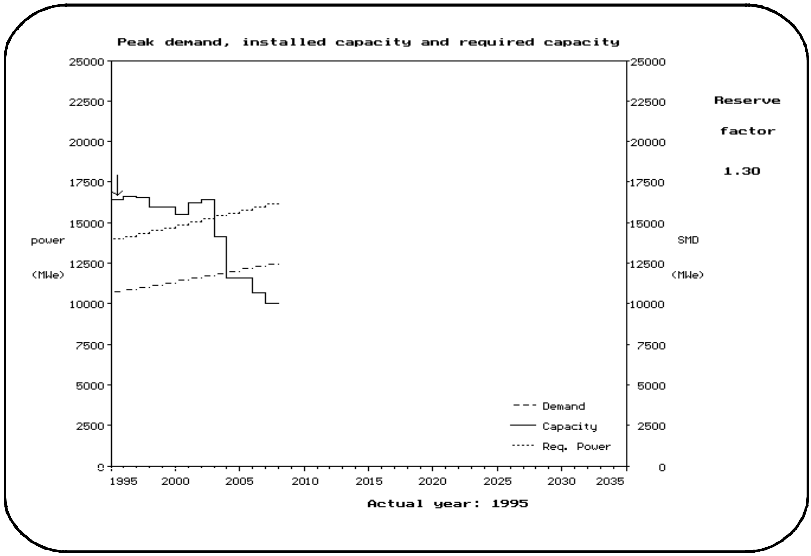
Screen 3: First the output of the starting year can be viewed. This output is the basis for further decisions to be made for the desired scenario.

Output: Electricity **generated** Year: **1995**

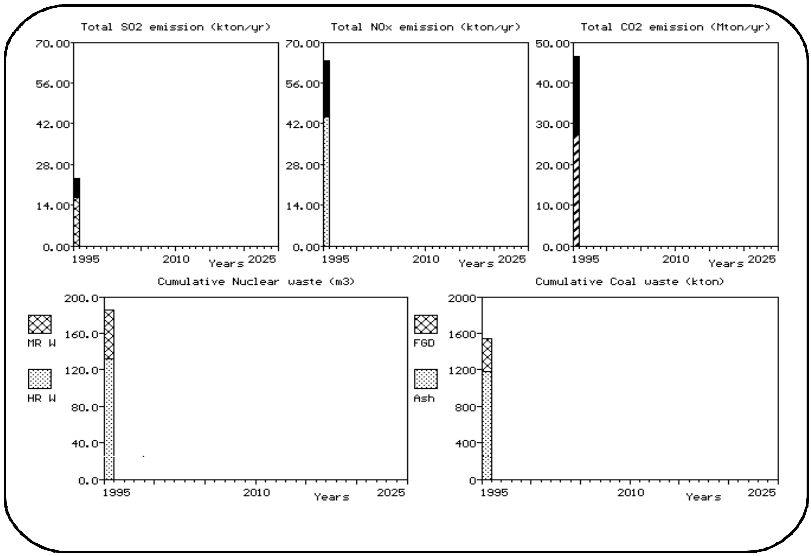
Power station	Electr. (TWhe)	Cap. (MWe)	LF (Hrs)	Eff. (%)	Fuel (PJ)	SO2-em (kton)	NOx-em (kton)	Costs fl/kWhe
Import	6.132	700	8760	0.0	0.00	0.00	0.00	0.100
Nuclear	3.437	521	6597	0.0	36.39	0.00	0.00	0.017
CHP	7.695	1575	4887	47.9	58.51	0.00	4.85	0.101
STAG NG	6.806	1005	6772	50.0	49.00	0.00	2.21	0.104
STAG CG	1.475	225	6556	43.0	12.35	0.36	0.99	0.075
Coal new	7.335	1200	6112	41.5	63.61	3.70	1.27	0.078
Coal	12.843	2909	4414	39.6	116.86	12.09	22.22	0.092
STAG	0.370	121	3055	43.0	3.10	0.00	0.54	0.119
Conv. O/G	12.254	7860	1559	42.1	105.04	0.56	12.24	0.152
GT Peak	0.001	315	5	25.0	0.02	0.00	0.00	3.406
Total	58.348	16432	3551	43.4	444.89	16.71	44.32	0.107

Peak demand (SMD)	:	10757	(MWe)
Reserve factor	:	1.53	
Expected Unserved Electricity (EUE)	:	1.0	(GWhe)
Loss Of Load Probability (LOLP)	:	0.6	(days/10 years)

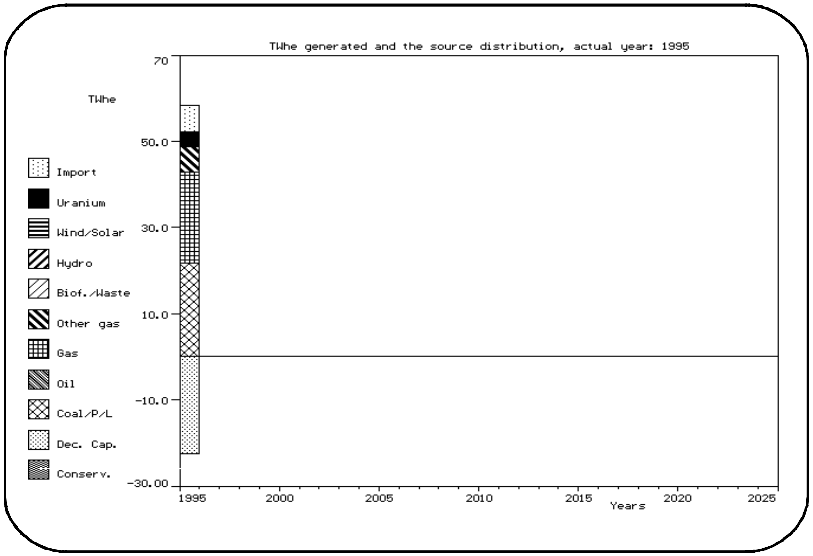
Screen 4: The detailed performance of the present electricity production system is presented in the "**Generation**" screen.



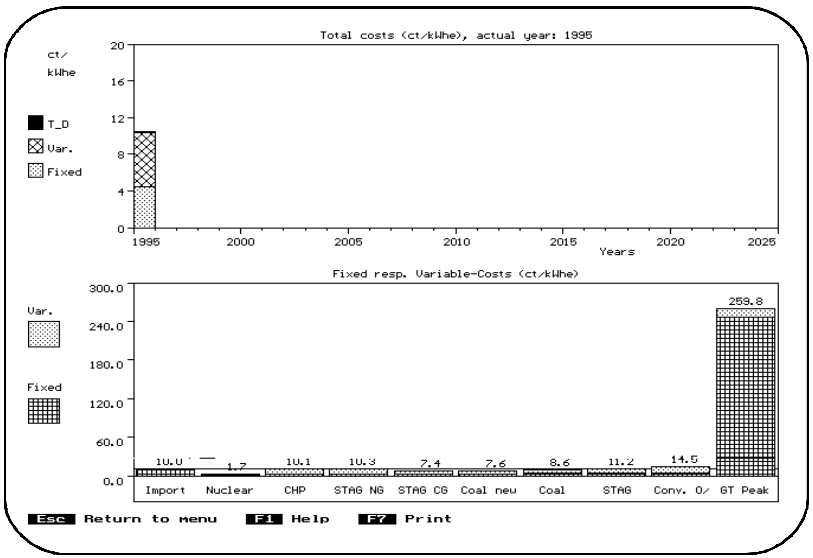
Screen 5: In the "**Planning**" graph a *prognosis* is shown of the future electricity demand, the capacity required for a reliable electricity production system and the capacity installed.



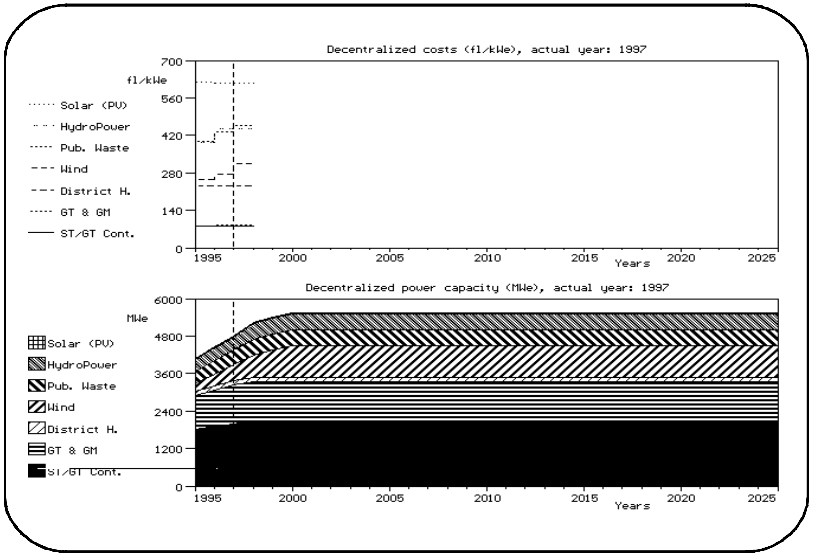
Screen 6: In this screen: "**Environment**", the five major pollutants from the electricity generating system are presented. The solid waste data concern cumulative figures.



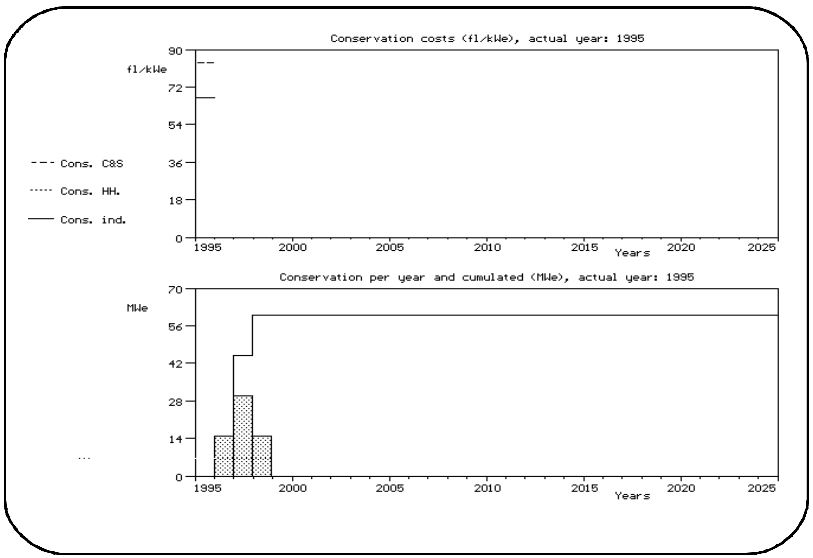
Screen 7: In this screen: "**fuels (G)**", the fuel mix of the electricity system is shown. Conservation and decentral capacity are presented as negative generated electricity.



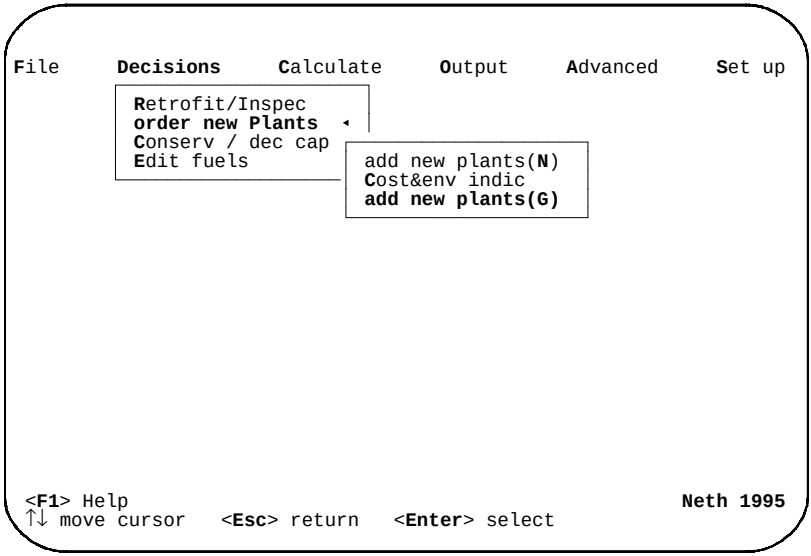
Screen 8: This screen: "**cOsts (g)**, shows the overall production costs per kWhe in the upper graph and the production costs per type of power station in the lower graph.



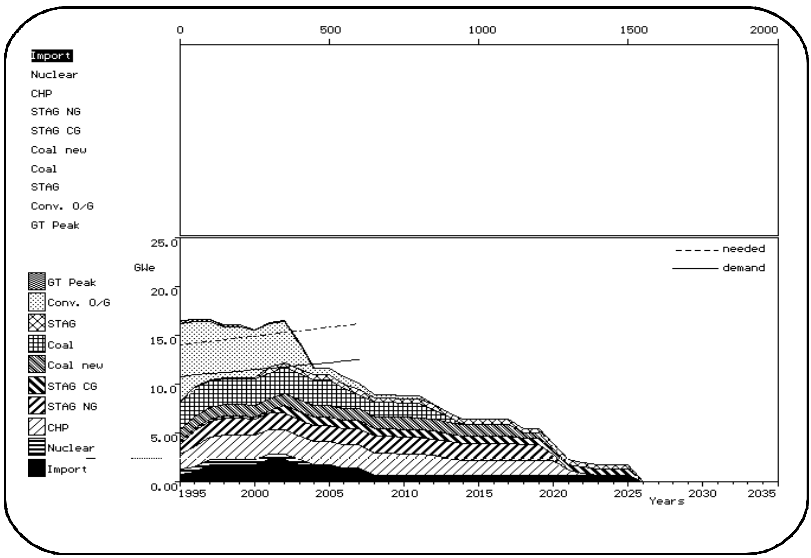
Screen 9: In this screen: "**Dem reduction**", the installed decentral capacity (lower graph) and the costs per kWe (upper graph) are shown. The costs depend on the marginal costs (cf. *Screen 24*).



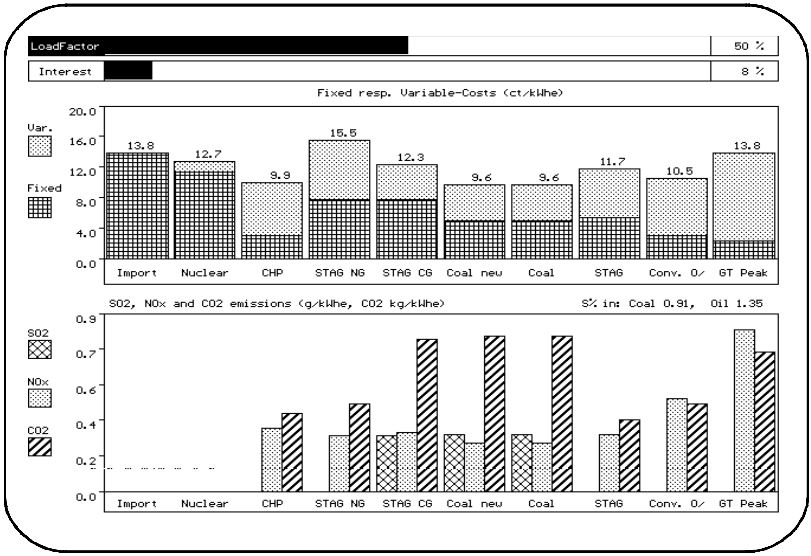
Screen 10: In this screen: "**Dem reduction**", the installed conservation cap. (per year: bars, cumulative: line) and the costs per kWhe are shown. The costs depend on the marginal costs (cf. *Screen 24*).



Screen 11: The next step is to make your decisions, based on the output data. New power stations can be built graphically (cf. *Screen 12*) or numerically (cf. *Screen 14*).



Screen 12: In this screen: "**add new plants (G)**", power stations can be built on a "back of an envelope" manner. The result of building a power station can be viewed directly in the capacity graph.



Screen 13: In this screen: "**Cost&env indic**", power stations can be compared in terms of their costs and their environmental impact (gaseous emissions), for a load factor chosen and interest rate.

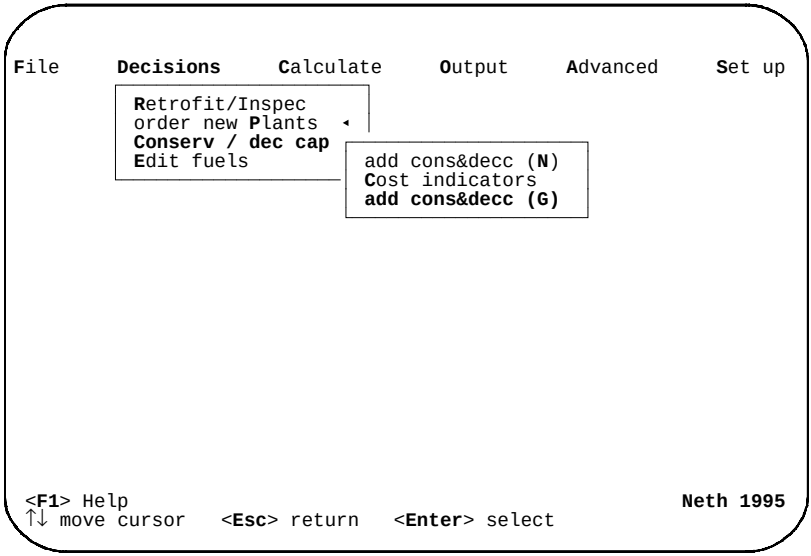
Input-screen: order new power plants actual year: 1995

Pow. typ.	EL	TL	CT	Cap	FT	FiCo	Ma Co	LT	Eff.	SO2	NOx	Num	MWe
Import	10	10	3	50	I	4000	0.002	B				0	0
Import	10	10	3	50	I	4000	0.002	B				0	0
Nuclear	20	25	9	900	U	4850	0.012	B				0	0
CHP	20	25	4	10	G	1200	0.014	B	0.50	0.00	45	0	0
CHP	20	25	4	25	G	1300	0.010	B	0.50	0.00	45	0	0
STAG NG	20	25	6	600	G	3300	0.013	B	0.45	0.95	36	0	0
STAG CG	20	25	6	600	C	3300	0.013	B	0.43	0.95	36	0	0
Coal new	20	25	6	600	C	2100	0.013	B	0.42	0.95	29	0	0

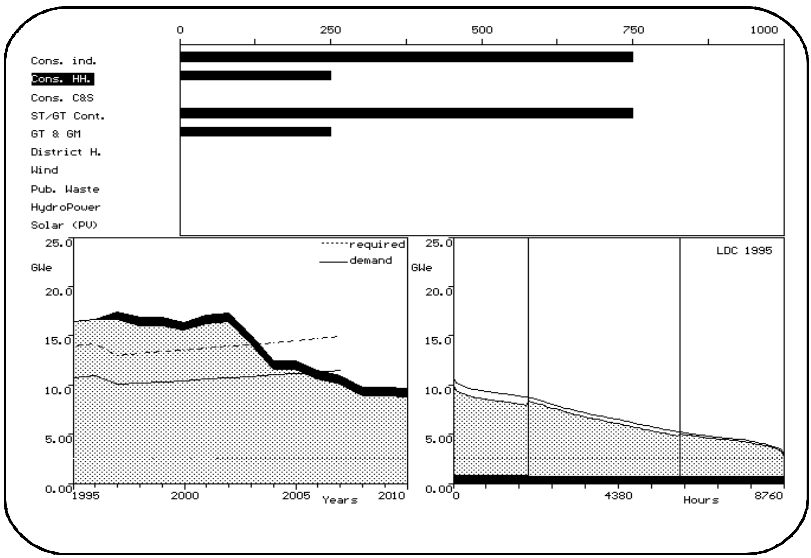
Total capacity ordered (MWe) 0

↑↓ move cursor <**Esc**> return to menu
For additional types see Modify (Add offers).

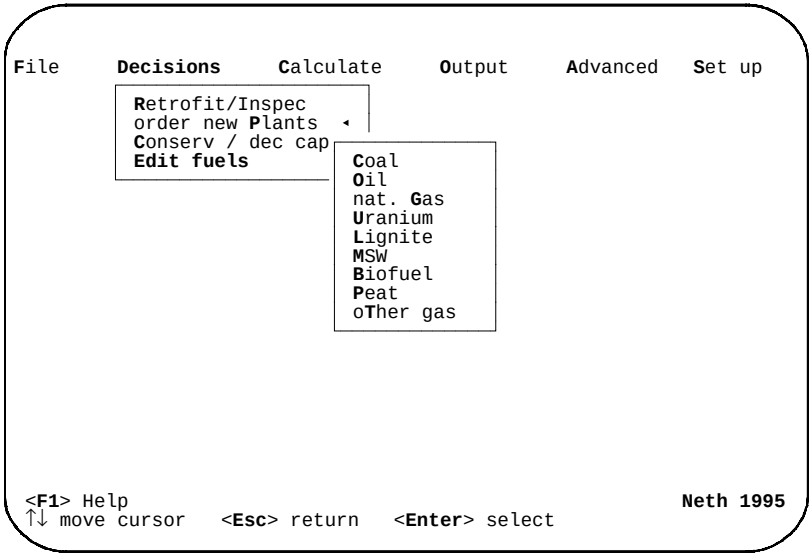
Screen 14: In this screen: "**add new plant (N)**," the user can order new power plants. Characteristics of the present power plants are showed here, in contrast to *Screen 12*.



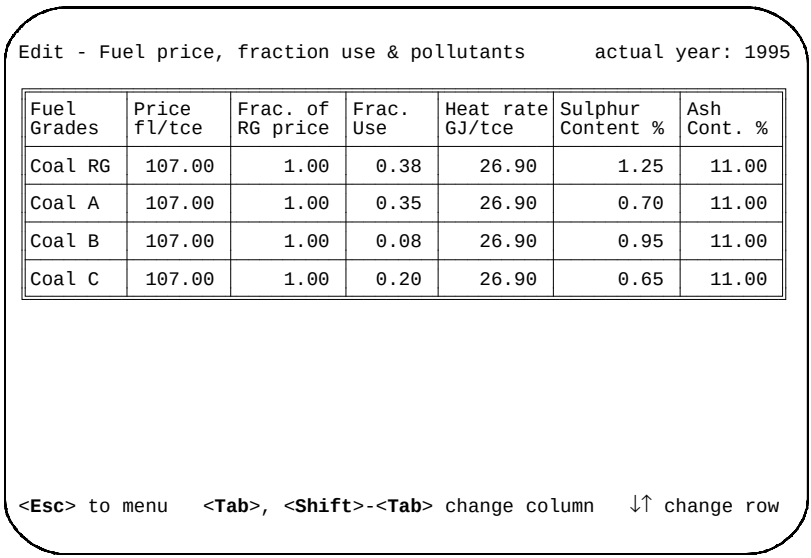
Screen 15: In this sub-menu conservation measures and decentral capacity can be ordered. Only "**add cons&decc (G)**" is shown here (cf. *Screen 16*); the others are treated like the central capacity.



Screen 16: In this screen: "**add cons&dec (G)**," new orders can be placed. The left panel shows the effect on the installed capacity and the peak demand while the right panel shows its effect on the LDC.

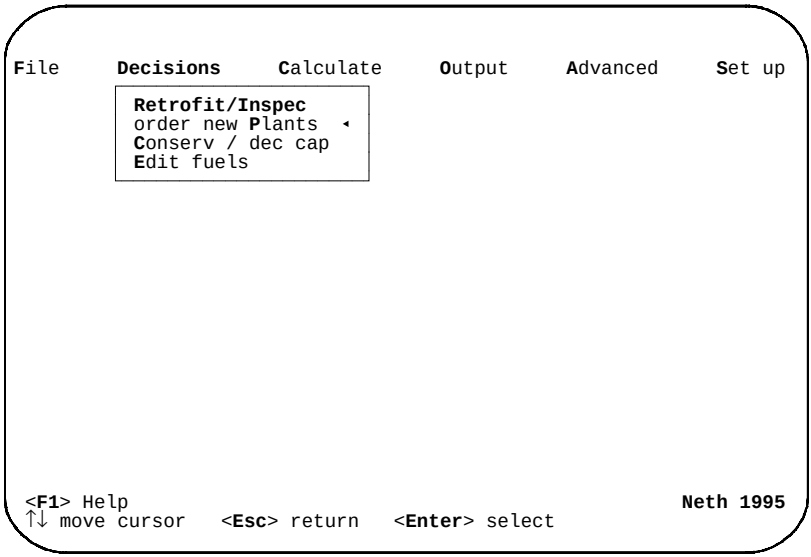


Screen 17: Fuel characteristics are not coupled to power plants directly (e.g. SO_2 emission in g/GJ) but are present in the form of large contracts (e.g. S contents in %) which can change each year.



Fuel Grades	Price fl/tce	Frac. of RG price	Frac. Use	Heat rate GJ/tce	Sulphur Content %	Ash Cont. %
Coal RG	107.00	1.00	0.38	26.90	1.25	11.00
Coal A	107.00	1.00	0.35	26.90	0.70	11.00
Coal B	107.00	1.00	0.08	26.90	0.95	11.00
Coal C	107.00	1.00	0.20	26.90	0.65	11.00

Screen 18: In this screen, an example is given of a fuel contracts as described in *Screen 17*. Four types of fuel with their specific characteristics can be selected in a certain combination.



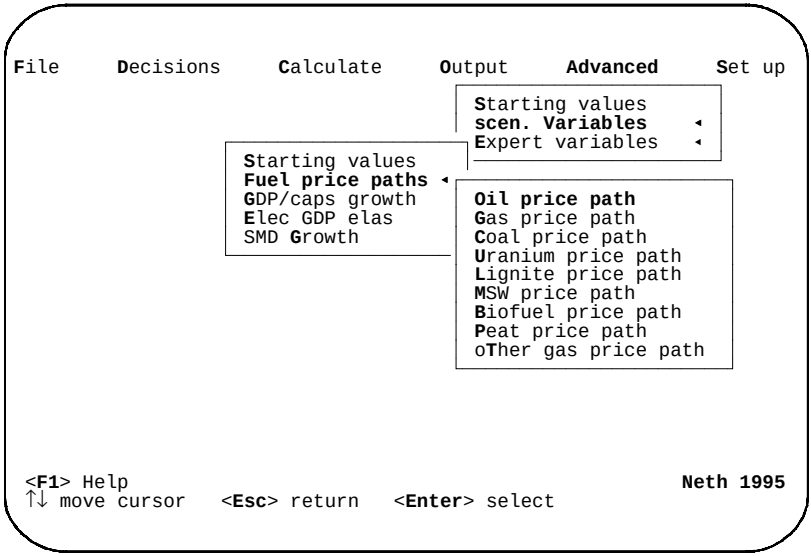
Screen 19: Retrofit options (e.g. life-time extension of a power plant or ad FGD cleaning equipment to an existing power plant) are also an option for the user.

Edit-screen: retrofit existing power stations actual year: 1995

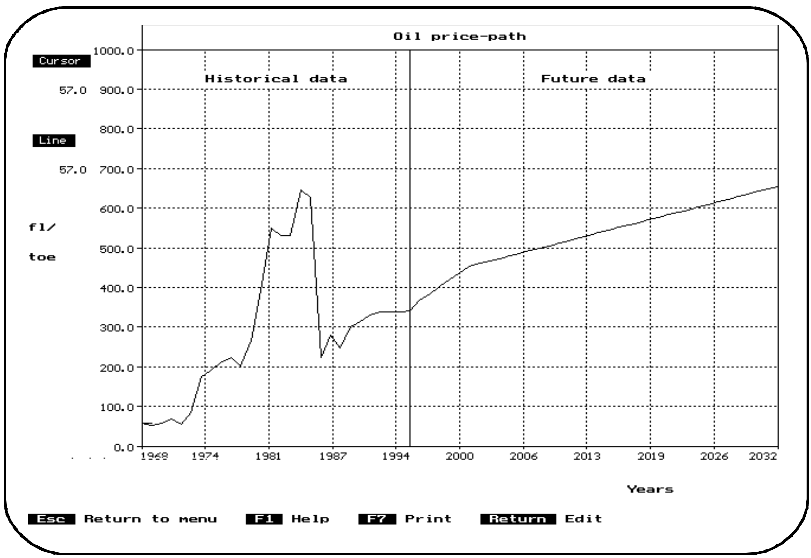
Nr	Power types	Y in	Y Out	Cap.	FT	Ret C	LT	Eff.	SO2 er	NOx em
1	Import	1993	1996	700	I	0	B			
2	Nuclear	1986	2011	16	U	0	B			
3	Nuclear	1973	2004	449	U	0	B			
4	Nuclear	1969	2004	56	U	0	B			
5	Conv. O/G	1986	1997	362	H	0	B	0.41	0.96	100
6	Conv. O/G	1974	1997	459	H	0	B	0.41	1.00	200
7	CHP	1995	2021	225	G	0	M	0.53	0.00	30
8	CHP	1995	2021	310	G	0	M	0.53	0.00	30
9	CHP	1993	2012	67	G	0	M	0.50	0.00	65

↓↑,<**PgDn**>,<**PgUp**> move cursor <**Enter**> select <**Esc**> to menu
<**Del**> delete power station

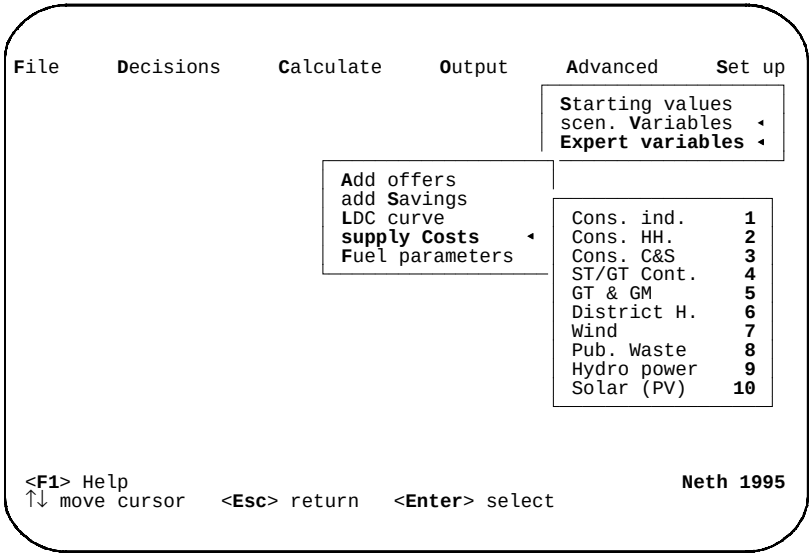
Screen 20: This screen: "**Retrofit/inspec**", shows the existing plant and the retrofit possibilities. The costs for retrofitting a power plant should be estimated by the user and be filled in, in this table.



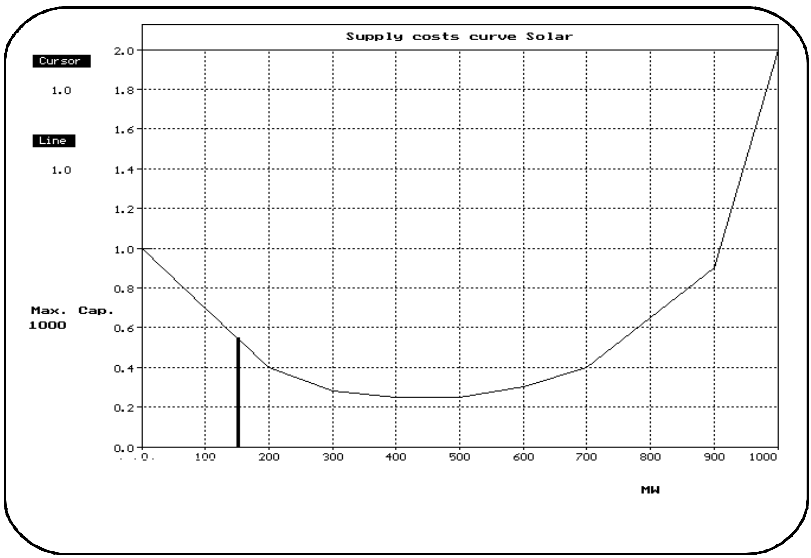
Screen 21: For more experienced users or in a negotiation context, scenario default variables (e.g. the oil price path: cf. *Screen 22* or GDP time-series) can be modified.



Screen 22: In this screen, the oil price path can be modified graphically. Depending on the input data, price paths for other fuels can either be a time-series or can be coupled to the oil price present.



Screen 23: Also for experienced users is the option to adjust some parameters, change or add type of power plants and change the supply cost curve for conservation & decentral options.



Screen 24: In this screen, the supply cost curve of solar PV can be adjusted. Solar energy will first become cheaper in this example (150 MW of solar PV is installed in this graph).