Weekly Asset Portfolio Management in a Hydro-Thermal Power System

Josef H. Bogensperger
(Austrian Power Trading, Vienna)

7.11.2000

Erstellt 15.10.2000

Asset based risk management in the electricity sector means
to **handle newest technology** to get stabile and profitable decisions
but dispatchers are risk avers
to make sure that they can **handle daily business !**

There are two tasks:

- portfolio management (*propose* an optimal solution) and
- risk evaluation / measurement (calculate the actual exposure and evaluate the changes out of a specific measure - *try and error*)

What tasks are risk management today?

These decisions which take place now for the next week will be supported by the tool *(type "here and now")*

- state (on/off) of base load thermal power stations
- execution of bought options (Puts and Calls)
- contracts with flexible parts (to be announced the week before)
- how much electricity should be sold as week ahead contracts

These decisions which take place later on are included in the model *(type "wait and see")*

- daily trading
- change schedule of pumped storage plants
- change schedule of daily storage plants
- change schedule of thermal plants

Which types of decisions are included?

s there a need for stochastic weekly portfolio management?

tochastic input data

- day ahead prices (price forward curve, volatility) short term
- electricity demand in supply contracts (load forecast - temperature, daylight) short term
- run-of-river generation (generation forecast - rain, temperature at glaciers) short term
- valuation of water and fuel in storage/contract (water value, fuel value) long term

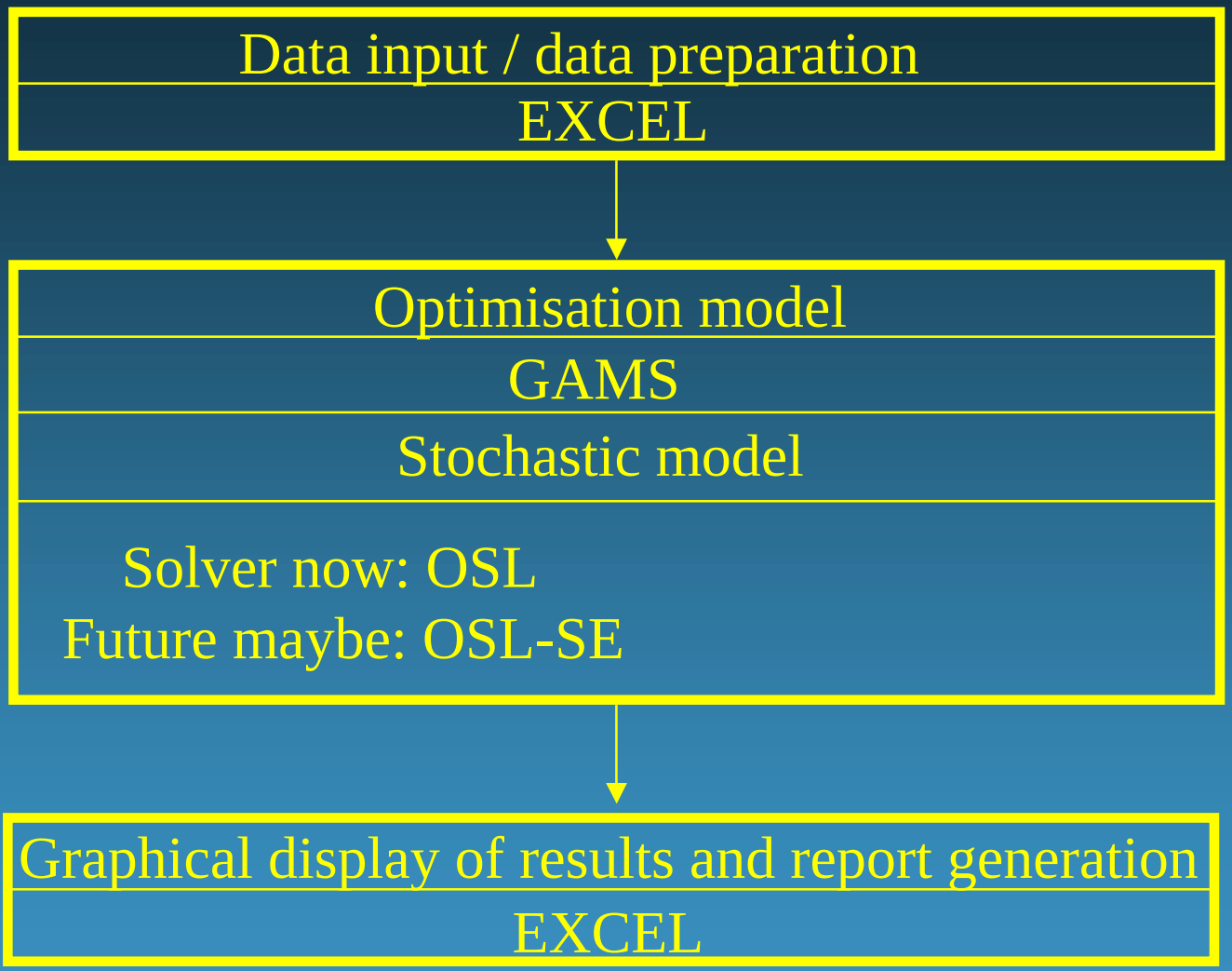
ariation leads to a big bunch of scenarios.

tatement: *"In 60% of all cases thermal plant 1 is on"*
ut this statistical figure does not necessarily mean that this is a robust decision.

dvantage of stochastic planning - All scenarios are considered the same time
→ here and now decisions lead to clear decision proposals

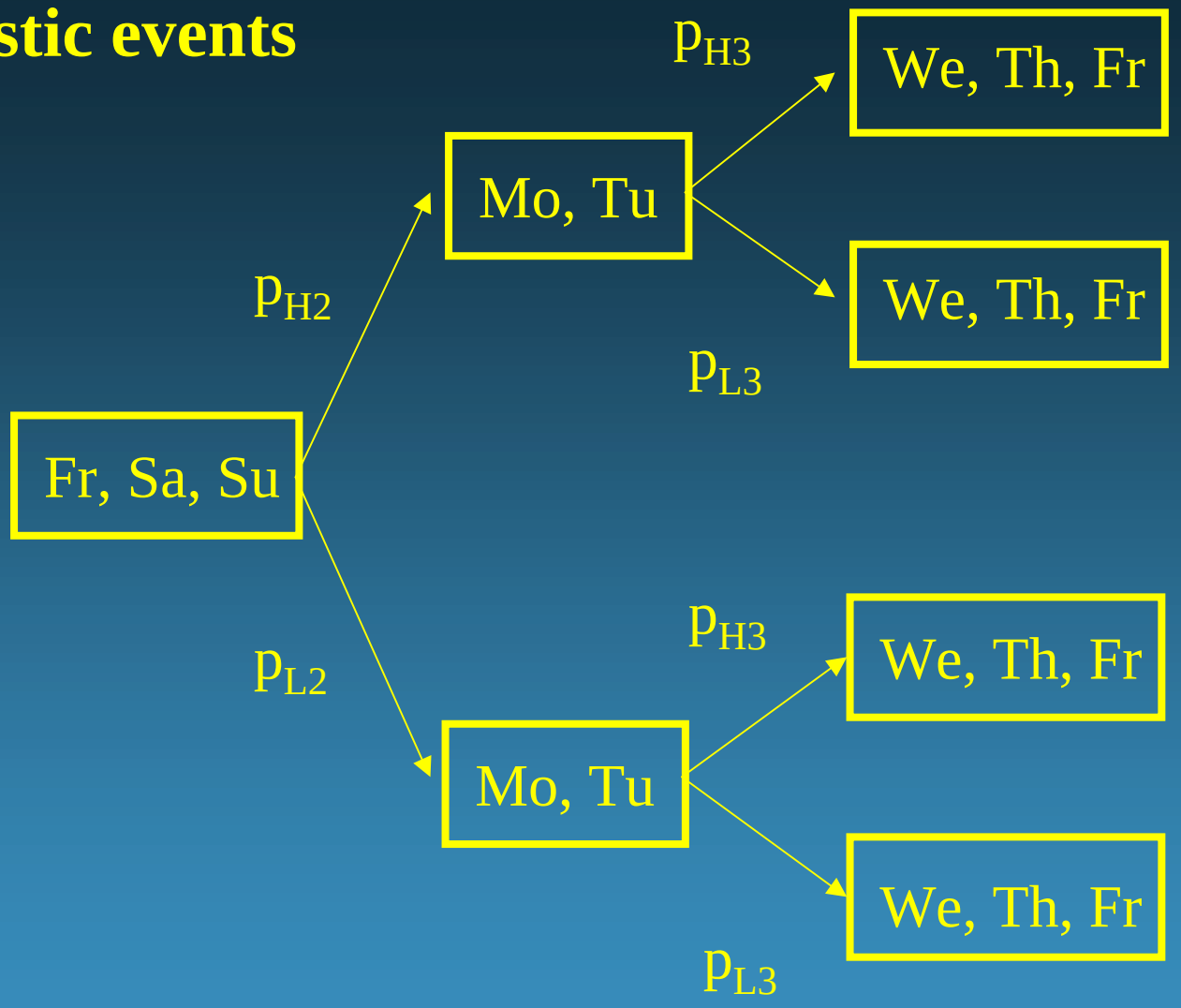
Why a stochastic model?

Concept for the weekly portfolio management



How is the tool concept?

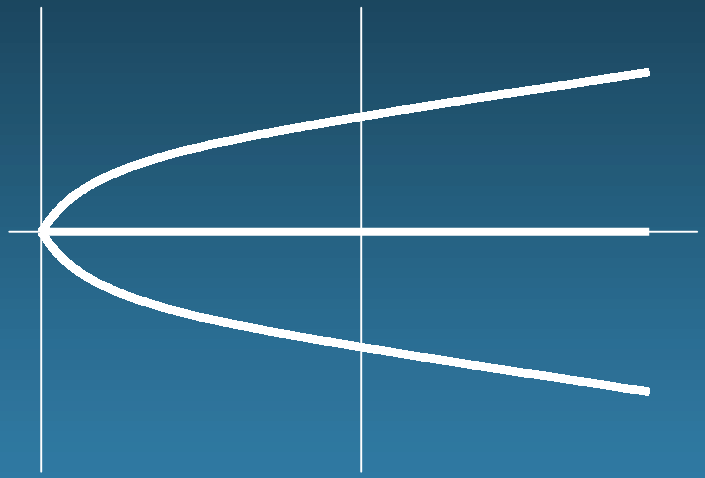
Short term stochastic events



This tree exists for each long term stochastic event

What is the structure of the basic tree?

Definition of basic scenarios



	binary	ternary
	0,5	0,2
	0,0	0,6
	0,5	0,2

1st „stage“ deterministic

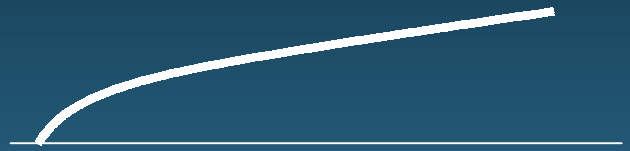
2nd „stage“ stoch. developm.

3rd „stage“ stoch. developm.

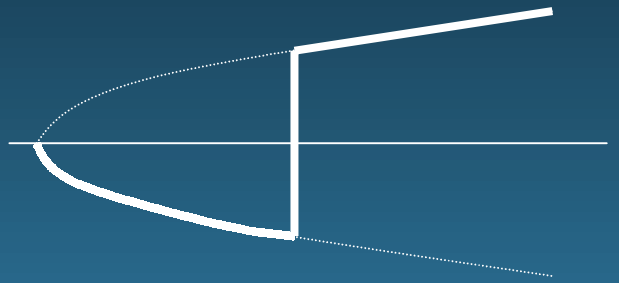
What is the basic data for this problem?

Types of scenarios in such a binary tree

B: 0,5*0,5=0,25
T: 0,2*0,2=0,04



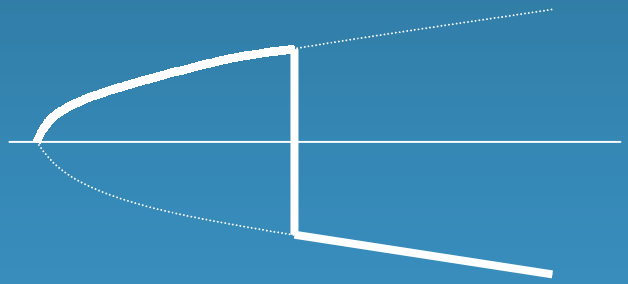
B: 0,5*0,5=0,25
T: 0,2*0,2=0,04



ere is no average scenario in the binary tree!

B: 0,5*0,5=0,25
T: 0,2*0,2=0,04

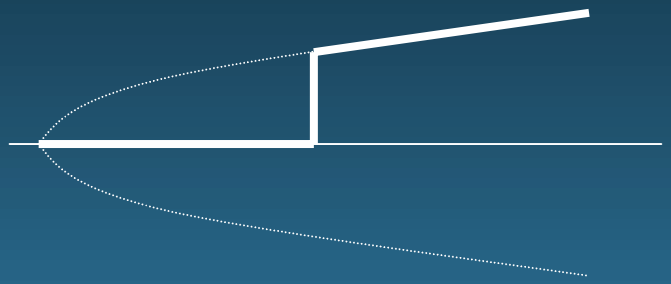
B: 0,5*0,5=0,25
T: 0,2*0,2=0,04



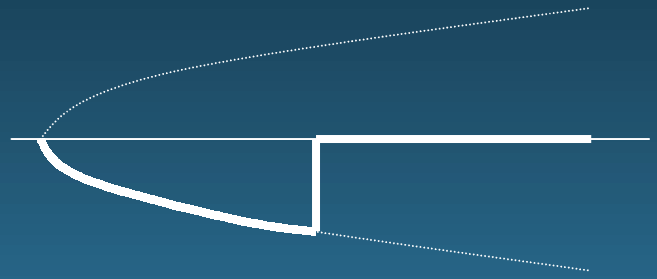
What types of scenarios are in the binary tree?

Additional types of scenarios in such a ternary tree

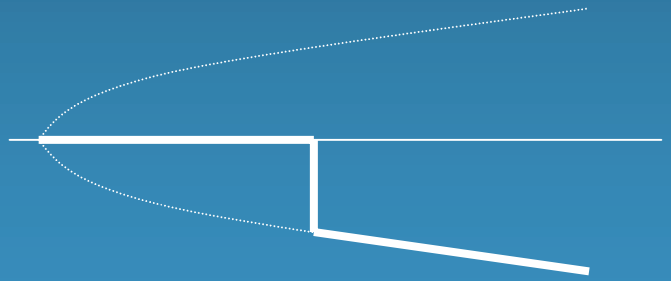
B: none
T: 0,6*0,2=0,12



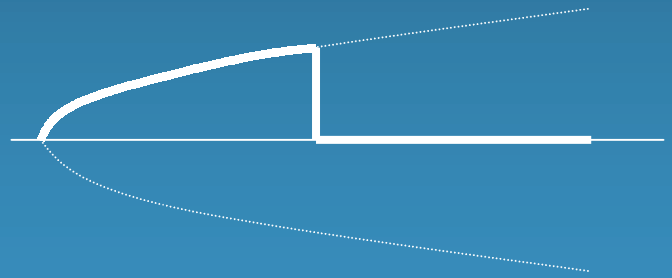
B: none
T: 0,2*0,6=0,12



B: none
T: 0,6*0,2=0,12

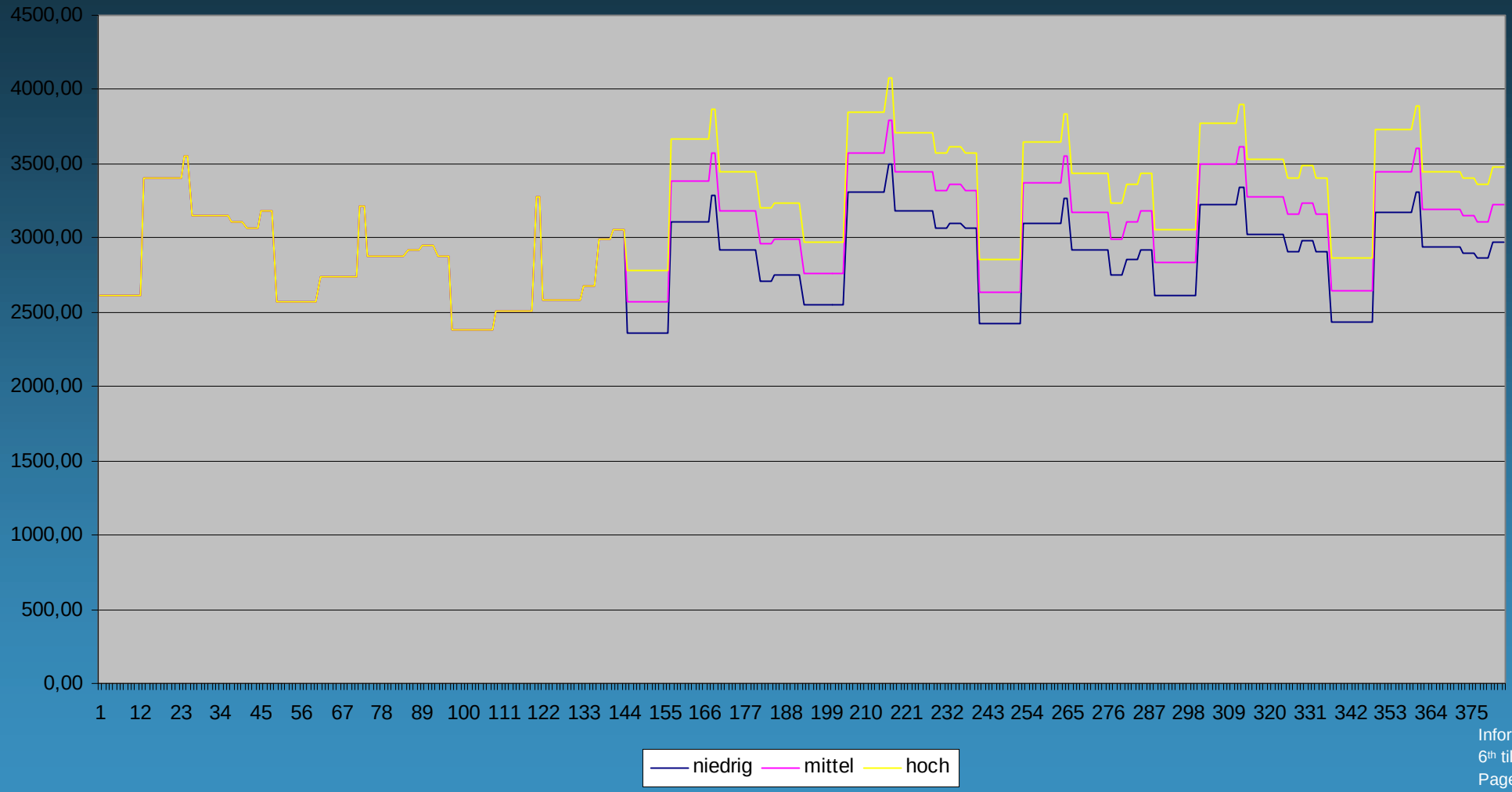


B: none
T: 0,2*0,6=0,12



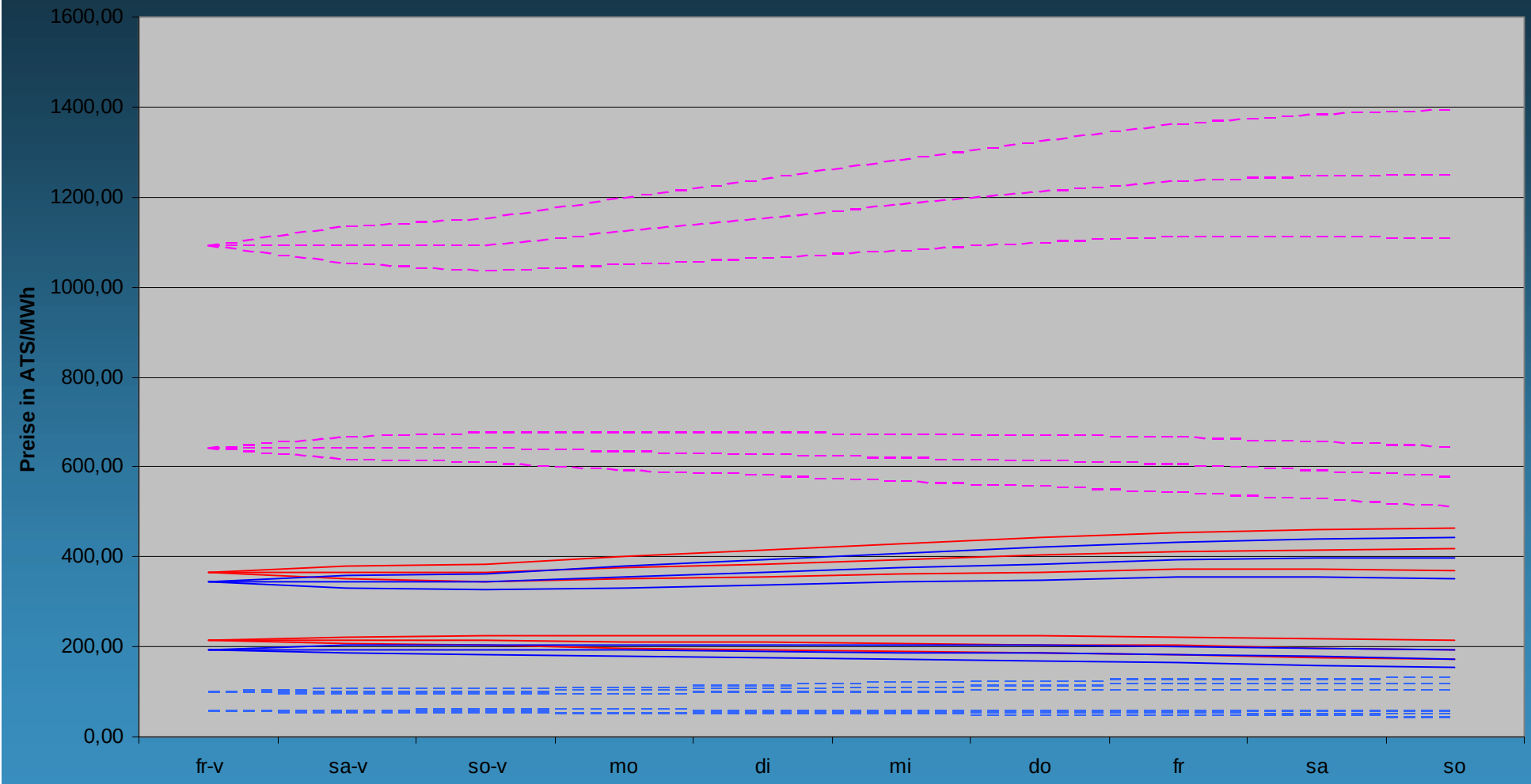
What is the appropriate tree for this problem?

Structure of system demand



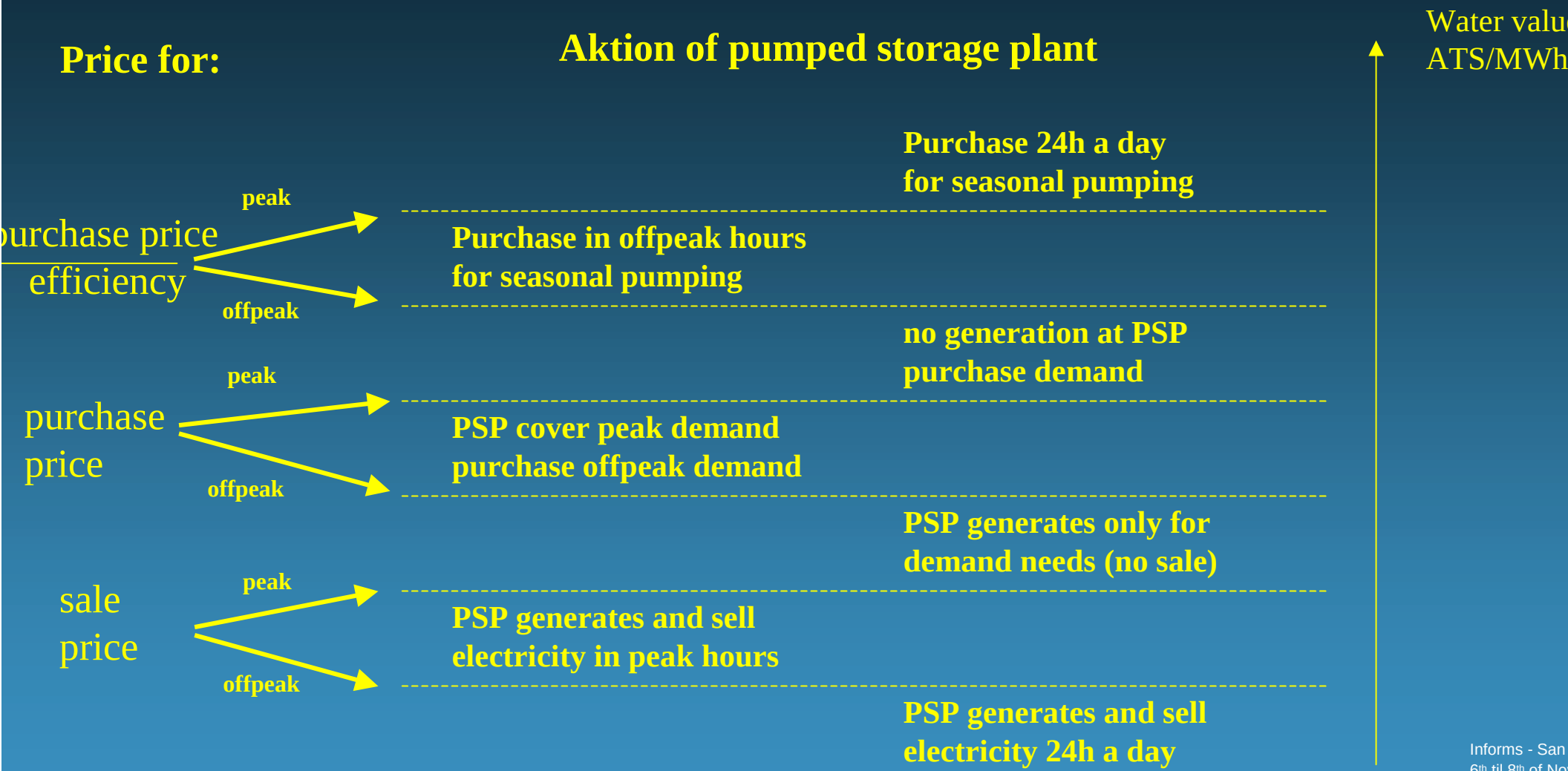
How much is the system demand?

Structure of day ahead prices



How much are the day ahead prices?

Utilisation of pumped storage plants by scenario



What influence have water values?

Net open position before optimisation

andbreite der offene Position der einzelnen Tage									
					negativ=short		positiv=long		
				Peak				Offpeak	
			Minimum	Mittel	Maximum		Minimum	Mittel	Maximum
13.10.00	fr-v	GWh							
14.10.00	sa-v	GWh	7236,68281		15185,061		8159,65252		14826,5762
15.10.00	so-v	GWh	6735,68902		14172,0579		8747,68902		15928,0579
16.10.00	mo	GWh	2705,05655		9895,05793		7139,19334		14733,0579
17.10.00	di	GWh	-6647,06743		8574,05793		257,841717		13054,0579
18.10.00	mi	GWh	-5535,04878		8893,24169		-857,04878		12736,3101
19.10.00	do	GWh	-5639,04878		4761,6797		-753,04878		10251,1343
20.10.00	fr	GWh	-5483,04878		5397,68902		-909,04878		9613,68902
21.10.00	sa	GWh	-2740,04878		8012,68902		239,95122		10720,689
22.10.00	so	GWh	-713,04878		10031,689		1162,95122		11651,689
inimum == Lauf_niedrig +Tagesspeicher_nurpeak +Importe -Bedarf_hoch -EnBWTurb -Exporte									
laximum == Lauf_hoch +Tagesspeicher_nurpeak +Importe +EnBWPumpe -Bedarf_niedrieg -EnBWTurb/2 -Exporte									

How much is the net open position?

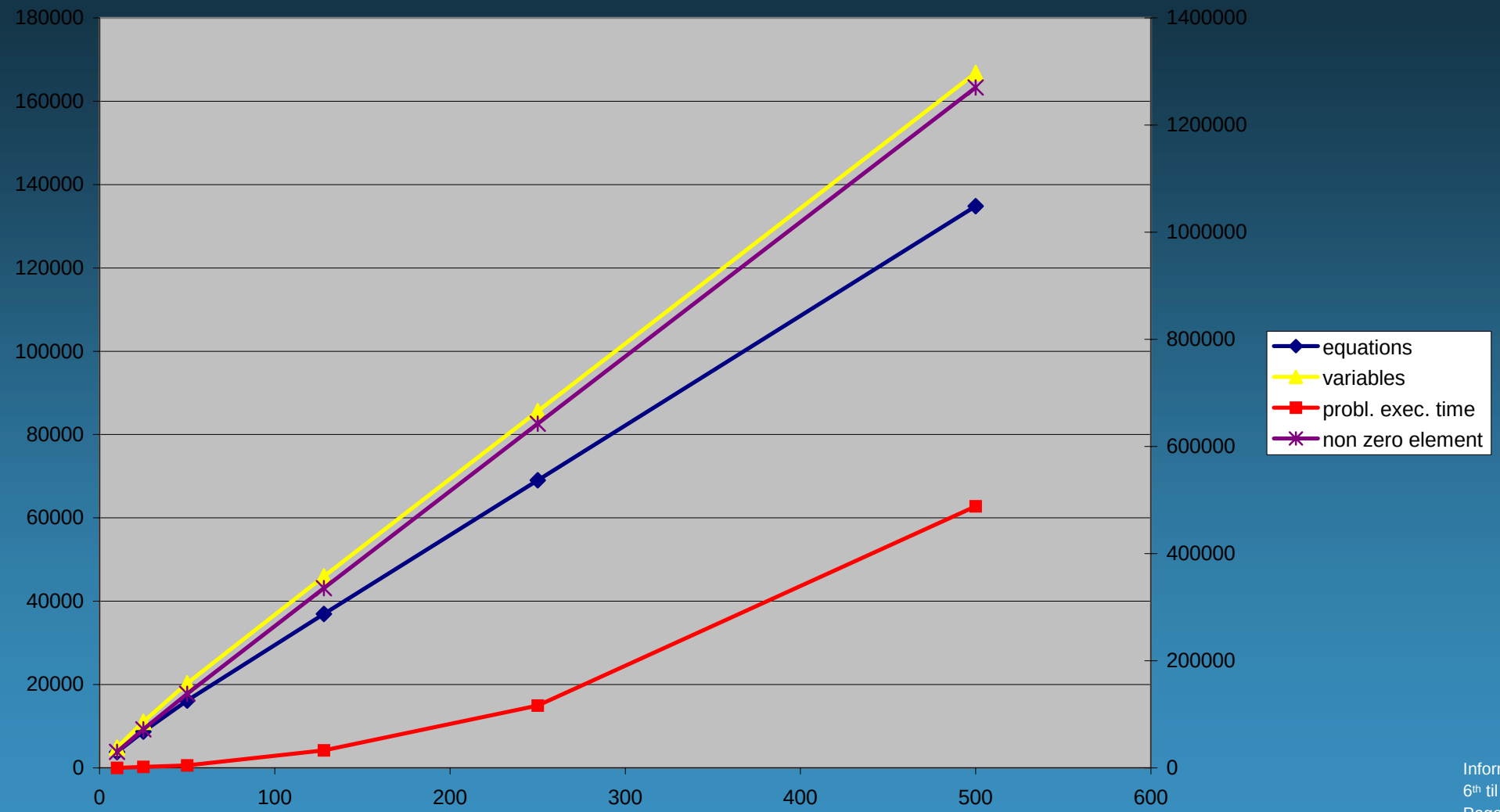
Model statistics

DSL

cenarios	[-]	det	10	25	50	128	250	500	expec.ir
quations	[-]	695	3781	8711	16181	36953	69061	134801	
ocks of equ.	[-]	10	10	10	10	10	10	10	
ariables	[-]	1028	4885	11036	20317	45979	85621	166783	1
ocks of varia.	[-]	26	26	26	26	26	26	26	
on zero element	[-]	4330	30051	71749	138497	335489	642324	1270205	4
screte var.	[-]	40	40	40	40	40	40	40	
eneration space	[MB]	75,4	85,3	87,4	90,6	99,5	113,1	141,4	7
ener. time	[s]	0,20	1,48	3,07	6,20	18,10	30,68	67,94	
xec. time	[s]	50,3	54,1	55,9	59,2	83,0	86,63	125,6	
orkspace	[MB]	1,83	7,59	17,72	33,75	80,52	153,3	302,1	
obl. exec. time	[s]	2,1	29,3	222	615	4221,0	14984	62782	
laxed optimum	[ATS]	1,196E+07	7,230E+06	6,897E+06	7,224E+06	7,105E+06	7,147E+06	7,150E+06	
jective value	[ATS]	1,198E+07	7,392E+06	7,038E+06	7,366E+06	7,246E+06	7,287E+06	7,300E+06	5,500E-
lative gap	[%]	0,19	1,30	2,04	1,96	1,98	1,96	1,09	

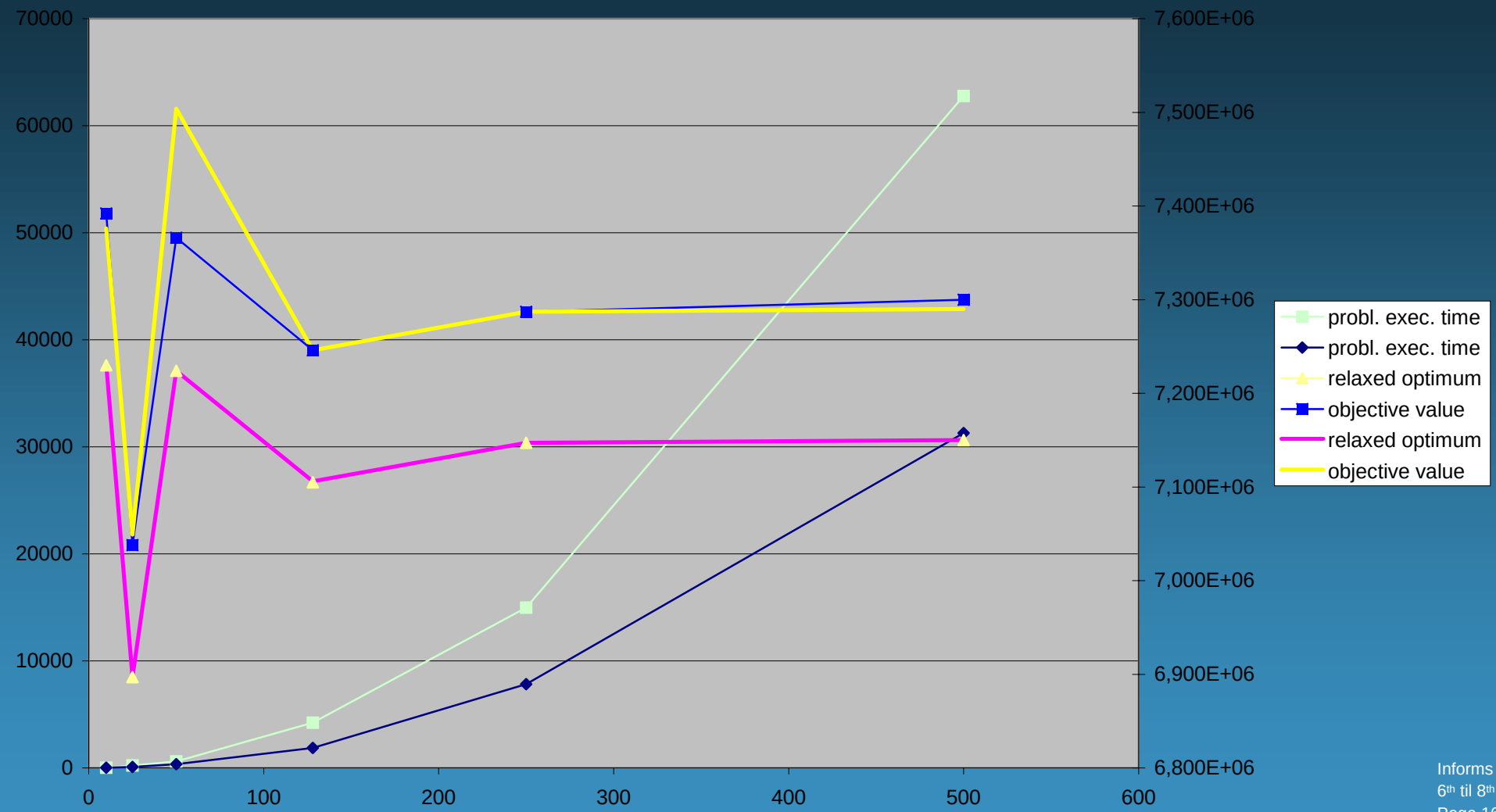
Hardware: Pentium III 500 MHz 256 MB

The problem size and its dependence on the number of scenarios



What is the problem size and its growth?

Solution time and objective value



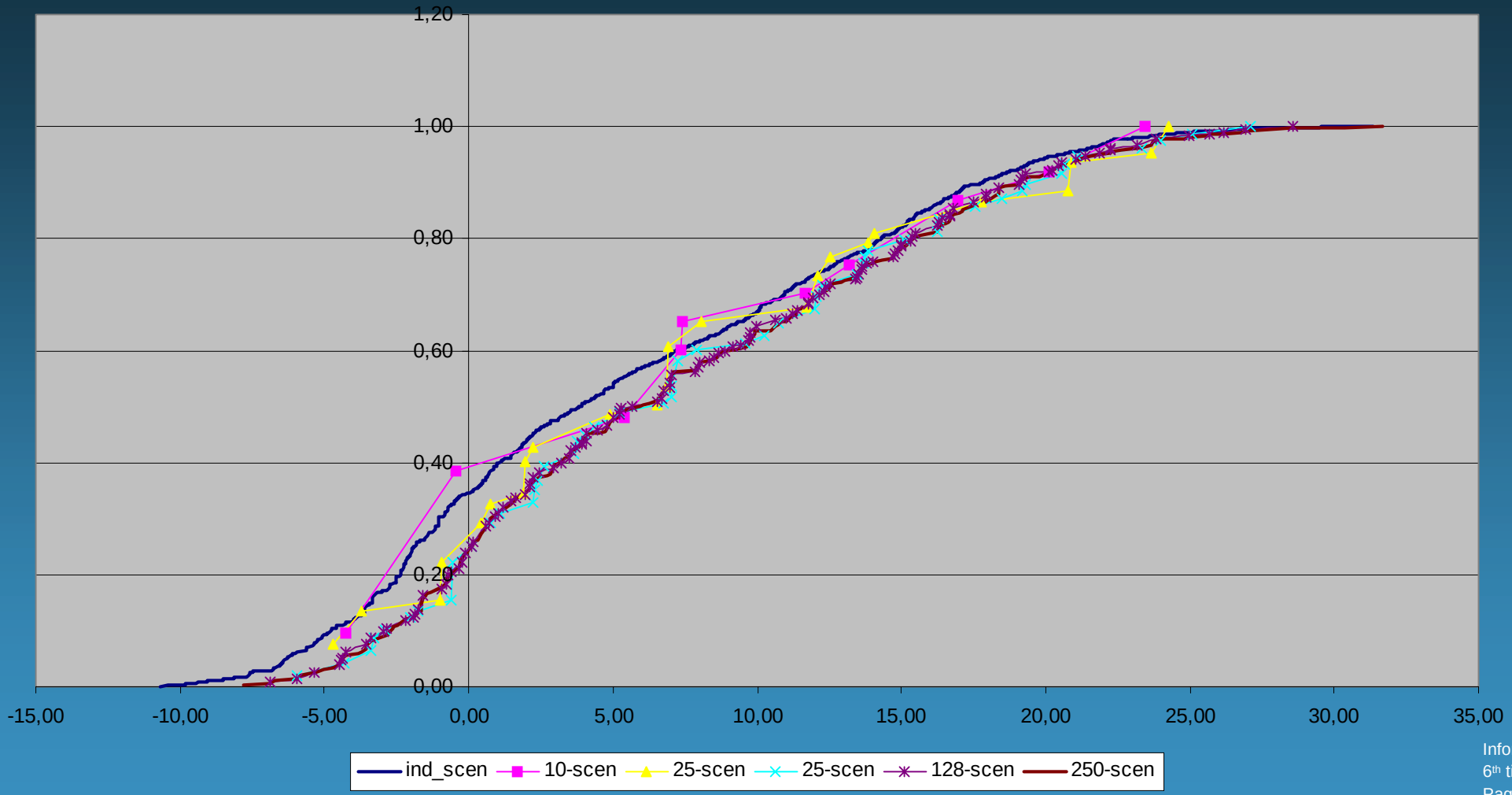
How is the resource utilisation?

Decisions view

scenarios	[-]	det	10	25	50	128	250	500	expec.in
Exp Bd Mo-Fr	[MW]	530	310	250	308	284	276	300	
Exp HT Mo-Fr	[MW]								
Exp NT Mo-Fr	[MW]								
Exp Bd Sa-Fr	[MW]								
Exp NT Sa-Fr	[MW]								
mp Bd Mo-Fr	[MW]								
mp HT Mo-Fr	[MW]								
mp NT Mo-Fr	[MW]	311							
mp Bd Sa-Fr	[MW]								
mp NT Sa-Fr	[MW]	245							
r-V	units	1,2							
sa	units								
so	units			2	2	2	2		
no	units	1,2	1,2,5	1,2	1,2,5	1,2,5	1,2,5	1,2,5	
li	units	1,2	1,2,5	1,2	1,2,5	1,2,5	1,2,5	1,2,5	
ni	units	1,2	1,2,5	1,2	1,2,5	1,2,5	1,2,5	1,2,5	
lo	units	1,2	1,2,5	1,2	1,2,5	1,2,5	1,2,5	1,2,5	
r	units	1,2	1,2,5	1,2	1,2,5	1,2,5	1,2,5	1,2,5	

What are the proposals for the here and now decisions?

Distribution of cost for different approximations



CPL

How is the distribution of the cost function?

Übersicht über die Ergebnisse

Szenario: **laufn - laufn**

Rechnung ab 28.01.00

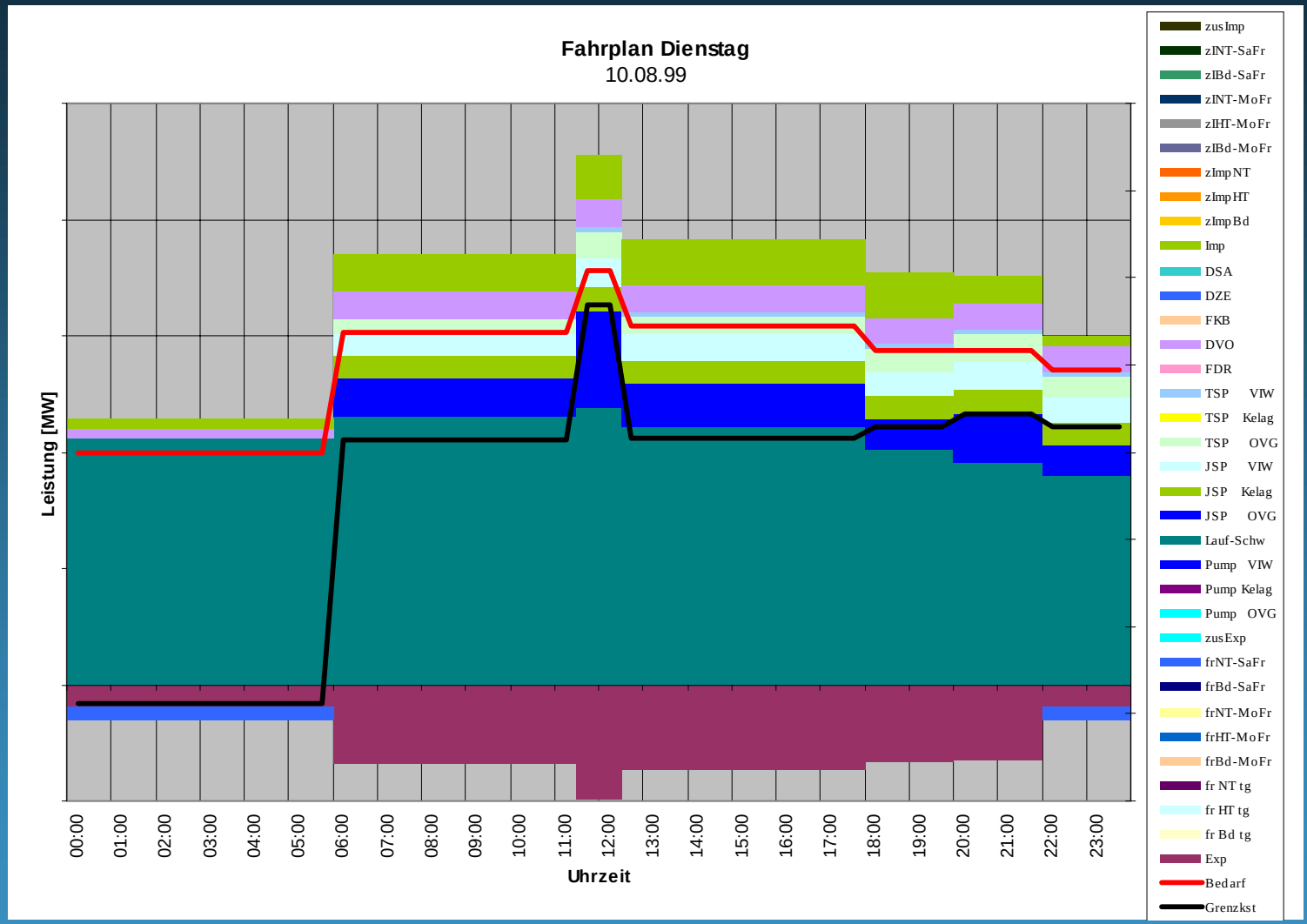
Deckung

		fr-v	Samstag	Sonntag	Montag	Dienstag	Mittwoch	Donnerstag	Freitag	Woche (GWh)
Summe Inl.+Pu.+Exp.	**GWh**	**101,84**	**86,00**	**80,41**	**98,81**	**96,39**	**99,43**	**96,68**	**99,55**	**657,27**
Inlandsbedarf	MWh	52978	50632	48634	56390	57388	57392	57394	57394	**385,22**
Kontrahierte Exporte	MWh	22635	18640	18640	22335	22635	22635	22635	22635	**150,16**
Tagesbänder 0-24	MWh	15360	0	1752	0	0	0	0	0	**1,75**
Tagesbänder HT	MWh	8880	0	0	0	0	0	0	0	**0,00**
Tagesbänder NT	MWh	0	0	0	0	0	0	0	0	**0,00**
Wochenband Mo-Fr	MWh	0	0	0	6096	6096	6096	6096	6096	**30,48**
HT-Band Mo-Fr	MWh	0	0	0	0	0	0	0	0	**0,00**
NT-Band Mo-Fr	MWh	0	0	0	0	0	0	0	0	**0,00**
Wochenband Sa-Fr	MWh	0	8304	8304	8304	8304	8304	8304	8304	**58,13**
NT-Band Sa-Fr	MWh	0	0	0	0	0	0	0	0	**0,00**
Überschuß	MWh	830	4188	106	3168	442	2484	556	2598	**13,54**
Summe Zusatzverkauf	*MWh*	*25070*	*12492*	*10162*	*17568*	*14842*	*16884*	*14956*	*16998*	**103,90**
Pumpe	MWh	1152	4236	2970	2520	1526	2520	1698	2520	**17,99**

		fr-v	Samstag	Sonntag	Montag	Dienstag	Mittwoch	Donnerstag	Freitag	Woche (GWh)
Summe Aufbringung	**GWh**	**101,85**	**86,01**	**80,41**	**98,81**	**96,39**	**99,43**	**96,68**	**99,55**	**657,28**
Lauf-Schwell	MWh	67647	65172	62637	62666	62637	62666	62637	62666	**441,08**
JSp	MWh	7884	6865	5033	8483	7411	6845	7408	5889	**47,93**
TSp	MWh	1200	1200	1200	1202	1200	1202	1200	1202	**8,41**
Summe Wasser	*MWh*	*76731*	*73237*	*68870*	*72350*	*71247*	*70712*	*71244*	*69757*	**497,42**
Dampf	MWh	13104	5475	3750	14448	13130	14448	13419	14448	**79,12**
Kontrahierte Importe	MWh	12015	7297	7792	12015	12015	12015	12015	12015	**75,16**
Zusätzliche Importbänder	MWh	0	0	0	0	0	2256	0	3328	**5,58**
Defizit	MWh	0	0	0	0	0	0	0	0	**0,00**

Are the energy quantities correct?

Plant schedule for one day



Now:

10 days per scenario

128 scenarios

Behave the model similar to reality?

Future development

Market

"***Old***" products - (power and energy limited) are now complex swing options they will exist still on the OTC market but are not very liquid.

At power exchanges and OTC there are already standard products with characteristics (defining their flexibility) like base, peak, offpeak, super peak they are very liquid and they are used mainly in daily business.

These products are traded using methods broadly used in financial markets (OTC, futures, forwards, verious versions of options, swaps etc.)

Model

- Stochastic models will be important
- Trinomial trees
- Elastic prices
- Number of options will increase

What will / should happen in future?