Example 5: Electricity Production Costs
Base Case Assumptions

Combined Cycle Power Plant (base load) with
360 mi USD investment at 70% debt share.

Two options for market approach:

A: 5,000h at 720 MW (56.5% efficiency) plus
1,000h at 230 MW (36.5% efficiency)
= 5,319h at 720 MW (54.7% efficiency)

B: 5,000h at 720 MW (56.5% efficiency)

Min. spot market price for additional production ?
How much could the investment increase ?

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A new power plant shall be built, and the investor has the option to include an existing old gas turbine which he would use only during peak price hours and sell this electricity on the spot market.

This additional turbine has a low efficiency, so it will be only worth using it when the electricity price is high. How much would be the minimum peak price to start the turbine? And how much investment is justified to install the existing turbine and connect it to the new plant?

These questions will be answered by PG-ROI.

The plant is designed to operate medium load, i. e. 5000 hrs per year, and of these there are 1000 hrs considered peak price.

General Input Data

Power		Value
Electrical Net Power	MW	720
El. Full Load oper. Hours	h/a	5000
El. Net Efficiency	---	56,50%

Operating Costs		Value
Personnel	mill. EUR/a	2,5
Insurance	mill. EUR/a	2
Fixed Maintenance	mill. EUR/a	13
Other Costs A	mill. EUR/a	
Other Costs B	mill. EUR/a	
Variable Maintenance	EUR/MWh	0,1
Fuel	EUR/GJ	2,5
Consumables	EUR/MWh	0,25

Operating Revenues		Value
Fixed Revenues Electricity	mill. EUR/a	
Other Revenues D	mill. EUR/a	
Other Revenues E	mill. EUR/a	
Other Revenues F	mill. EUR/a	
Variable Rev. Electr.	EUR/MWh	32,00

Investment	No interest during construction		
Investment Volume		mill. EUR	360

Lifetime		
Hand over (End of Commiss.)	Date	1.1.2003
Lifetime from Commiss.	Years	20
Tax Depreciation Time	Years	15

Financing			
Debt Share 1		---	70,00%
Debt Interest Rate		---	8,00%
Start of Debt Service	Straight line	Date	1.1.2003
Debt Service		Years	15
Debt Share 2		---	
Debt Interest Rate		---	
Start of Debt Service	Straight line	Date	
Debt Service		Years	

Calc. Equity Costs		
Equity Share	---	30%
Interest Rate	---	10,00%
Equity Service	Years	10

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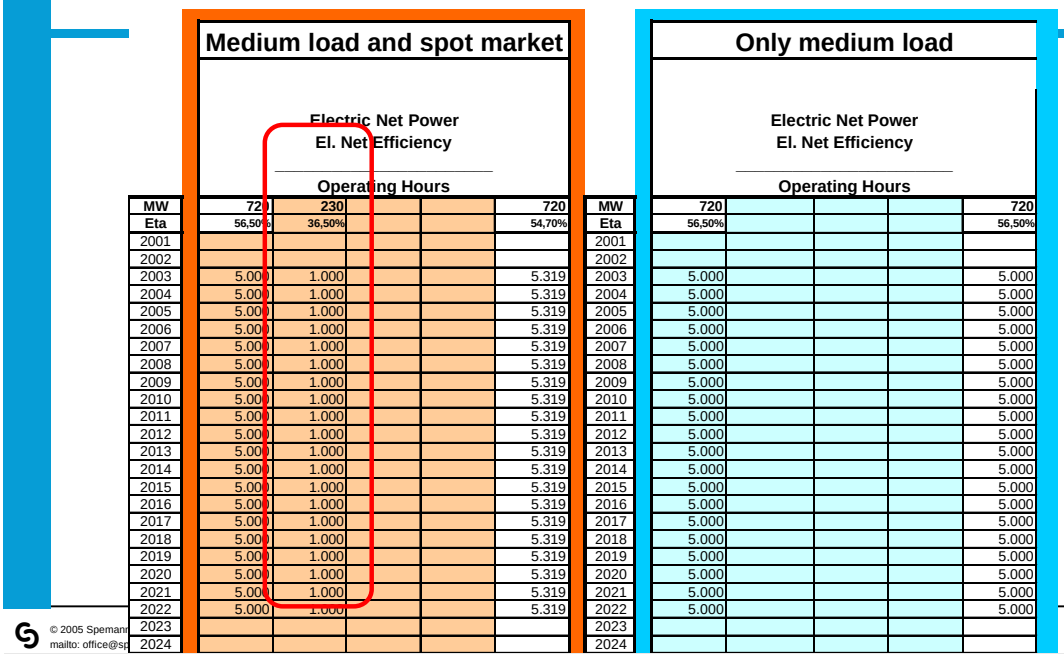
The general input data include the basic performance data of the new plant, and they assume a price of 32 EUR/MWh for electricity.

These data are identical for both options.

Input Operating Hours



Medium load and spot market

Electric Net Power
El. Net Efficiency

Operating Hours

MW	720	230			720
Eta	56,50%	36,50%			54,70%
2001					
2002					
2003	5.000	1.000			5.319
2004	5.000	1.000			5.319
2005	5.000	1.000			5.319
2006	5.000	1.000			5.319
2007	5.000	1.000			5.319
2008	5.000	1.000			5.319
2009	5.000	1.000			5.319
2010	5.000	1.000			5.319
2011	5.000	1.000			5.319
2012	5.000	1.000			5.319
2013	5.000	1.000			5.319
2014	5.000	1.000			5.319
2015	5.000	1.000			5.319
2016	5.000	1.000			5.319
2017	5.000	1.000			5.319
2018	5.000	1.000			5.319
2019	5.000	1.000			5.319
2020	5.000	1.000			5.319
2021	5.000	1.000			5.319
2022	5.000	1.000			5.319
2023					
2024					

Only medium load

Electric Net Power
El. Net Efficiency

Operating Hours

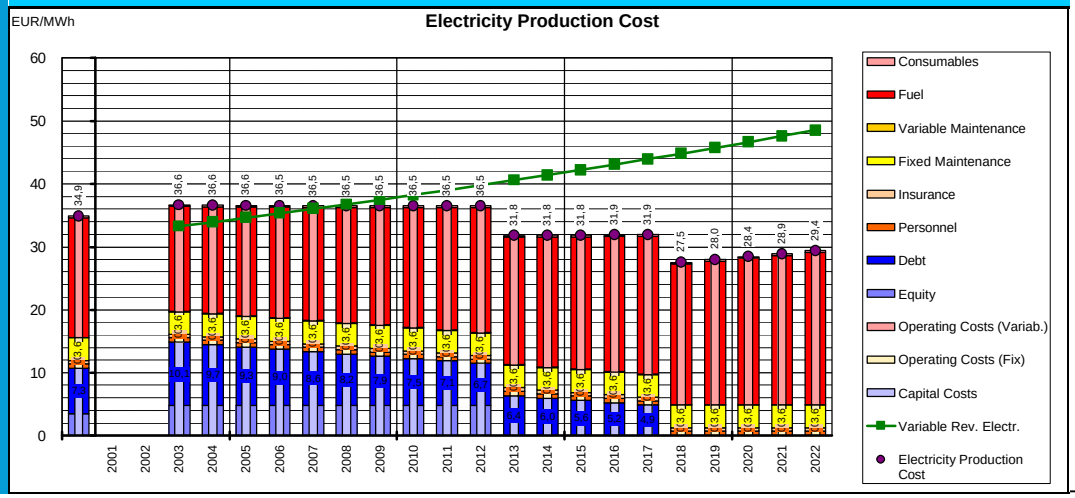
MW	720				720
Eta	56,50%				56,50%
2001					
2002					
2003	5.000				5.000
2004	5.000				5.000
2005	5.000				5.000
2006	5.000				5.000
2007	5.000				5.000
2008	5.000				5.000
2009	5.000				5.000
2010	5.000				5.000
2011	5.000				5.000
2012	5.000				5.000
2013	5.000				5.000
2014	5.000				5.000
2015	5.000				5.000
2016	5.000				5.000
2017	5.000				5.000
2018	5.000				5.000
2019	5.000				5.000
2020	5.000				5.000
2021	5.000				5.000
2022	5.000				5.000
2023					
2024					

The difference between both options (with additional gas turbine, covering medium load and additional peak hours, or only the medium load plant alone).

The additional gas turbine has 230MW capacity and would run 1000 hrs a year at 36.5% efficiency (see red circle).

Results B: Only medium load

Electricity Production Cost		Levelized	2001	2002	2003	2004	2005
Capital Costs	EUR/MWh	10,695			14,853	14,480	14,106
Fixed Operating Costs	EUR/MWh	4,861			4,861	4,861	4,861
Variable Operating Costs	EUR/MWh	19,308			16,923	17,254	17,592
Electricity Production Cost	**EUR/MWh**	**34,864**			**36,637**	**36,595**	**36,560**

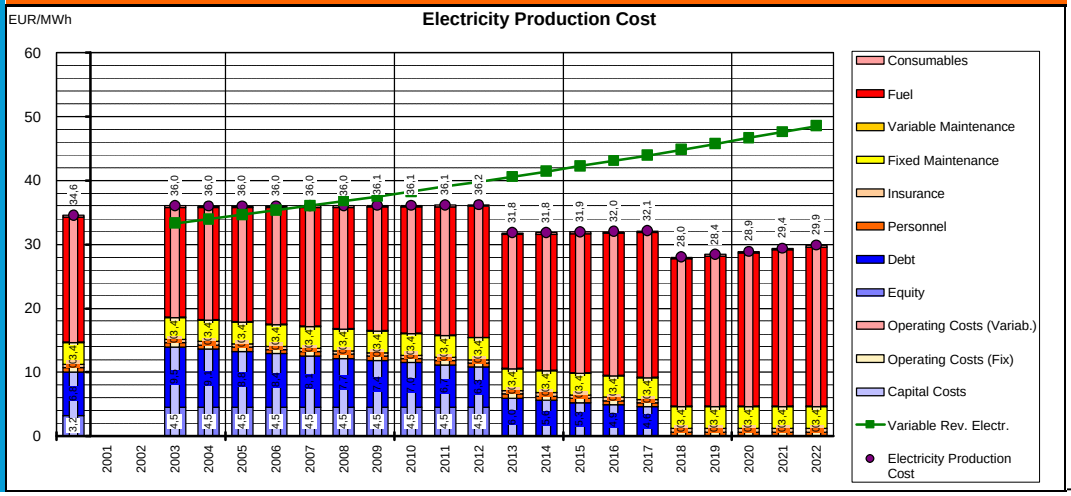


The graphic shows the results of the new power plant alone. The electricity production costs compose of fuel costs and capital costs mainly, as well as some additional costs for maintenance and personnel.

The initial production costs are 36.637 EUR/MWh, changing over the years due to inflation and interest.

Results A: Medium load and spot market

Electricity Production Cost		Levelized	2001	2002	2003	2004	2005
Capital Costs	EUR/MWh	10,053			13,961	13,610	13,259
Fixed Operating Costs	EUR/MWh	4,569			4,569	4,569	4,569
Variable Operating Costs	EUR/MWh	19,932			17,468	17,810	18,160
Electricity Production Cost	**EUR/MWh**	**34,554**			**35,998**	**35,990**	**35,988**

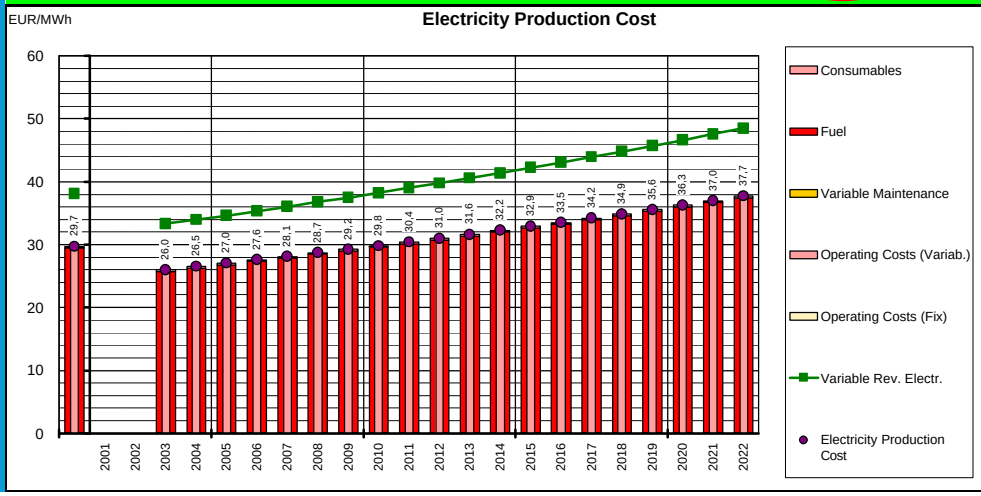


The electricity production costs of the plant including the use of the additional turbine are lower (35.998 instead of 36.637 initial EPC in 2003).

This seems to be surprising, but when looking at the details, in becomes clear that the variable costs (fuel) are higher, due to the low efficiency of the additional turbine, and the capital costs are lower, due to the fact that until now, no additional investment was considered.

Results D: Only spot market (1000 hr/yr at 230 MW)

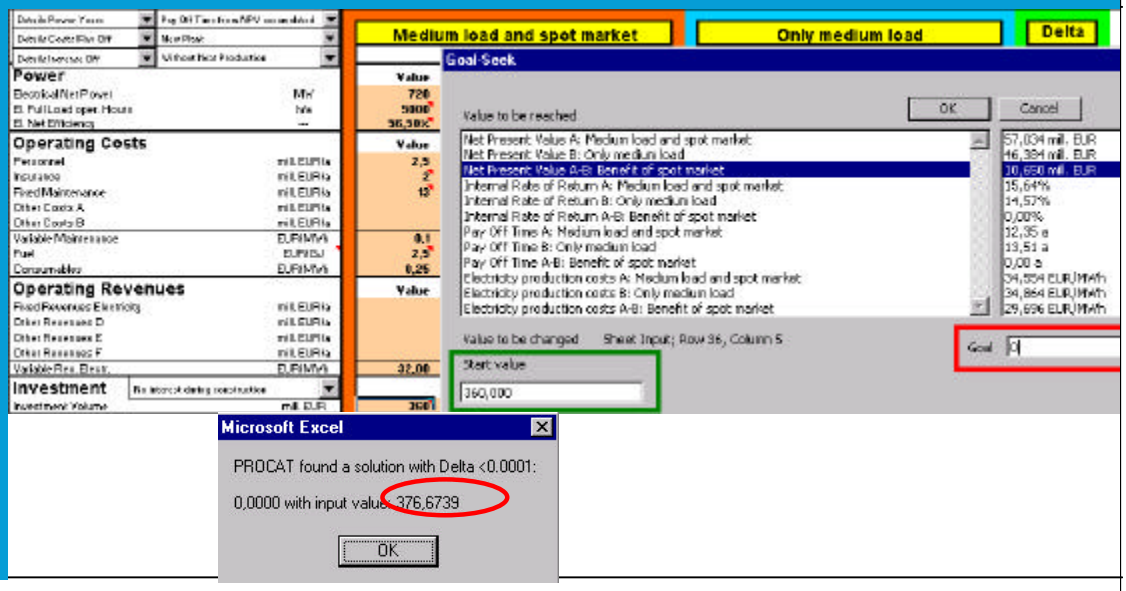
Electricity Production Cost		Levelized	2001	2002	2003	2004	2005
Capital Costs	EUR/MWh						
Fixed Operating Costs	EUR/MWh						
Variable Operating Costs	EUR/MWh	29,696			26,004	26,517	27,040
Electricity Production Cost	**EUR/MWh**	**29,696**			**26,004**	**26,517**	**27,040**



The result of the Delta Analysis shows the pure costs for the electricity that is produced by the additional gas turbine alone. They only consist of fuel costs, as there are neither personnel costs nor capital costs expected.

The fuel costs are 26 EUR/MWh initially, lower than the average electricity price of 32 EUR/MWh (green line)

Goal seek for investment volume



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The next step is defining the justified additional investment for the gas turbine.

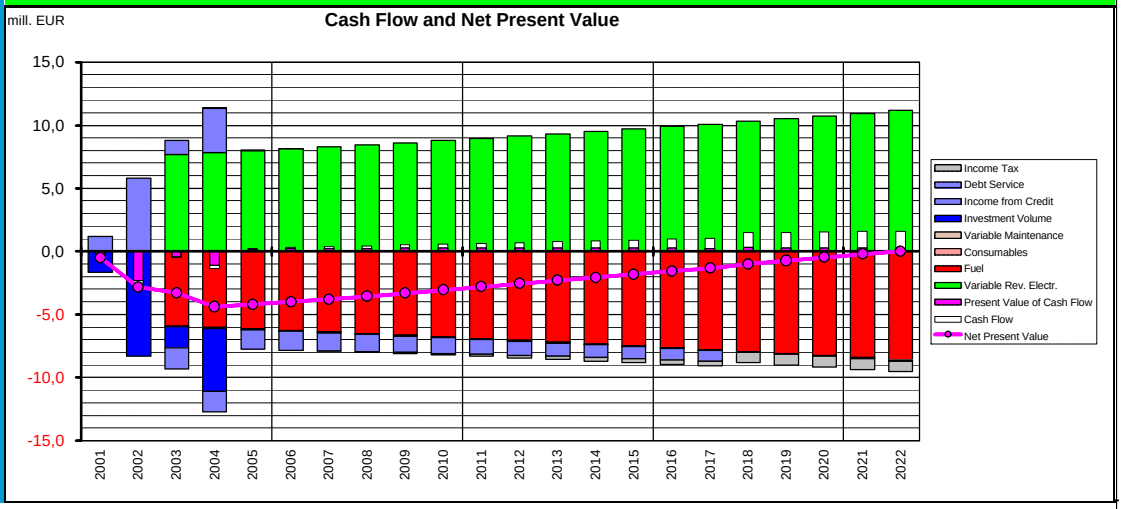
„Justified“ means in this example, that no additional Net Present Value is needed, the Delta NPV should be Zero.

PG-ROI finds the solution with its goal seek function: 376.6739 mEUR Investment. Compared to the 360 mEUR, the delta is 16.67 mEUR.

Spot market sales justify a 16.67 mi Investment

Investment		
Debt	mill. EUR	11,672
Equity	mill. EUR	5,002
Capital Requirement	**mill. EUR**	**16,674**

Net Present Value (10,0%) at 1.1.2002	mill. EUR	0,000
Internal Rate of Return till 2011	% / a	
Internal Rate of Return till 2022	**% / a**	**10,0%**
Pay Off Time from 1.1.2003 (a)		



If the installation of the additional turbine was 16.674 mEUR, the Net Present Value of that investment over the lifetime would be zero, confirming the goal seek analysis.

Such an investment would not be very attractive, but it gives the upper limit of justified investment, therefore answers the question that was asked in this example.