Example 4: Long Term Maintenance
Base Case Assumptions

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

Two options for turbine maintenance:

- A: each 40,000 EOT one month stop and 3 mi costs
- B: each 32,000 EOT one month stop and 2.5 mi costs

Does this extra maintenance pay off?
How much can A cost to be even (NPV) with B?

In this example, a new power plant could be equipped with a standard turbine or with a special coating on the turbine blades which allows to extend the maintenance intervals.

The „normal“ blades require a major maintenance during one month every 32,000 operating hours, and the blades with special coating only every 40,000 hours.

This will result in a benefit of higher production, but the price for each new set of blades is higher: 3 mUSD instead or 2.5 mUSD. Do these additional costs for maintenance pay off?

The criterion to determine whether the two alternatives have equal benefits should be the Net Present Value (NPV).

General Input Data

		Value	Min %	Max %	Distr.		Value
Power							
Electrical Net Power	MW	**720**					**720**
El. Full Load oper. Hours	h/a	**8000**				91,3% NCF	**8000**
El. Net Efficiency	---	**56,50%**				6372 kJ/kWh	**56,50%**
Operating Costs		**Value**	**Min %**	**Max %**	**Distr.**	**Incrs.**	**Value**
Personnel	mill. USD/a						
Insurance	mill. USD/a						
Fixed Maintenance	mill. USD/a						
Long Term Maintenance	mill. USD/a	**3**	75,0%	200,0%		3,0%	**2,5**
Other Costs B	mill. USD/a						
Variable Maintenance	USD/MWh						
Fuel	USD/GJ	**3**				2,0%	**3**
Consumables	USD/MWh						

mailto: office@spemann.com Tel: +49-172-8114335

The general input data determine the plant performance with 720 MW, 8000 hrs/yr and 56.5% efficiency for both options.

The difference is the in the costs for long term maintenance, which is 3 mUSD for each maintenance with special coated blades and only 2.5 mUSD at each maintenance with normal blades.

Input Operating Hours

Long Term Maintenance Contract

Power, Operating Hours and Efficiency

40,000 EOT Maintenance

	Electric Net Power / El. Net Efficiency — Operating Hours				Degradation Factor — %		Equ. op-hrs
MW	720	720					720
Eta	56,50%				MW	Eta	
2001							
2002							
2003	8.000						8.000
2004	8.000						8.000
2005	8.000						8.000
2006	8.000						8.000
2007	8.000						8.000
2008	8.000	-667					7.333
2009	8.000						8.000
2010	8.000						8.000
2011	8.000						8.000
2012	8.000						8.000
2013	8.000	-667					7.333
2014	8.000						8.000
2015	8.000						8.000
2016	8.000						8.000
2017	8.000						8.000
2018	8.000	-667					7.333
2019	8.000						8.000
2020	8.000						8.000
2021	8.000						8.000
2022	8.000						8.000
2023	8.000	-667					7.333
2024	8.000						8.000
2025	8.000						8.000
2026	8.000						8.000
2027	8.000						8.000

32,000 EOT Maintenance

	Electric Net Power / El. Net Efficiency — Operating Hours				Degradation Factor — %		Equ. op-hrs
MW	720	720					720
Eta	56,50%				MW	Eta	
2001							
2002							
2003	8.000						8.000
2004	8.000						8.000
2005	8.000						8.000
2006	8.000						8.000
2007	8.000	-667					7.333
2008	8.000						8.000
2009	8.000						8.000
2010	8.000						8.000
2011	8.000	-667					7.333
2012	8.000						8.000
2013	8.000						8.000
2014	8.000						8.000
2015	8.000	-667					7.333
2016	8.000						8.000
2017	8.000						8.000
2018	8.000						8.000
2019	8.000	-667					7.333
2020	8.000						8.000
2021	8.000						8.000
2022	8.000						8.000
2023	8.000	-667					7.333
2024	8.000						8.000
2025	8.000						8.000
2026	8.000						8.000
2027	8.000						8.000

mailto: office@spemann.com Te

The downtime for each maintenance cycle is put in the sheet „Power“, in this case as „negative hours“. It also would be possible to just fill 7333 hrs in the left column, only for highlighting the difference it was set into two different columns.

The first option “40,000” has four downtimes over the whole lifetime, and the second option has five downtimes.

Input Costs

Long Term Maintenance Contract

Other Costs and Revenues

40,000 EOT Maintenance

mill. USD	Long Term Maintenance	Other Costs B	Other Revenues D	Other Revenues E	Other Revenues F
2001					
2002					
2003					
2004					
2005					
2006					
2007					
2008	3				
2009					
2010					
2011					
2012					
2013	3				
2014					
2015					
2016					
2017					
2018	3				
2019					
2020					
2021					
2022					
2023	3				

32,000 EOT Maintenance

mill. USD	Long Term Maintenance	Other Costs B	Other Revenues D	Other Revenues E	Other Revenues F
2001					
2002					
2003					
2004					
2005					
2006					
2007	2,5				
2008					
2009					
2010					
2011	2,5				
2012					
2013					
2014					
2015	2,5				
2016					
2017					
2018					
2019	2,5				
2020					
2021					
2022					
2023	2,5				

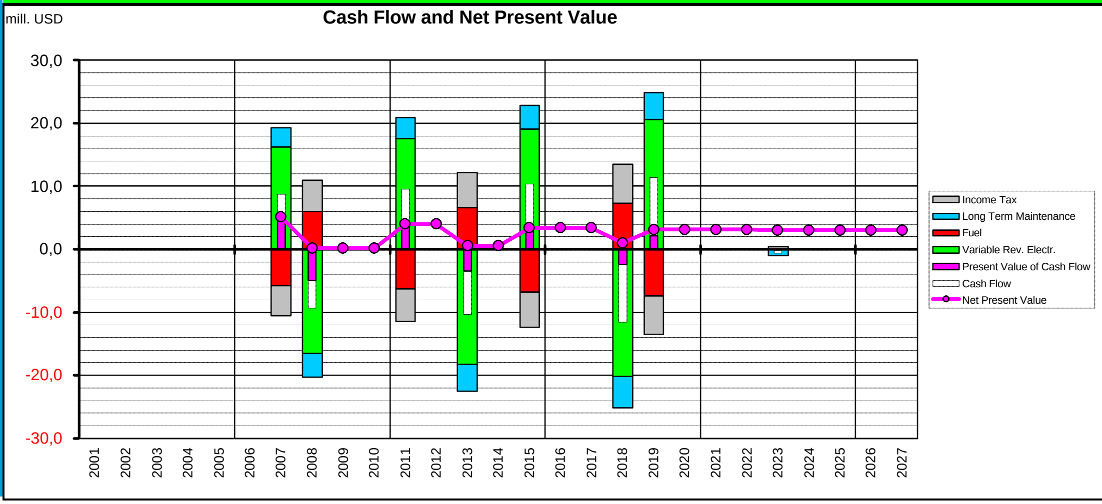
mailto: office@spemann.com Tel: +49-172-8114335

The costs for the new turbine blades correspond to the downtime schedule, so that in each year when a maintenance takes place, the costs for new blades occur. These date are put in the sheets „Costs“, linking the value of each cell by formula to the 3 or 2.5 mUSD in the general data input sheet.

Results D: Delta

Investment		
Debt	mill. USD	
Equity	mill. USD	
Capital Requirement	**mill. USD**	

Net Present Value (10,0%) at 1.1.2002	**mill. USD**	**3,014**
Internal Rate of Return till 2011	% / a	
Internal Rate of Return till 2027	**% / a**	
Pay Off Time from 1.1.2003 (a)		



mailto: office@spemann.com Tel: +49-172-8114335

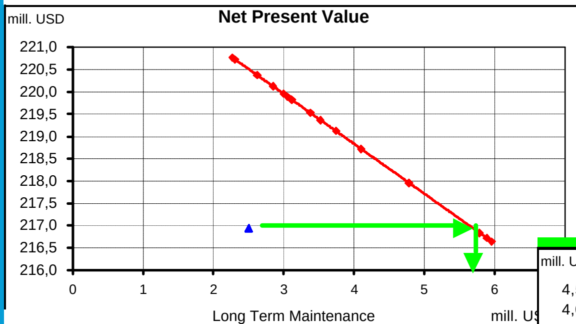
PG-ROI offers the result from the comparison of the two projects in its Delta Analysis.

The graphic shows the benefit of the first option over the second option, so that in the year 2007, when no downtime is needed, the benefit is additional revenues (positive green column) accompanied by additional fuel costs (negative red column), but the not-spending on maintenance costs (positive blue column 2.5 mUSD).

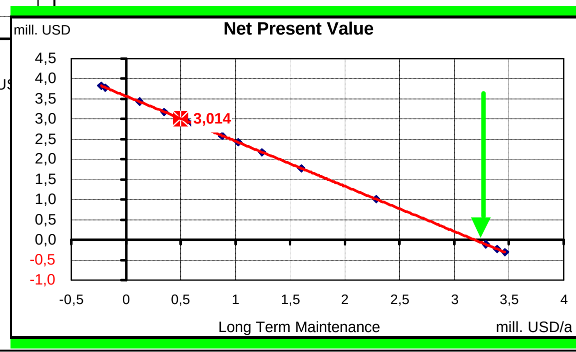
This picture changes in the following year 2008, when the exact contrary occurs: loss of revenues, but savings in fuel costs during down time. Additionally, the costs of maintenance apply (3 mUSD, negative blue column).

The same sequence of up and down takes place in the following years until finally there is one downtime saved and the cash-flow remains positive. The Net Present Value for saving one downtime results in 3.014 mUSD, even though the costs for each maintenance cycle are higher.

Sensitivity for LTM Costs for 40,000 EOT



Goal:
NPV A = NPV B or
NPV = 0 for Delta



The costs for each maintenance could be 5.75 mi USD
(2.5 + 3.25 = 5.75)

mailto: office@spemann.com Tel: +49-172-8114335

The criterion to compare the two options was set to be equal Net Present Value of both options, or Zero NPV for the Delta Analysis.

A simple sensitivity analysis reveals that this goal would be achieved, if the maintenance costs for the special coated turbine blades were 3.25 mUSD higher than for the normal blades.

In the example, the price difference was assumed to be only 0.5 mUSD, so that the provider of special coated turbine blades should have good arguments to convince his potential customer to use them.