Discounted Cash Flows Method applied to KEV - Solution

The net present value (NPV) at time \( t_0 \) is using

Discrete compounding:
\[
NPV_{t_0} = \sum_t \frac{C_t}{(1 + r_d)^{t-t_0}} \quad (1)
\]

Continuous compounding:
\[
NPV_{t_0} = \sum_t C_t \cdot e^{-r_c(t-t_0)} \quad (2)
\]

where

\( r_d, r_c \) : risk-adjusted discount factors per annum (c = continuous case, d = discrete case)

\( C_t \) : (yearly) cash-flow

\( t - t_0 \) : discounting period (\( t_0 = \text{now} \))

Exercise 1 – PV Power Plant

a) Calculate the Net Present Value (NPV) assuming annually payment (Annual discount factor: 0.05).
Applying (1) in a table yields CHF 13074.

b) What is the discount factor if you would just break even with your investment? Interpretation?
The discount factor has to be varied until the NPV is zero. For example using the Excel built-in solver yields: \( r = 0.0726 \).
As the NPV in a) is larger than zero, the discount factor has to be larger in b) The larger discount factor suggests an investment with a larger risk.

c) In reality, the remuneration is paid quarter annually. How does this change the NPV? Assume the same income for every quarter of the year. Interpretation?
The cash flow of a quarter is \( C_{\text{quarter}} = 1207.5 \text{ CHF} \).
Discounting the quarter annually cash flows yields a NPV of CHF 13708. This value is higher than in a. as the discounting periods are shorter and thus we profit more from compounded interest.

d) What would happen for continuous compounding (\( r = 0.05 \))? Calculate the discount factor in the continuous case, such that the NPV are equivalent in both cases.
Using (2) leads to a NPV CHF 12214.9, which is smaller than the result from (1). This means that the money has less value at the moment as its value increases more in the future due to continuous compounding.
In order to calculate an equivalent discount factor for the continuous case one can equate (1) and (2) and solve for \( r_c \). This leads to:
\[
r_c = \ln(1 + r_d) = 0.04879
\]

e) The PV panels power output reduces over time due to aging. The producer however guarantees you, that the power output will always be over 80% of the nominal power. How does the NPV change, if you assume a linear degradation to 80% of the nominal power at the
end of the PV plants lifetime (quarter annual remuneration)?
The same as c. except that quarter annual cash-flows now are calculated as:

\[ C_t = \text{(tariff)} \cdot E_{\text{max,quarter annually}} \cdot \left(1 - \frac{1 - 0.8}{t_{\text{end}}} \cdot (t - 0.5 \cdot \text{quarter} - t_0)\right) \]

where \( E_{\text{max}} \) is the production before degradation and \( t_{\text{end}} \) is the lifetime of the PV plant. This leads to a NPV of CHF 8226.

f) How much does the NPV decrease if you apply for KEV one year later (investment costs still 55kCHF)?
The tariff is reduced by 8% to 44.44 Rp./kWh. Assuming quarter annual payments as in c., the new NPV is CHF 8212.

Exercise 2 – Small Hydro Power Plant

a) Calculate the tariff.
The tariff is: 26 Rp./kWh

b) Calculate the NPV (quarterly payments, discount factor 0.05). Assume a fixed market price (6 Rp./kWh) for the rest of the lifetime with continuous compounding. Which renewable energy source has a bigger return relative to the invested money?
The quarter annual cash-flows for the next 25 years are discounted to the present using (1). The expected incomes from the market after the first 25 years are continuously discounted back until the end of the KEV period \( (t_0 = 25\text{years}) \), and are then discretely discounted to the present time \( t_0 \), i.e. 25 years back. This leads to a NPV of CHF 289'031. Building the quotients of NPVs and the investments yields:

<table>
<thead>
<tr>
<th>PV: PV:</th>
<th>Small Hydro:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>0.58</td>
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</table>

Therefore the relative return for the small hydro is higher.

Exercise 3 – Limitations

Prices are not constant (and have to be estimated). Thus e.g. the hydro power plant would act strategically and sell energy mainly during peak-load hours.