Climate Change

Assignment 4

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1. Calculate net benefit for each year
   To calculate the Net Benefit for each year of Micro Hydro Power (MHP) project, we'll subtract the total cost (Capital Cost + Operation & Maintenance Cost) from the Benefit,

$$Net\,Benefit = Benefit - (Capital\,Cost + Operation \wedge Maintenance\,Cost)$$

   Attached below is a snapshot of the Excel sheet with year-wise calculations of Net Benefit:

Year	Capital Cost	Operation & Maintenance Cost	Benefit	Net Benefit
2010	396.18	0	0	-396.18
2011	0	108	216	108
2012	0	108	216	108
2013	0	108	216	108
2014	0	108	216	108
2015	0	108	216	108
2016	0	108	216	108
2017	0	108	216	108
2018	0	108	216	108
2019	0	108	216	108
2020	0	108	216	108
2021	0	121	233	112
2022	0	121	233	112
2023	0	121	233	112
2024	0	121	233	112
2025	0	121	233	112
2026	0	121	233	112
2027	0	121	233	112
2028	0	121	233	112
2029	0	121	233	112
2030	0	121	233	112
2031	0	121	233	112
2032	0	121	233	112
2033	0	121	233	112
2034	0	121	233	112
2035	0	121	233	112

   Due to the high initial capital cost, the net benefit is negative in 2010 but steadily increases as both operational costs and benefits climb starting in 2011.

2. Calculate the overall Net Present Value of the project using a 12% discount rate.
We will use the net benefit for each year (calculated in Q1) to determine the MHP project's Net Present Value (NPV). We will then use a 12% discount rate to reduce those annual values to their present value.

Formula Used:

$$NPV = \sum_{t=0}^{n} \frac{Net\ Benefit_t}{¿¿}¿$$

where,

- $Net\ Benefit_t$ is the net benefit in year t
- $r = 0.12$ is the discount rate
- t ranges from 0 (for 2010) to 25 (for 2035)

Attached below is a snapshot of the Excel sheet with year-wise calculations of Discounted Net Benefit along with final NPV.

Year	Capital Cost	Operation & Maintenance Cost	Benefit	Net Benefit	Discounted Net Benefit
2010	396.18	0	0	-396.18	-396.18
2011	0	108	216	108	96.43
2012	0	108	216	108	86.10
2013	0	108	216	108	76.87
2014	0	108	216	108	68.64
2015	0	108	216	108	61.28
2016	0	108	216	108	54.72
2017	0	108	216	108	48.85
2018	0	108	216	108	43.62
2019	0	108	216	108	38.95
2020	0	108	216	108	34.77
2021	0	121	233	112	32.20
2022	0	121	233	112	28.75
2023	0	121	233	112	25.67
2024	0	121	233	112	22.92
2025	0	121	233	112	20.46
2026	0	121	233	112	18.27
2027	0	121	233	112	16.31
2028	0	121	233	112	14.56
2029	0	121	233	112	13.00
2030	0	121	233	112	11.61
2031	0	121	233	112	10.37
2032	0	121	233	112	9.26
2033	0	121	233	112	8.26
2034	0	121	233	112	7.38
2035	0	121	233	112	6.59
				NPV	459650.6884

All 26 years' **Discounted Net Benefits** (from 2010 to 2035) are added together to calculate NPV.

NPV = PKR 459,650.6884

3. For how many years does the MHP project have negative total net present value?

To address this, we add the Discounted Net Benefit from each year to the previous sum to determine the Cumulative NPV year by year. We can see from this when the project begins to yield a positive total return.

Attached below is a snapshot of the Excel sheet with year-wise calculations of Cumulative NPV.

Year	Capital Cost	Operation & Maintenance Cost	Benefit	Net Benefit	Discounted Net Benefit	Cumulative NPV
2010	396.18	0	0	-396.18	-396.18	-396.18
2011	0	108	216	108	96.43	-299.75
2012	0	108	216	108	86.10	-213.65
2013	0	108	216	108	76.87	-136.78
2014	0	108	216	108	68.64	-68.15
2015	0	108	216	108	61.28	-6.86
2016	0	108	216	108	54.72	47.85
2017	0	108	216	108	48.85	96.71
2018	0	108	216	108	43.62	140.33
2019	0	108	216	108	38.95	179.27
2020	0	108	216	108	34.77	214.04
2021	0	121	233	112	32.20	246.24
2022	0	121	233	112	28.75	274.99
2023	0	121	233	112	25.67	300.66
2024	0	121	233	112	22.92	323.57
2025	0	121	233	112	20.46	344.04
2026	0	121	233	112	18.27	362.31
2027	0	121	233	112	16.31	378.62
2028	0	121	233	112	14.56	393.18
2029	0	121	233	112	13.00	406.19
2030	0	121	233	112	11.61	417.80
2031	0	121	233	112	10.37	428.16
2032	0	121	233	112	9.26	437.42
2033	0	121	233	112	8.26	445.68
2034	0	121	233	112	7.38	453.06
2035	0	121	233	112	6.59	459.65
				NPV	459650.6884	

As we can see that for the first **6 years (from 2010 to 2015)** the MHP project has a negative total net present value.

4. Is the project viable overall? Explain

   Yes, the project is viable overall. With a positive Net Present Value (NPV) of PKR 459,650.6884, the Micro Hydro Power (MHP) project demonstrates that, over a 25-year period, the present value of its benefits exceeds the present value of its expenses. The project continuously produces positive net benefits in the years that follow, even if a large initial capital cost in 2010 resulted in negative returns for the first six years. These favourable returns yield a net economic gain in addition to recovering the original investment. As a consequence, the project is long-term profitable and valuable.

5. Should savings in the cost of diesel fuel be included as part of the MHP net benefits? Explain

   Yes, the savings in diesel fuel cost should be included. The local population's main option is to use diesel generators, which are costly and bad for the environment, because they do not have access to the national electrical system. By moving to Micro Hydro Power (MHP), these towns can cut back on or completely stop using diesel. Both immediate cost

savings and a decrease in greenhouse gas (GHG) emissions are the outcomes of this. In order to more truly reflect the MHP project's overall worth, both economically and environmentally, these avoided costs should be included in the net benefit calculation since they represent actual economic benefits to the community.

6. Find the total annual GHG emissions reduced by the MHP.

   The aim is to determine the annual amount of carbon dioxide (CO_2) emissions that can be avoided by switching from fossil fuel-based sources, such as diesel generators, to the Micro Hydro Power (MHP) system.

   Data provided to us:

   - Installed Capacity = **1060 kWh**
   - Daily Operation Time = **11 hours**
   - Emissions from fossil fuels = **1.4 kg CO_2 per kWh**

   We'll first calculate how much energy the MHP system produces in one year.

   $$Annual\ Energy\ Output = 1060 \times 11 \times 365 = 4,255,900\ kWh/year$$

   This means the MHP system generates **4,255,900 kilowatt-hours** of clean electricity every year. Next, we will determine the GHG emissions that would have resulted from utilising fossil fuels to generate the same amount of energy:

   So, if diesel were used instead of hydro, the emissions would be,

   $$GHG\ Emissions\ Reduced = 4,255,900 \times 1.4 = 5,958,260\ kg\ CO_2/year$$

   Therefore, the MHP project reduces approximately **5.96 million kg of CO_2 emissions annually**, highlighting its strong environmental impact.

7. How much can the MHP earn per annum?

   We'll utilise the value of Certified Emission Reductions (CERs) (calculated in Q6) to calculate the possible annual revenue from carbon credits. The MHP lowers greenhouse gas emissions, which can be sold as credits, by avoiding the use of fossil fuels.

   Data we have:

   - Annual GHG emissions reduced = **5,958,260 kg of CO_2**
   - Price per **1000 kg of CO_2 (1 ton)** = **USD $23**

   We'll first convert the total annual CO_2 reduction from kg to tons

   $$CO_2 \in tons = \frac{5,958,260}{1000} = 5,958.26\ tons$$

   Now we multiply the total tons by the CER price

   $$Annual\ Revenue = 5,958.26 \times 23 = US\ \$137,039.98$$

The MHP can earn approximately **US $137,039.98** per year through CERs.

Here is the link of Google Sheet with all calculations: Assignment 4