# CBA – case study

## VULNERABILITY ANALYSIS AND RISK MANAGEMENT FOR WATER RELATED HAZARDS

Professor: **Canesi R.**

Teaching assistant: **Corti F. (franco.corti@unipd.it)**

**(MSc - Water and Geological Risk Engineering) - a.y. 2024 / 2025**

# Examples of guidelines

- EC - Guide to Cost-Benefit Analysis of Investment Projects for Cohesion Policy 2014-2020
- European Investment Bank
- Asian Development Bank
- Treasury Board of Canada
- Queensland Government – Department of Transport and Main Roads

# Cost-Benefit Analysis: Water and Wastewater Infrastructure Case Study

## Integrated Financial, Economic, and Risk Analysis

# Project description

Two key components:

1. **New Wastewater Treatment Facility**: The construction of a new plant to meet Directive 91/271/EEC requirements in a medium-sized city (population 375,000). This includes investments in infrastructure to reduce infiltration, increase collection rates, and ensure wastewater is transported to the treatment plant.
2. **Water Supply Network Extension**: Expanding the network to increase the number of people connected to the public water supply system.

**Current Situation**:

- No wastewater treatment facility exists, despite 95% of wastewater being collected. Untreated wastewater is discharged into a river categorized as "moderate" in the river basin management plan.
- The existing network is separate for rainwater and wastewater, deemed fit for use but requiring targeted rehabilitation in areas of high leakage.

**Compliance Context**:
The city is in a new EU Member State with a compliance deadline under Directive 91/271/EEC for agglomerations over 100,000 by 2020.

**Operation & Ownership**:
The current water service operator, 100% municipality-owned, will own and manage the new infrastructure for operation and maintenance.

# Project objectives

**1.Improving Wastewater Management**:

- Increasing sewage collection and treatment to ensure compliance.
- Extending the sewage network to connect an additional 15,000 people.
- Ensuring 100% transfer of untreated wastewater to a compliant treatment plant, raising the coverage rate to 99%.

**2.Enhancing Public Water Supply**:

- Connecting 7,500 additional people to the public water supply network, improving overall water supply coverage to 99.5%
- .

**3.Environmental Improvements**:

- Sludge will be dried, composted, and used in agriculture.
- The chemical quality of the river will be improved from “moderate” to “good” in alignment with the Water Framework Directive.

**4.Alignment with National Goals**:

- The project supports the goals of “Water and Sewerage Management” under the operational program “Environment & Infrastructure.”
- It contributes to the following national targets:

# Demand Analysis - description

**Forecast Demand**

- **Population**: Starts at 375,000 and gradually *decreases* to 348,700 over 30 years, reflecting demographic trends.

**Water Demand**

- **Per Capita Consumption**: Starts at 1,200 liters per capita per day (l/c/d) and stabilizes at 1,150 l/c/d from year 5 onward, increasing to 1,240 l/c/d by year 30.
- **Population Connected**: Initially 99% of the population is connected and remains constant over the period.
- **Total Water Demand**: Ranges between 229.9 million $m^3$/year at the start and increases slightly to 233.0 million $m^3$/year by year 30.

**Wastewater Demand**

- **Population Connected**: Starts at 95% and stabilizes at 99% after year 4.
- **Total Wastewater Generation**: Fluctuates between 225.5 million $m^3$/year and 234.0 million $m^3$/year by year 30.

**Incremental Demand (due to network extension)**

Water and wastewater increments are relatively small (rising to a maximum of 0.6 million $m^3$/year for both).

# Demand Analysis - table

**Table 1:** Demand Analysis

| DEMAND | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Construction | | | Operation | | | | | | | | | | | | |
| **Calculation of Forecast Demand** | | | | | | | | | | | | | | | | | |
| Population | 000s | 375.0 | 374.1 | 373.1 | 372.2 | 371.3 | 370.3 | 369.4 | 368.5 | 367.6 | 366.6 | 365.7 | 364.8 | 363.9 | 357.6 | 353.1 | 348.7 |
| **Water** | | | | | | | | | | | | | | | | | |
| Per Capita Consumption | l/c/d | 120.0 | 120.0 | 120.0 | 115.0 | 115.0 | 115.0 | 115.0 | 115.0 | 115.0 | 115.0 | 115.0 | 115.0 | 115.0 | 115.0 | 119.0 | 124.0 |
| Population Connected | % | 97.5% | 98.0% | 98.5% | 99.5% | 99.5% | 99.5% | 99.5% | 99.5% | 99.5% | 99.5% | 99.5% | 99.5% | 99.5% | 99.5% | 99.5% | 99.5% |
| Domestic Consumption | m m³ | 16.0 | 16.1 | 16.1 | 15.5 | 15.5 | 15.5 | 15.4 | 15.4 | 15.4 | 15.3 | 15.3 | 15.2 | 15.2 | 14.9 | 15.3 | 15.7 |
| Commercial & Institutional | m m³ | 4.6 | 4.6 | 4.6 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.3 | 4.3 | 4.4 | 4.5 |
| Industrial | m m³ | 2.3 | 2.3 | 2.4 | 2.5 | 2.5 | 2.6 | 2.7 | 2.7 | 2.8 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 |
| **Total Water** | **m m³** | **22.9** | **23.0** | **23.1** | **22.4** | **22.5** | **22.5** | **22.5** | **22.5** | **22.5** | **22.5** | **22.5** | **22.4** | **22.4** | **22.1** | **22.5** | **23.0** |
| **Waste Water** | | | | | | | | | | | | | | | | | |
| Population Connected | % | 95.0% | 96.0% | 97.5% | 99.0% | 99.0% | 99.0% | 99.0% | 99.0% | 99.0% | 99.0% | 99.0% | 99.0% | 99.0% | 99% | 99% | 99.0% |
| Domestic Consumption | m m³ | 15.6 | 15.7 | 15.9 | 15.5 | 15.4 | 15.4 | 15.4 | 15.3 | 15.3 | 15.2 | 15.2 | 15.2 | 15.1 | 14.9 | 15.2 | 15.6 |
| Commercial & Institutional | m m³ | 4.6 | 4.6 | 4.6 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.3 | 4.3 | 4.4 | 4.5 |
| Industrial | m m³ | 2.3 | 2.3 | 2.4 | 2.5 | 2.5 | 2.6 | 2.7 | 2.7 | 2.8 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 |
| **Total Waste Water** | **m m³** | **22.5** | **22.7** | **22.9** | **22.4** | **22.4** | **22.4** | **22.4** | **22.4** | **22.4** | **22.5** | **22.4** | **22.4** | **22.3** | **22.0** | **22.4** | **23.0** |
| Incremental Demand due to extension of network (included in the above) | | | | | | | | | | | | | | | | | |
| Water | m m³ | 0.0 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Waste Water | m m³ | 0.0 | 0.2 | 0.4 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |

# Option Analysis

Table 2: Option Analysis: WWTP Strategy

| Alternative | NPV WWTP Investment Cost | NPV Network Investment Cost | NPV Operating Cost | NPV Total | Ranking |
|---|---|---|---|---|---|
| | EUR | EUR | EUR | EUR | |
| WWTP Strategy 1: Two smaller plants and networks serving different sides of the river | 45,000,000 | 8,000,000 | 37,000,000 | 90,000,000 | 2° |
| **WWTP Strategy 2: Single plant and network covering whole city with tunnel under the river to link the two networks** | **38,000,000** | **10,000,000** | **32,000,000** | **80,000,000** | **1°** |

Table 3: Option Analysis: WWTP Location

| Alternative | NPV WWTP Investment Cost | NPV Network Investment Cost | NPV Operating Cost | NPV Total | Ranking |
|---|---|---|---|---|---|
| | EUR | EUR | EUR | EUR | |
| WWTP Location 1: Lower elevation, but requiring high cost of main collector | 38,000,000 | 12,000,000 | 31,000,000 | 81,000,000 | 2° |
| **WWTP Location 2: Higher elevation, requiring some additional pumping cost.** | **38,000,000** | **10,000,000** | **32,000,000** | **80,000,000** | **1°** |

Table 4: Option Analysis: Sludge Management

| Alternative | NPV Investment Cost | NPV Operating Cost | NPV Total | Ranking |
|---|---|---|---|---|
| | EUR | EUR | EUR | |
| **Option 1: Re-use in agriculture and/ or energy crops (after dewatering)** | **0** | **13,000,000** | **13,000,000** | **1°** |
| Option 2:Drying and use as a fuel in cement or power plant | 5,000,000 | 21,100,000 | 26,100,000 | 2° |
| Option 3: Drying and incineration of sludge and deposit of ash at landfill | 22,000,000 | 33,500,000 | 55,500,000 | 3° |

# Project Costs breakdown

| Project Investment Cost (m EUR) | Total cost | Ineligible cost[196] | Eligible cost |
|---|---|---|---|
| Planning/design fees | 4.0 | - | 4.0 |
| Building and network assets (pipes) | 44.0 | - | 44.0 |
| Equipment and machinery | 10.0 | - | 10.0 |
| Technical assistance | 2.5 | - | 2.5 |
| Publicity | 1.0 | - | 1.0 |
| Supervision during implementation | 3.0 | - | 3.0 |
| Contingencies | 5.5 | - | 5.5 |
| **Sub-TOTAL** | **70.0** | **-** | **70.0** |
| VAT | 14.0 | 14.0 | - |
| **TOTAL** | **84.0** | **14.0** | **70.0** |

"All costs are eligible for EC grant funding apart from VAT (which is recoverable by the beneficiary)."

# Affordability and Tariff Analysis

**Household Income Impact**:

- Monthly per capita income starts at €194mln and grows to €212mln by year 30 (real terms).
- The project maintains affordability, with the tariff impact ranging between **2.71%–3.10%** of household income.

**Revenue and Tariff Details**:

- Incremental project revenues are sufficient to cover
  - **100% of incremental operating costs**.
  - **100% of incremental depreciation costs**.

**Tariff Structure**:

- Aims to balance financial cost recovery (FCR) with affordability constraints.
- Revenue grows from €32.7 mln (construction phase) to €38.5 mln by year 30.

Table 6: Affordability and Tariff

| Affordability and Tariff | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Construction | | | Operation | | | | | | | | | | | | |
| **Calculation of Affordability Constrained Tariff** | | | | | | | | | | | | | | | | | |
| Actual Monthly Per Capita Household Income | mEUR | 194 | 195 | 195 | 196 | 196 | 197 | 197 | 198 | 199 | 199 | 200 | 200 | 201 | 205 | 209 | 212 |
| Forecast Growth in Household Income (Real Terms) | Euro/m³ | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% |
| Without Project Revenue | mEUR | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.6 | 32.5 | 32.4 | 32.4 |
| Without Project Tariff | Euro/m³ | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 1.45 | 1.46 | 1.46 | 1.47 |
| % of Household Income | % | 2.71% | 2.70% | 2.69% | 2.69% | 2.68% | 2.67% | 2.66% | 2.65% | 2.65% | 2.64% | 2.63% | 2.62% | 2.62% | 2.56% | 2.53% | 2.49% |
| Project Incremental Operating Costs | mEUR | | | | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.6 |
| Project Incremental Depreciation | mEUR | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 |
| Project Incremental Profit Margin | mEUR | | | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| With Project Revenue (for FCR) | mEUR | 32.7 | 32.7 | 32.7 | 38.5 | 38.6 | 38.6 | 38.6 | 38.6 | 38.6 | 38.6 | 38.6 | 38.5 | 38.5 | 38.3 | 38.3 | 38.3 |
| With Project Tariff (for FCR) | Euro/m³ | | | | 1.71 | 1.71 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.71 | 1.71 | 1.73 | 1.73 | 1.73 |
| % of Household Income | % | | | | 3.17% | 3.16% | 3.16% | 3.15% | 3.14% | 3.13% | 3.12% | 3.11% | 3.10% | 3.09% | 3.02% | 2.98% | 2.93% |
| % of Incremental Opex Covered by Incremental Tariff | % | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| % of Incremental Depn Covered by Incremental Tariff | % | | | | 13% | 17% | 22% | 27% | 32% | 37% | 42% | 47% | 52% | 57% | 94% | 100% | 100% |
| Actual With Project Revenue | mEUR | 32.7 | 32.7 | 32.7 | 36.5 | 36.6 | 36.7 | 36.8 | 36.9 | 37.0 | 37.2 | 37.2 | 37.3 | 37.4 | 38.0 | 38.3 | 38.3 |
| Actual With Project Tariff | Euro/m³ | 1.44 | 1.44 | 1.44 | 1.61 | 1.62 | 1.62 | 1.62 | 1.63 | 1.63 | 1.64 | 1.64 | 1.65 | 1.66 | 1.71 | 1.73 | 1.73 |
| % of Household Income | % | 2.71% | 2.70% | 2.69% | 3.00% | 3.00% | 3.00% | 3.00% | 3.00% | 3.00% | 3.00% | 3.00% | 3.00% | 3.00% | 3.00% | 2.98% | 2.93% |

**Affordability Constraint**: The project is designed to maintain household affordability (without exceeding the affordability threshold around 3% of household income) while ensuring cost recovery, aligning with EU policy objectives.

# Financial and Economic Analysis

**Key Assumptions**

1. **Discount Rates**:
   - **Financial Analysis**: 4%.
   - **Economic Analysis**: 5%.

2. **Time Horizon**: 30 years.

3. **Residual Value**:
   - €14.8 million for Financial Rate of Return (FRR).
   - €70.5 million for Economic Rate of Return (ERR).

Residual value includes:

- Net present value (NPV) of project cash flows over a 14-year extension beyond the projection period.
- Replacement provisions for equipment.

# Financial and Economic Analysis - 2

**EU Grant Calculation**

- **Total Eligible Costs**: €70 million.
- **EU Grant**: €45.3 million (53.9% of total funding).
- **Public Contribution (Municipality)**: €24.7 million (29.4%).
- **Ineligible Costs (VAT)**: €14 million (16.7%).

Table 7: Calculation of EU Grant

| EU GRANT | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Construction | | | Operation | | | | | | | | | | | | |
| Calculation of the Discounted Investment Cost (DIC) | | NPV 4% | | | | | | | | | | | | | | | | |
| Investment cost (excluding contingencies) | mEUR | -59.6 | -18.5 | -22.5 | -23.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **DIC / Investment cost cash-flow** | **mEUR** | **-59.6** | **-18.5** | **-22.5** | **-23.5** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| Calculation of the Discounted Net Revenues (DNR) | | NPV 4% | | | | | | | | | | | | | | | | |
| Revenue | mEUR | 70.7 | 0.0 | 0.0 | 0.0 | 3.8 | 3.9 | 4.0 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.6 | 4.8 | 5.5 | 5.9 | 5.9 |
| O&M cost - Total | mEUR | -45.6 | 0.0 | 0.0 | 0.0 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.6 |
| O&M cost - WWTP (Variable) | mEUR | -23.2 | 0.0 | 0.0 | 0.0 | -1.6 | -1.6 | -1.6 | -1.6 | -1.6 | -1.6 | -1.6 | -1.6 | -1.6 | -1.6 | -1.6 | -1.6 | -1.6 |
| O&M cost - WWTP (Fixed) | mEUR | -14.5 | 0.0 | 0.0 | 0.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| O&M cost - WW Extension (Variable) | mEUR | -5.8 | 0.0 | 0.0 | 0.0 | -0.4 | -0.4 | -0.4 | -0.4 | -0.4 | -0.4 | -0.4 | -0.4 | -0.4 | -0.4 | -0.4 | -0.4 | -0.4 |
| O&M cost - WW Rehabilitation (Variable) | mEUR | 7.2 | 0.0 | 0.0 | 0.0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| O&M cost - Sludge (Variable) | mEUR | -11.6 | 0.0 | 0.0 | 0.0 | -0.8 | -0.8 | -0.8 | -0.8 | -0.8 | -0.8 | -0.8 | -0.8 | -0.8 | -0.8 | -0.8 | -0.8 | -0.8 |
| O&M cost - Water Extension (Variable) | mEUR | -2.9 | 0.0 | 0.0 | 0.0 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 |
| Replacement Cost | mEUR | -10.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -5.0 | -5.0 | 0.0 | 0.0 | 0.0 |
| Residual value of investments | mEUR | 4.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.8 |
| **DNR / Net revenue cash-flow** | **mEUR** | **14.2** | **0.0** | **0.0** | **0.0** | **0.3** | **0.4** | **0.5** | **0.6** | **0.7** | **0.8** | **0.9** | **1.0** | **-3.9** | **-3.7** | **2.1** | **2.4** | **17.2** |
| ELIGIBLE COST (EC) | mEUR | 70.0 | | | | | | | | | | | | | | | | |
| Pro-rata Application of DNR = (DIC - DNR) / DIC | | 76.2% | | | | | | | | | | | | | | | | |
| CO-FINANCING RATE IN PRIORITY AXIS (CF) | | 85.0% | | | | | | | | | | | | | | | | |
| EU GRANT ( = EC x PRO-RATA x CF) | mEUR | 45.3 | | | | | | | | | | | | | | | | |

| Financing Sources | mEUR | % share |
|---|---|---|
| EU grant | 45.3 | 53.9 % |
| Public contribution (Municipality) | 24.7 | 29.4 % |
| Project beneficiary's contribution (ineligible investment cost - VAT) | 14.0 | 16.7 % |
| **Total funding** | **84.0** | **100.0 %** |

# Financial and Economic Analysis - 3

Table 8: Calculation of FRR(C) and FRR(K)

| FRR(C) | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Construction | | | Operation | | | | | | | | | | | | |
| **Calculation of the Return on Investment** | | **NPV 4%** | | | | | | | | | | | | | | | | |
| Investment cost (excluding contingencies) | mEUR | -59.6 | -18.5 | -22.5 | -23.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Revenue | mEUR | 70.7 | 0.0 | 0.0 | 0.0 | 3.8 | 3.9 | 4.0 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.6 | 4.8 | 5.5 | 5.9 | 5.9 |
| O&M cost | mEUR | -61.0 | 0.0 | 0.0 | 0.0 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -8.5 | -8.5 | -3.5 | -3.5 | -3.6 |
| Residual value of investments | mEUR | 4.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.8 |
| **FNPV(C) - before EU grant / Net cash-flow** | **mEUR** | **-45.4** | **-18.5** | **-22.5** | **-23.5** | **0.3** | **0.4** | **0.5** | **0.6** | **0.7** | **0.8** | **0.9** | **1.0** | **-3.9** | **-3.7** | **2.1** | **2.4** | **17.2** |
| **FRR(C) - before EU grant** | | **-2.2%** | | | | | | | | | | | | | | | | |

| FRR(K) | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Construction | | | Operation | | | | | | | | | | | | |
| **National Financing Sources** | | | | | | | | | | | | | | | | | | |
| Public contribution (Municipality) | mEUR | | 7.0 | 8.7 | 9.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Calculation of the Return on National Capital** | | **NPV 4%** | | | | | | | | | | | | | | | | |
| Public contribution (Municipality) | mEUR | -22.8 | -7.0 | -8.7 | -9.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Interest payments | mEUR | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Principal repayments | mEUR | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O&M cost | mEUR | -61.0 | 0.0 | 0.0 | 0.0 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -8.5 | -8.5 | -3.5 | -3.5 | -3.6 |
| Revenue | mEUR | 70.7 | 0.0 | 0.0 | 0.0 | 3.8 | 3.9 | 4.0 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.6 | 4.8 | 5.5 | 5.9 | 5.9 |
| Residual value of investments | mEUR | 4.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.8 |
| **FNPV(K) - after EU grant / Net cash-flow** | **mEUR** | **-8.6** | **-7.0** | **-8.7** | **-9.0** | **0.3** | **0.4** | **0.5** | **0.6** | **0.7** | **0.8** | **0.9** | **1.0** | **-3.9** | **-3.7** | **2.1** | **2.4** | **17.2** |
| **FRR(K) - after EU grant** | | **1.8%** | | | | | | | | | | | | | | | | |

# Financial and Economic Analysis - 4

**Financial Rate of Return on Investment (FRR(C))**:

- **Without EU Grant**: -2.2% (below the 4% benchmark, showing the need for grant support).
- **After EU Grant**: 1.8% (within acceptable range).

**Return on National Capital (FRR(K))**:
Achieves 1.8%, ensuring fair support without excessive returns.

*"Thus FRR(C) at -2.2 % is well below the discount rate of 4.0 % showing that the project needs grant financing support, whereas FRR(K) at 1.8 % shows that the envisaged level of support remains within a reasonable range and does not provide for an excessive return to national capital."*

# Financial and Economic Analysis - 5

Table 9: Sustainability

| FINANCIAL SUSTAINABILITY | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Construction | | | Operation | | | | | | | | | | | | |
| **Verification of Financial Sustainability for "With-Project Scenario"** | | | | | | | | | | | | | | | | | |
| Without Project Revenue | mEUR | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.6 | 32.5 | 32.4 | 32.4 |
| Incremental Revenue | mEUR | | | | 3.8 | 3.9 | 4.0 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.6 | 5.0 | 5.5 | 5.9 | 5.9 |
| **Total Revenue** | **mEUR** | **32.7** | **32.7** | **32.7** | **36.5** | **36.6** | **36.7** | **36.8** | **36.9** | **37.0** | **37.2** | **37.2** | **37.3** | **37.6** | **38.0** | **38.3** | **38.3** |
| Without Project Operating Costs (including Tax) | mEUR | 22.9 | 22.9 | 22.9 | 22.9 | 22.9 | 22.9 | 22.9 | 22.9 | 22.9 | 22.9 | 22.9 | 22.9 | 22.8 | 22.7 | 22.7 | 22.7 |
| Incremental Operating Cost | mEUR | | | | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.6 |
| Incremental Income Tax | mEUR | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Without Project Maintenance & Replacement Cost | mEUR | 7.0 | 7.0 | 7.0 | 14.0 | 14.0 | 7.0 | 7.0 | 7.0 | 14.0 | 14.0 | 7.0 | 7.0 | 14.0 | 14.0 | 14.0 | 14.0 |
| Incremental Maintenance & Replacement Cost | mEUR | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total Cost** | **mEUR** | **29.9** | **29.9** | **29.9** | **40.4** | **40.4** | **33.4** | **33.5** | **33.5** | **40.5** | **40.5** | **33.5** | **38.4** | **40.4** | **40.3** | **40.3** | **40.3** |
| Cash B/F | mEUR | 0.5 | 3.3 | 6.1 | 9.0 | 5.0 | 1.1 | 4.3 | 7.7 | 11.1 | 7.7 | 4.3 | 8.1 | 3.1 | 11.1 | 11.3 | 22.4 |
| Cash Generated | mEUR | 2.8 | 2.8 | 2.8 | -4.0 | -3.9 | 3.2 | 3.3 | 3.5 | -3.4 | -3.3 | 3.8 | -1.1 | -2.8 | -2.3 | -2.0 | -2.0 |
| Cash C/F | mEUR | 3.3 | 6.1 | 9.0 | 5.0 | 1.1 | 4.3 | 7.7 | 11.1 | 7.7 | 4.3 | 8.1 | 7.0 | 0.2 | 8.8 | 9.3 | 20.4 |

# Monetization of benefits

The project's economic benefits are quantified in terms of societal and environmental improvements, summarized below:

**Environmental Water Quality (Net Present Value - €118.5 million)**:
- Improved river conditions due to reduced untreated discharge.
- Willingness-to-pay estimates used for valuation (€25/person/year), reflecting increased recreational and ecological value.

**Savings for New Sewerage Connections (NPV - €19.0 million)**:
- Cost savings from no longer maintaining on-site tanks, such as septic systems.
- Direct operational and maintenance cost savings benefit connected users (15,000 people).

**Savings for New Water Supply Connections (NPV - €7.6 million)**:
- Households connected to the public water supply save on private pumping costs, benefiting 7,500 new connections.

# Economic indicators

Table 10: Calculation of ERR and economic cost-benefit ratio

| ERR | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Construction | | | Operation | | | | | | | | | | | | |
| **Calculation of the Economic Rate of Return** | | **NPV 5%** | | | | | | | | | | | | | | | | |
| Investment cost (excluding contingencies) | mEUR | -56.1 | -17.8 | -21.6 | -22.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O&M cost (including replacement cost) | mEUR | -50.5 | 0.0 | 0.0 | 0.0 | -3.3 | -3.3 | -3.3 | -3.3 | -3.3 | -3.3 | -3.3 | -3.3 | -8.3 | -8.3 | -3.3 | -3.3 | -3.4 |
| Residual value of investments | mEUR | 16.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 70.5 |
| **Total economic cost** | **mEUR** | **-90.2** | **-17.8** | **-21.6** | **-22.6** | **-3.3** | **-3.3** | **-3.3** | **-3.3** | **-3.3** | **-3.3** | **-3.3** | **-3.3** | **-8.3** | **-8.3** | **-3.3** | **-3.3** | **67.2** |
| Benefit for improved environmental quality (WTP) | mEUR | 118.6 | 0.0 | 0.0 | 0.0 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 |
| Direct savings to users no longer needing closed tanks | mEUR | 19.0 | 0.0 | 0.0 | 0.0 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Direct savings to users no longer needing wells | mEUR | 7.6 | 0.0 | 0.0 | 0.0 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| **Total economic benefits** | **mEUR** | 145,1 | **0.0** | **0.0** | **0.0** | **11.5** | **11.5** | **11.5** | **11.5** | **11.5** | **11.5** | **11.5** | **11.5** | **11.5** | **11.5** | **11.5** | **11.5** | **11.5** |
| **ENPV / Net economic benefits of the project** | **mEUR** | **54.9** | **-17.8** | **-21.6** | **-22.6** | **8.2** | **8.2** | **8.2** | **8.2** | **8.2** | **8.2** | **8.2** | **8.2** | **3.2** | **3.2** | **8.2** | **8.2** | **78.6** |
| **ERR** | | **11.1%** | | | | | | | | | | | | | | | | |
| **B/C RATIO** | | **1.61** | | | | | | | | | | | | | | | | |

Based on the positive economic indicators resulting from the analysis, the implementation of the project is expected to increase social welfare and it is therefore worth supporting with a grant from the EU. It will also contribute to meeting the agreed national targets in compliance with the Urban Waste Water Treatment Directive (and thus also avoid possible financial penalties).

**Economic Net Present Value (ENPV)**:

- NPV of economic benefits: €145.1 mln.
- ENPV: €54.9 mln

**Economic Rate of Return (ERR)**: is **11.1%**, well above the 5% economic discount rate, demonstrating high social and economic viability.

**Benefit-Cost Ratio (B/C Ratio)**: is 1.61, indicating €1.61 of benefit for every €1 invested.

# Sensitivity analysis

**Increase in Investment Cost**:
ENPV Elasticity: 11%.
Switch Value: 90% increase (threshold before ENPV turns negative).
FNPV Elasticity: 1.4%.
Switch Value: 70% increase.

**Reduction in Economic Benefits**:
ENPV Elasticity: 3.1%.
Switch Value: 32% reduction.

**Reduction in Tariff/Revenue**:
FNPV Elasticity: 14.8%.
Switch Value: -77% reduction.

**Reduction in Water Demand**:
FNPV Elasticity: 2.0%.
Switch Value: -50%.

**Increase in Incremental Operating Costs**:
ENPV Elasticity: 1.0%.
Switch Value: 105% increase.
FNPV Elasticity: 14.9%.
Switch Value: 73% increase.

| Variable | ENPV elasticity | Switching value | FNPV/(C) elasticity | Switch-ing value |
|---|---|---|---|---|
| Increase in investment cost | 1.1 % | 90 % | 1.4 % | 70 % |
| Reduction in valuation of economic benefits | 3.1 % | 32 % | - | - |
| Reduction in tariff (and therefore revenue) | - | - | 14.8 % | -7 % |
| Reduction in volumes of water i.e. demand (both with and without scenario) | - | - | 2.0 % | -50 % |
| increase in incremental operating costs as a result of the project | 1.0 % | 105 % | 1.4 % | -73 % |

# Risk analysis

A risk matrix identifies the probability, severity, and mitigative measures for risks affecting demand, implementation, and operations:

**Demand-Side Risks**:
- **Risk**: Reduced water demand due to population decline or system inefficiencies.
- **Severity**: Low.
- **Mitigation**:
  - Ensuring robust demand modeling.
  - Accelerating connections and addressing service gaps.

**Implementation Risks**:
- **Risk**: Delays in tendering or land acquisition.
- **Severity**: Low to moderate.
- **Mitigation**:
  - Securing land early and utilizing specialized technical assistance.
  - Contingency planning for delayed tendering.

**Operational Risks**:
- **Risk**: Flow of wastewater to WWTP or technology failures.
- **Severity**: Low.
- **Mitigation**:
  - Designing networks to optimize flow.
  - Selecting best-available technology for WWTP operations.

# Risk analysis

Key risks: Demand shortfalls, implementation delays.
Mitigation: Robust demand modeling, early land acquisition.

| Risk description | Proba-bility* (P) | Sever-ity (S) | Risk level* (=P*S) | Risk prevention / mitigation measures | Residual risk after prevention/ mitigation measures |
|---|---|---|---|---|---|
| **Demand side risks** | | | | | |
| Volumes of water consumed and wastewater produced fall below level to extension of tender procedures | B | III | Low ate | Household demand (at 120 l/c/d) is already at the low end of expectations and is expected to decrease a further small amount to 115 l/c/d as a result of price elasticity. There is more uncertainty in the context of industrial demand, but this is only about 10 % of the total. A large part of the specialised technical assistance. Procurement and build schedule appears feasible and has adequate contingency to fit within the eligibility period. Function in charge: Project beneficiary. | Low |
| **Operational risks** | | | | | |
| Flow of wastewa-ter to WWTP (i.e. connection) will not be achieved | B | III | Low | Project has been designed to include the necessary collectors to link outflows to the WWTP – under a single financing plan. Function in charge: Project beneficiary. | Low |
| Failure of WWTP technology to achieve project objectives | A | IV | Low | Selection of proven, best-available technologies Function in charge: Project beneficiary. | Low |
| Failure of customers to connect to the network | B | III | Low | Legislation in force requires users to connect within 12 months or in any case pay for wastewater discharge. Additionally, the utility will streamline the approval process for making connections. Function in charge: Project beneficiary. | Low |

** Evaluation scale:* *Probability: A. Very Unlikely; B. Unlikely; C. About as likely as not; D. Likely; E. Very Likely.*
*Severity:* *I. No effect; II. Minor; III. Moderate; IV. Critical; V. Catastrophic.*
*Risk level:* *Low; Moderate; High; Very High*

# Risk analysis - 2

| | | | | | |
|---|---|---|---|---|---|
| **Implementation risks** | | | | | |
| Problems with land purchase | B | II | Low | Land for both new WWTP and new pipeline extensions is either publically owned or (in a few cases) relevant permissions have been obtained.<br>Function in charge: Project beneficiary. | Low |
| Delays related to extension of tender procedures | C | III | Moder-ate | Promoter's procurement division to be supported by specialised technical assistance. Procurement and build schedule appears feasible and has adequate contingency to fit within the eligibility period.<br>Function in charge: Project beneficiary. | Low |
| **Operational risks** | | | | | |
| Flow of wastewa-ter to WWTP (i.e. connection) will not be achieved | B | III | Low | Project has been designed to include the necessary collectors to link outflows to the WWTP – under a single financing plan.<br>Function in charge: Project beneficiary. | Low |
| Failure of WWTP technology to achieve project objectives | A | IV | Low | Selection of proven, best-available technologies<br>Function in charge: Project beneficiary. | Low |
| Failure of customers to connect to the network | B | III | Low | Legislation in force requires users to connect within 12 months or in any case pay for wastewater discharge. Additionally, the utility will streamline the approval process for making connections.<br>Function in charge: Project beneficiary. | Low |

** Evaluation scale:* *Probability: A. Very Unlikely; B. Unlikely; C. About as likely as not; D. Likely; E. Very Likely.*
*Severity:* *I. No effect; II. Minor; III. Moderate; IV. Critical; V. Catastrophic*
*Risk level:* *Low; Moderate; High; Very High*

- Risk Analysis: High resilience to changes in costs and revenues.

# Conclusion

- Financially viable with EU grant support.
- Economically efficient with significant social and environmental benefits.
- Long-term sustainability ensured through robust planning.