**Sample Manual calculation example**

You have been hired by an independent power producer to prepare a pre-feasibility study of a small hydro project in China. The independent power producer is considering the development of a project where the electricity generated would be sold into the central electricity grid under the terms of a 15-year Electricity Purchase Agreement.

The site is located in the Rucehn country in the Hunan Province of China. The site is easily accessible by road and a reconnaissance survey of the site has already been completed. Based on the results of the reconnaissance study it was determined that a small concrete dam approximately 10 m high and 70 m long could be constructed and would provide approximately 125000 m3 of daily pondage and maintain an average water level elevation of 800 m. A suitable powerhouse location was identified near an existing hot spring resort where the river elevation is 280 m under normal flow conditions.

 An environmental assessment has determined that a minimum flow requirement of 0,035 m3/s is to be maintained annually. Based on the available topographic mapping, development of the site will involve several sections of canal and tunnel (operating as an underground canal) totalling approximately 4.1 km. Preliminary estimates indicate that an above-ground canal can be constructed for about 2.4 km through rocky terrain. The remaining 1.7 km will have to be tunnelled due to extremely steep mountain slopes. A 2.2 km welded steel penstock with a diameter of 1,25 m will be required between the end of the tunnel/canal conveyance structures and the powerhouse. The independent power producer has indicated a preference for a single turbine.

The independent power producer has provided you with the following flow-duration curve data of the site, obtained from the reconnaissance survey:

|  |  |
| --- | --- |
| Time (%) | Q (m3/s) |
| 0 | 5,49 |
| 5 | 3,99 |
| 10 | 3,24 |
| 15 | 2,79 |
| 20 | 2,55 |
| 25 | 2,39 |
| 30 | 2,24 |
| 35 | 2,09 |
| 40 | 1,89 |
| 45 | 1,69 |
| 50 | 1,54 |
| 55 | 1,47 |
| 60 | 1,39 |
| 65 | 1,26 |
| 70 | 1,14 |
| 75 | 0,89 |
| 80 | 0,69 |
| 85 | 0,59 |
| 90 | 0,51 |
| 95 | 0,41 |
| 100 | 0,34 |

The utility is currently offering an electricity purchase price of US$0.055/kWh.

**Assumptions:**

- The design flow corresponds to the flow at 40% of the time  
- hydraulic losses correspond to the friction losses in the penstock  
- generator efficiency is 90%   
- transmission and parasitic losses are 1% each  
- the firm flow is selected at 95% of the time  
- fuel conversion efficiency of the diesel engine is 30%  
- the diesel engine has a CO2 emission factor of 77,4 kg/GJ of fuel  
- downtime losses are 4%