Run-of-River Hydro Energy from a Flow Duration Curve

Annual energy and capacity factor of a run-of-river hydro scheme from a flow duration curve, the design flow, the turbine's minimum flow, head and efficiency.

Method: Flow-duration method for run-of-river hydro

Input parameters

Unit system: SI

Parameter	Value	Unit
Flow exceeded 5 % of the time	43,200	m³/h
Flow exceeded 20 % of the time	21,600	m³/h
Flow exceeded 50 % of the time	10,800	m³/h
Flow exceeded 80 % of the time	5,400.0	m³/h
Flow exceeded 95 % of the time	2,880.0	m³/h
Design (turbine) flow	14,400	m³/h
Minimum turbine flow (fraction of design)	25.000	%
Residual (compensation) flow left in the river	1,080.0	m³/h
Net head	40.000	m
Turbine and generator efficiency	85.000	%

Calculated results

Parameter	Value	Unit
Rated power at design flow	1,333.7	kW
Annual energy	7,441.2	MWh
Capacity factor	63.691	%
Mean flow used	9,171.5	m³/h
Time at or above design flow	37.000	%

Notes for this case

• Flow duration curve linear between the given exceedance points (flat beyond 5 % and 95 %); usable flow = min(Q − Q_res, Q_d), zero below the turbine minimum. Efficiency is taken constant; real part-load efficiency curves lower output at low flows. Water density 1,000 kg/m³.

Formula and method

$$E = \eta \rho g H_n \cdot 8760\,h \cdot \frac{1}{100} \int_0^{100} \min\left[\max(Q(p) - Q_{res}, 0), Q_d\right] dp$$

Variables

Q_5	Flow exceeded 5 % of the time	m³/s
Q_{20}	Flow exceeded 20 % of the time	m³/s
Q_{50}	Flow exceeded 50 % of the time	m³/s
Q_{80}	Flow exceeded 80 % of the time	m³/s
Q_{95}	Flow exceeded 95 % of the time	m³/s
Q_d	Design (turbine) flow	m³/s
f_{min}	Minimum turbine flow (fraction of design)	-

Q_{res}	Residual (compensation) flow left in the river	m³/s
H_n	Net head	m
η	Turbine and generator efficiency	-
P_r	Rated power at design flow	W
E	Annual energy	J
CF	Capacity factor	-
$\bar{Q}_{used}$	Mean flow used	m³/s
t_{design}	Time at or above design flow	-

Method and standards

Flow duration energy.

Assumptions and limits

- Constant efficiency; piecewise-linear flow duration curve.

References

Flow-duration method for run-of-river hydro

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/hydro-power/hydro-flow-duration-energy

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Reopens the calculator with the inputs of this report.