# Levelized Cost of Electricity

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The Levelized Cost of Electricity (LCOE) is a standard cost metric for quantifying the economic performance of an electricity-generating technology [1]. The cost of power generation or LCOE depends on the site selection and Device selection as shown in figure 1.

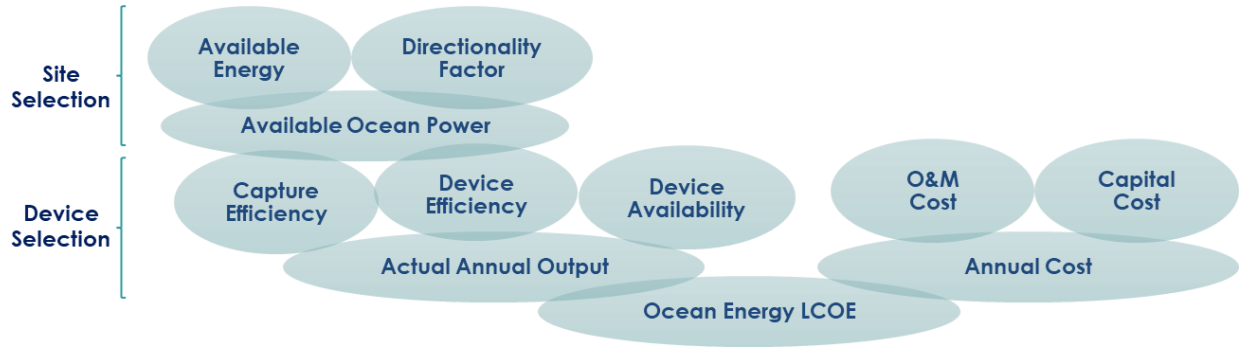


Fig. 1 LOCE calculation factors

Assuming that the capital expenditure occurs in year zero, and plant operation starts in year one, the LCOE is given by,

$$LCOE = \frac{CC + \sum_{t=1}^{n} \frac{OM_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{AEP_t}{(1+i)^t}} \quad \left(\frac{\$}{kWh}\right)$$

Where,

- *CC* – Capital Costs of power plant ($/kW)
- *AEP* – Annual Energy production (kWh)
- *i* – Discounted rate
- *n* – Facility lifetime (years)
- *OM* – Annualized operating cost ($)

## Levelized Cost of Electricity under Uncertainty

From our research we have obtained the approximate values for uncertainties in MRE generation and has been tabulated in table 1.

Table 1: MRE approximate uncertainty values.

| Costs | Uncertainty (Approximately) |
|---|---|
| CapEx | ± 15% |
| OpEx | ± 70% |
| Mid Life refitting | ± 16% |
| Decommissioning | ± 100% |

The LCOE under uncertainty is given by,

$$LCOE^u = \frac{CC^u + \frac{Mid^u}{(1+i)^{n/2}} + \sum_{t=1}^{n} \frac{OM_t^u}{(1+i)^t} + \frac{Dec^u}{(1+i)^{n+1}}}{\sum_{t=1}^{n} \frac{AEP_t}{(1+i)^t}} \quad \left(\frac{\$}{kWh}\right)$$

Where,

- $CC^u$ – Capital Costs of power plant under uncertainty
- $Mid^u$ – Midlife refitting cost under uncertainty
- $OM^u$ – Annualized operating cost under uncertainty
- $Dec^u$ – Decommissioning cost under uncertainty

**Reasons for high LCOE**

1. Project Risk:
   - Cost overruns and unpredicted events
   - Harsh marine environment
   - Equipment Damages
2. Technical Risk:
   - Reliability
   - Efficiency and utilization
   - New unproven technology or lack of experience
3. Other Risks
   - Political support
   - Lack of subsidy
4. High grid connection and transmission charges (remote locations).

**How to reduce the LCOE?**

1. Increase the volume or Scale.
   - Upscale the number of devices.
   - Increase the number of devices in an area.
   - Standardization of device production.
2. Identify optimal production methods.
   - Perfect Location identification
   - Collaborations with similar technology companies
   - Add Contractors
   - Add engineering support (Knowledge sharing)
   - Implementation of Total preventive maintenance to reduce O&Ms.
3. Innovation and effective product development
   - Material selection
   - Perfect foundation or mooring plans.
   - Developing low risky devices
   - Elimination of excess mechanical devices such as gear box
   - Developing tunable/adaptive devices
   - Development of subsea high voltage cables (both AC and DC)
   - Easy installation devices
   - Low operation and maintenance cost devices

**References:**


1. Chozas, J. (2015). International levelized cost of energy for ocean energy technologies. Ocean Energy Syst.