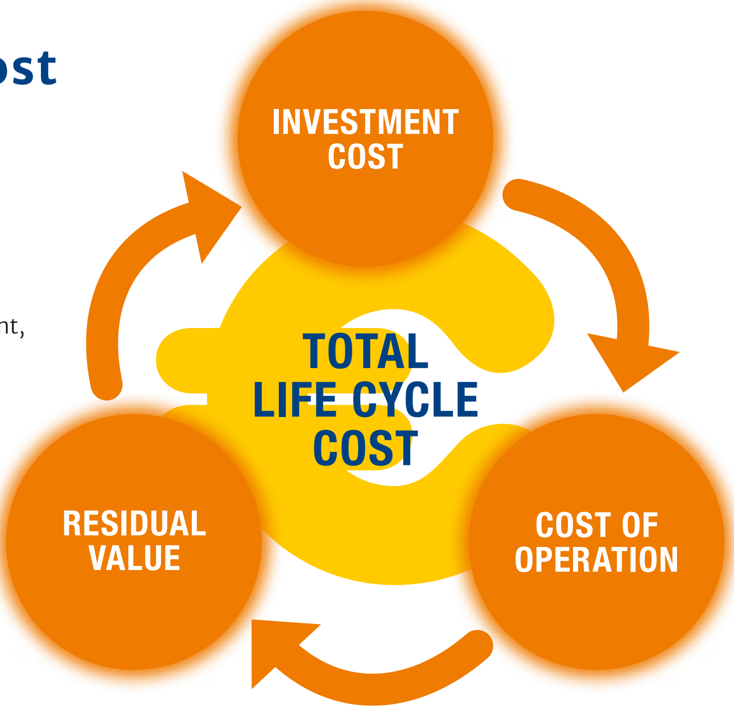
Applying a life-cycle approach to smart urban lighting investment decisions

Life cycle cost (LCC) analysis tries to define the long-term economic costs of an investment. The use of LCC analysis for an urban smart lighting case is challenging, given the high level of uncertainty.[1]

Data input needed to calculate the life-cycle cost of smart urban lighting projects

The life cycle cost is the present value of a system's required investments in all its phases.

1. **Investment cost.** Procurement, design, project management, purchase of products etc.
2. **Operation costs.** Energy, maintenance, insurance, administration
3. **Residual value.** In case it can be sold after its demise, but it might be negative value: e.g. removal and recycling costs.



Expected characteristics and risks in smart urban lighting projects

1. **Procurement costs** might rise with level of innovation because of lack of in-house know-how.
2. **Maintenance costs** expected to be lower, good risk management of expected energy price increase.
3. **High expected real estate value** of distributed urban infrastructure for Internet of Things devices, uncertainty concerning the LED unit and the recycling options.

Life cycle cost include investments, but it is a wider assessment than only procurement costs. In smart urban lighting LCC, the technology lifespan is a key driver of overall costs. Demand product warranty or risk-sharing contracts to manage the long-term uncertainty.

See next page for more information

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LIFE CYCLE COST ASSESSMENT OF SMART URBAN LIGHTING INVESTMENT DECISIONS

Achieving an overall life cycle assessment

To achieve an overall life cycle assessment, indirect economic impacts as well as the environment must be considered. An economic externality is the negative or positive impact (cost or benefit) resulting from a transaction, but not accounted for in its price, affecting third parties. The main direct externality of smart urban lighting project is light pollution, reducing dark night skies[2] and insect populations.[3]

Also, the LCC method should include the luminous properties and the light pollution externality to properly compare different options.[4] Smart lighting offers the potential to solve this issue, but this improvement will not appear in a straightforward matter without a clear strategy:

Include light pollution in your life cycle cost assessment and familiarise your organisation with this theme.

Photo: Shutterstock

Example of light pollution.

Photo: Topi Haapanen

Example of adequate lighting. Porvoo, Finland.

The rebound paradox

The rebound paradox is the well-documented phenomenon that energy-efficiency measures can result in smaller savings than expected, given an induced additional demand from the users. The size of this effect is difficult to measure, and existing research does not support the backfire hypothesis (more efficient technology leading to greater overall energy consumption).[5]

However, you should keep these issues in mind when designing your smart urban lighting project and try to minimise rebound risks.

Decision support under deep uncertainty

The combination of novel technology, evolving sustainability requirements, and climate change impact on our cities, produces a context of deep uncertainty over the decisions related to smart urban lighting investments. Deep uncertainty means that experts or decision makers cannot agree on the probabilities of important factors affecting the decision or its consequences.

In such cases, framing the decision correctly ("decision structuring") is more important than looking at any particular project assessment (such as LCA). "Deep uncertainty decision support" is a branch of applied research that municipalities can use to improve their operations.[6]

References:

1 The uncertainty comes mostly from lack of data quality and the most common method to address it is sensitivity analisys. See for example: Patrick Ilg et al. Uncertainty in life cycle costing for long-range infrastructure. Part I: leveling the playing field to address uncertainties. The International Journal of Life Cycle Assessment. February 2017, Volume 22.

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3 Avalon C.S.Owens et al. Light pollution is a driver of insect declines. Biological Conservation. Available online 16 November 2019. The Guardian news quoting this paper: https://www.theguardian.com/environment/2019/nov/22/light-pollution-insect-apocalypse.

4 Leena Tähkämö et al. Life cycle cost analysis of three renewed street lighting installations in Finland. International Journal of Life Cycle Assess (2012) 17:154–164.

5 Gillingham, Kenneth, David Rapson, Gernot Wagner. The Rebound Effect and Energy Efficiency Policy. Review of Environmental Economics and Policy, Volume 10, Issue 1, 2016.

6 Helgerson, Casey. Structuring decisions under deep uncertainty. Topoi, 14 August 2018.

See also: www.darksky.org

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