

Business cases for isolated and grid connected microgrids: Methodology and applications



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HIGHLIGHTS

- A methodology for formulating and quantifying a microgrid business case is proposed.
- Dependency of the microgrid business case on DER technology mix is investigated.
- The effect of DERs penetration level on microgrid business cases is analyzed.
- Applications to practical microgrids (remote and grid connected) are discussed.
- Results show over 30% savings to stakeholders and a profitability index above 15.

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ABSTRACT

Microgrids are receiving increasing attention from power systems planners as a means to integrate distributed energy resources (DER) including renewable energy resources into the grid, and as a means of balancing the variability of renewable resources and loads with flexible generation. A key to justifying microgrids is establishing their business case. This helps to set the structure and configuration of the microgrid, including defining the DER required to feed part or all of the loads and the level of control required from the microgrid controller. This paper proposes a systematic approach and methodology for formulating and quantifying a microgrid business case. The framework adapts the use case approach to the microgrid context. It defines stakeholders, benefits and beneficiaries and determines the dependency of the business case on microgrid technologies. A method to quantify and allocate benefits is proposed. Applications to practical microgrids are discussed, including remote communities, remote mining sites and grid connected critical distribution grids.

1. Introduction

The benefits of setting up microgrids include increased resiliency to exceptional weather, a potential reduction in the cost of energy, the mitigation of greenhouse gas emissions where thermal power plants are used, and the diversification of the energy supply. Microgrids can be configured for a number of applications including the following: (a) remote electric systems, namely remote communities, remote mining sites and other remote installations, such as military compounds in the northern territories of Canada; (b) grid-connected configurations, namely critical infrastructure, communities, campuses, and commercial and industrial installations. To facilitate the successful implementation and deployment of microgrids, convincing business cases must be produced. Business cases capture the reasoning for initiating a specific project, activity and task or investing in a new technology. They can

range from a highly comprehensive and well structured document to an informal briefing and may aim to seek funding or approval, or may seek to influence a policy making process. The business case document should provide the strategic context for an investment decision, a detailed description of the proposed option and its analysis and recommended decision [1]. The traditional approach to most engineering investment analysis or business cases is to estimate the total revenue or benefit realized through the investment and compare it with the total cost incurred to determine the profitability of the investment. However, for microgrid investments, not all cost and benefits may be captured by the investing entity. These benefits may affect various stakeholders within the power system such as the utility, microgrid customers, independent power producers (IPP), policy makers and society, which may not necessarily be the investing actors. These stakeholders are significant components of the business case whose interests have to be

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Nomenclature**Indices**

g	index for power supply from the grid
i	index for all energy resources
k	index for contingency
t	index for time
y	index for years of project lifetime
A	set of existing resources i in the network
B	set of indices for all new DERs
D	set of dispatchable generating units
E	set of indices for electrical output of resource i
H	set of indices for thermal output of resource i
Q	set of indices of non-CHP gas fired thermal units
T	set of indices of time t within a year
Y	set of indices of years y in the project lifetime J

Parameters

a_i	power capacity of existing asset i
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$d^e(t)$	electric load at time t
$d^h(t)$	thermal load at time t
C_i^b	budget constraint for resource i
C_i^c	capital expenditure of resource i
C_i^f	fuel cost for resource i
C_i^z	emissions cost for resource i
C_i^m	maintenance cost for resource i
C_{base}	energy cost in base case
$C_{\mu G}$	energy cost in microgrid (μG)
X_i^{max}	maximum power capacity of for a new resource i

Operation level variables

$P_i^e(t)$	hourly electrical output of resource i
$P_i^h(t)$	hourly thermal output of resource i

Design level variables

x_i	capacity of DER assets to be installed
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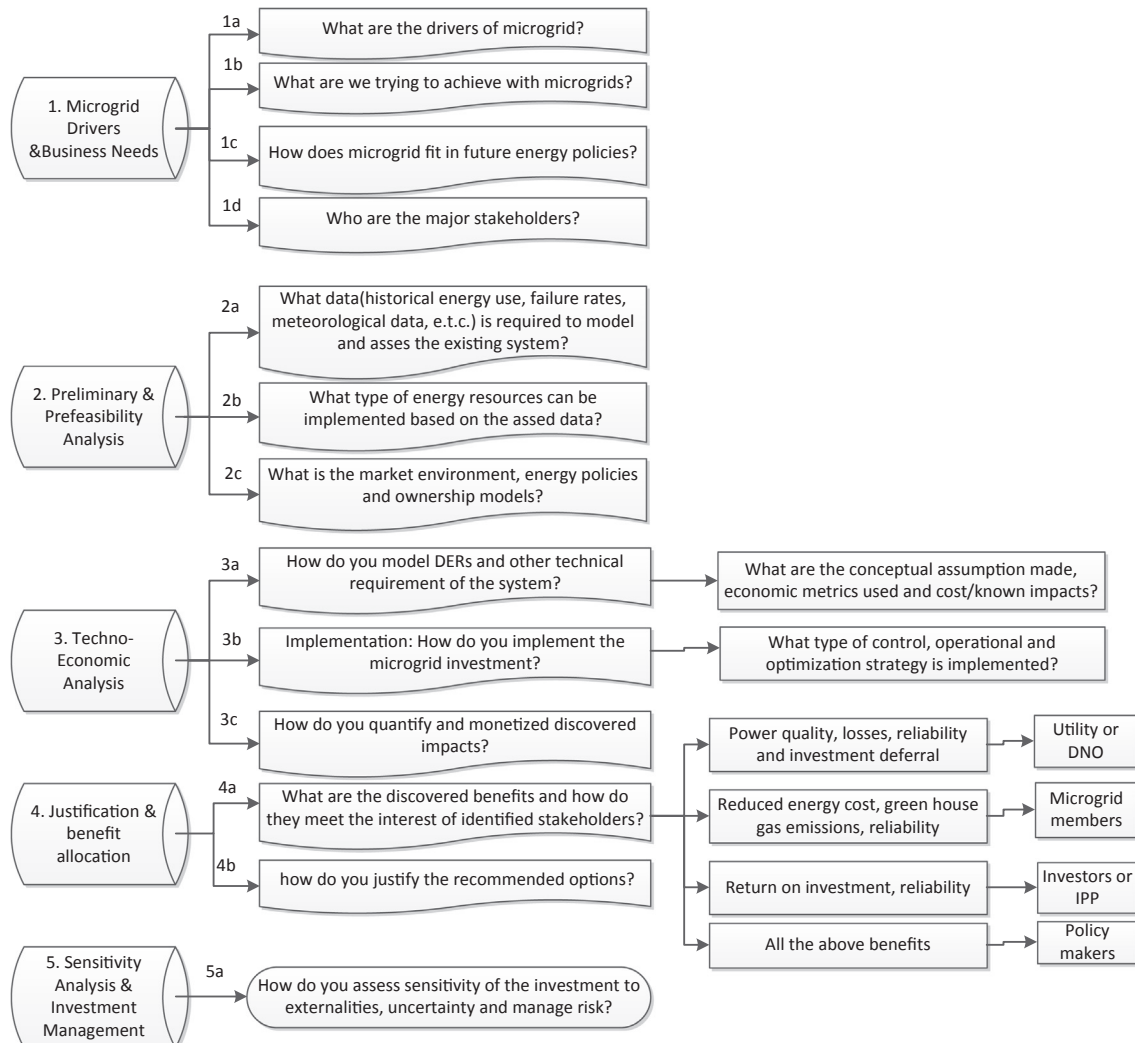


Fig. 1. General overview of microgrid business case.

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