Y9.GEH2.1 Probabilistic Formulation of Cost / Benefit Analysis in the FREEDM System

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Overview

This project is a cost to benefit analysis of the FREEDM distribution system.

Cost analysis of the FREEDM system: versus a conventional system

Benefit analysis: determine the benefits the FREEDM system offers and quantify these benefits

Tradeoff / sensitivity analysis: tradeoff of performance versus cost, and sensitivity of the study is accomplished by an innovative *probabilistic model*.

Progress reported

- Cost to benefit analysis with realistic examples have been studied and reported in the literature
- Improve the probabilistic models
- Document the project further: paper in preparation for the IEEE Transactions on Power Delivery
- Evaluate the impact of declining annual energy demands in the US, and declining generation costs
- Completed analysis of net present value

Potential impact

- Justification of investment in the FREEDM system
- Inclusion of recent trends in electricity pricing in the US
- Commercialization of the FREEDM system
- An innovative technique to be used in distribution planning

Methods

- Develop a mapping between the FREEDM system functions to identify the benefits.
- Quantify the benefits and costs, and model the benefits and costs probabilistically (i.e., with a *probability density function*)
- Alternative methods considered: a *probabilistic calculation of net present value* (NPV), e.g., based on the Kaldor – Hicks criterion that NPV > 0 is the indicator of financial efficiency
- Do a cost-benefit analysis over the lifetime of the system, e.g., a calculation of the payback period probabilistically (e.g., the probability density of a variable that is a function of several probabilistic variates). Methods used: Monte Carlo; system theoretic; Mellin transform

The ratio distribution payback = $Y = C/B$ becomes a simple product under the Mellin transform,

$$M(C) = C(s) = \int_0^{\infty} \lambda^{s-1} C(\lambda) d\lambda$$

$$M(Y) = Y(s) = C(s)B(2-s)$$

Total investment cost

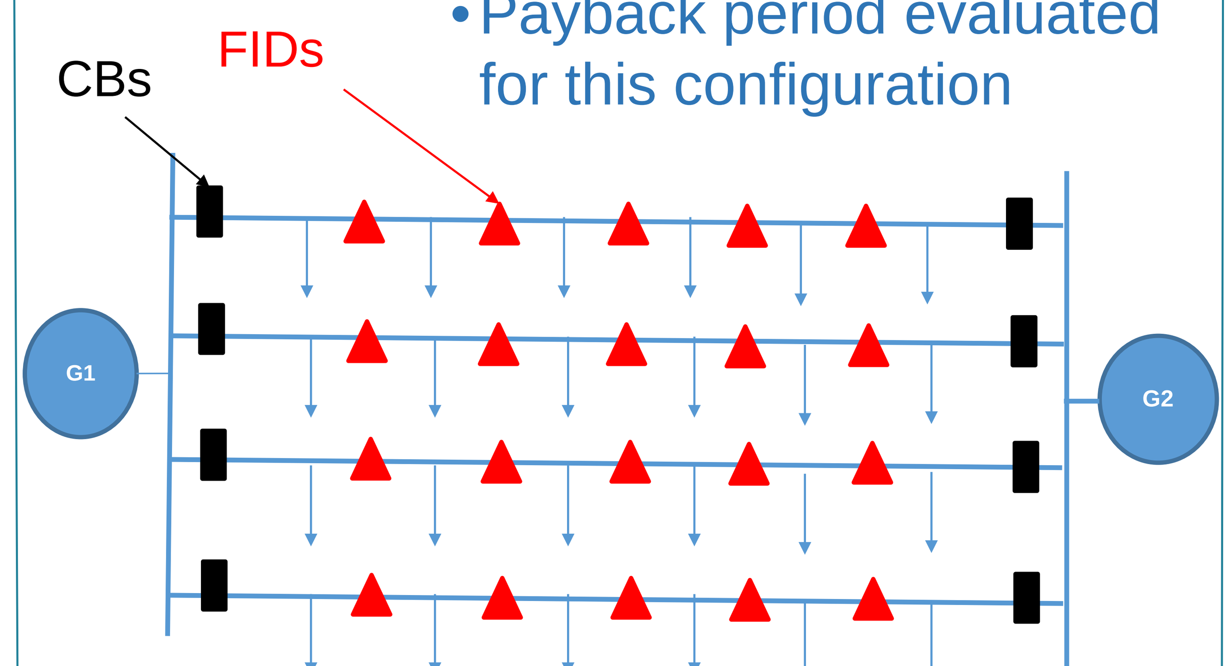
Monetized benefits

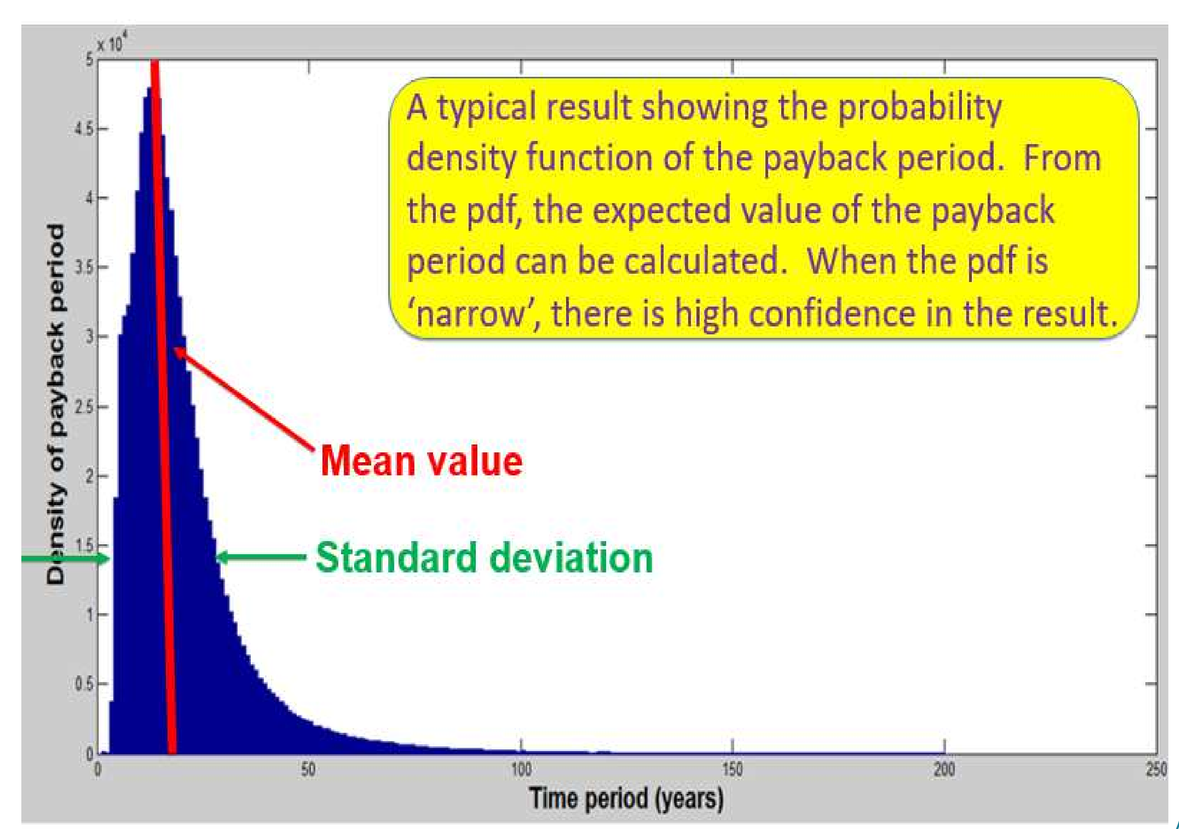
Results

Completed work

- Mapping of functionalities to benefits and costs of the SST, FID, and conductors.
- Evaluation of the value of reliability enhancements.
- Calculation of the statistical results of the cost / benefit analysis
- Publication in the literature, one paper already accepted in IEEE Trans. on Power Delivery

- Probabilistic CBA based on four doubly fed FREEDM feeders
- 1 MVA load per feeder
- Payback period evaluated for this configuration





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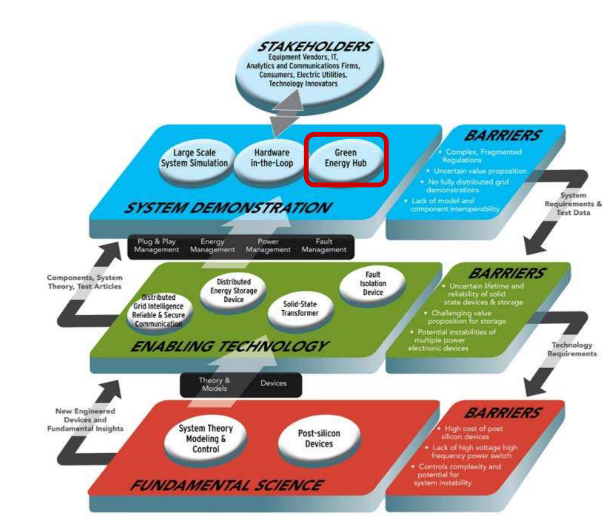

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