Task 16 "Energy Services"
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IEA Workshop: Beyond Energy Savings_03/2018

Incorporating Multiple Project Benefits into Life-Cycle Cost-Benefit Analyses of Deep Energy Retrofits in Office Buildings

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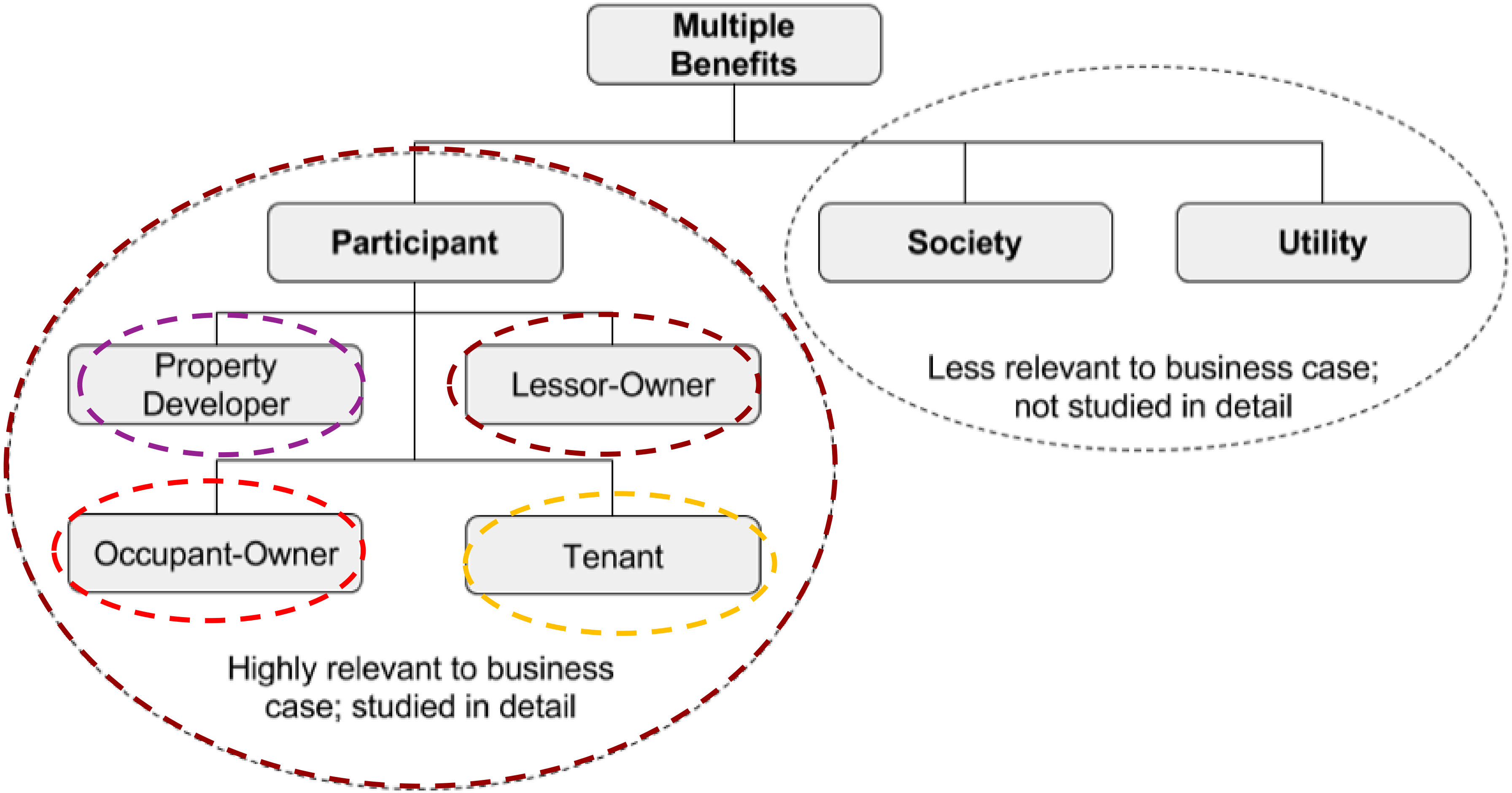
Outline / Methods of approach

1. **Case study**:
   - Office building DER to ‘Passive House’ standard in Germany
2. **Investment analyses** of case study**:**
   - **Dynamic Life Cycle Cost Benefit Analysis** (LCCBA) **model** based on project, equity and debt cash flows
   => **Economic** & **financial KPIs and sensitivity analysis**
3. **Multiple Benefits** (MB):
   - Development of a **MB classification grid**
   => Introduction of **„Multiple Project Benefits“** (MPB)
4. **Literature and good practice research** (focus on project level)
   => Lower + upper **MPB values** for **office buildings**
   => **Comparable MPB metrics**: **EUR/m²/year** and **NPVs**

Classification of multiple benefits according to primary beneficiaries



[Source: Bleyl et al. 2017 based on Lazar & Colburn 2013]

=> „**Multiple Project Benefits** (MPB)“

Multiple Benefits classification grid

Difficulty of quantification: Easy ⟷ Difficult

Relevance to business case: High ⟷ Low

Relevance \ Difficulty	Easy	Difficult
High	Recommended approach: - Quantify, include in economic analyses if possible *Study examples:* - ***Maintenance costs*** - ***Rental premium*** - ***Sales premium***	Recommended approach: - Discuss with project stakeholders *Study examples:* - ***Employee productivity*** - *"Green/Sustainable" image* - *Building aesthetics*
Low	Recommended approach: - Investigate for outside partnerships, quantify if necessary *Study examples:* - ***GHG emissions** (due to low carbon price)* - *Avoided utility infrastructure*	Recommended approach: - Investigate for outside partnerships *Study examples:* - *Job creation* - *GHG emissions (societal value and local air quality)* - *Energy security*

[Source: Bleyl et al. 2017]

Results: Financially valuated DER Multiple Project Benefits (MPB)

Multiple Project Benefits of DER	
1.	**Work productivity increase** (0.57% - 1.14%)
2a.	**Rental income increase** (1% - 5.3%)
2b.	**Building sales price increase** (2.5% - 6.5%)
3.	**CO_2 savings** (6 - 79 EUR/t)
4.	**Maintenance cost savings** (2.1 - 3 EUR/m2/y)
5a.	**Energy cost savings project term** (25 years)
5b.	**Add. energy cost savings over techn. lifetime** (40 y.)

Source: [Bleyl et al. 2017]

Pecuniary values of DER Multiple Benefits.
Metric: EUR/m²: 1. Per year; 2. NPVs of P-CF

	Multiple Project Benefits of DER	Range	Valuation EUR/ $(m^2 * y)$	Valuation NPV: EUR/m²
1.	**Work productivity increase** (0.57% - 1.14%)	Lower	10,4	219
		Upper	20,8	439
2a.	**Rental income increase** (1% - 5.3%)	Lower	1,2	25
		Upper	6,4	134
2b.	**Building sales price increase** (2.5% - 6.5%)	Lower		100
		Upper		260
3.	**CO_2 savings** (6 - 79 EUR/t)	Lower	0,3	6
		Upper	3,8	79
4.	**Maintenance cost savings** (2.1 - 3 EUR/m2/y)	Lower	2,1	44
		Upper	3,0	63
5a.	**Energy cost savings project term** (25 years)	Lower	16,8	354
		Upper	16,8	354
5b.	**Add. energy cost savings over techn. lifetime** (40 y.)	Lower	16,8	157
		Upper	16,8	157

Source: [Bleyl et al. 2017]

Annotations:

Conservative values!

Net present value (NPV of project cash flows (P-CF) over 25 years, 1,5%/year price increase, WACC 3% as discount rate.

To compare: **CAPEX** (for energy retrofit only): **330 EUR/m²**

Pecuniary values of DER Multiple Benefits and accountability to different stakeholders

	Multiple Project Benefits of DER	Range	Valuation: EUR/(m^2 * y)	Valuation: NPV: EUR/m^2	Beneficiaries – Different owner perspectives: Property develop.	Occupant-owner	Lessor-owner	Tenant
1.	**Work productivity increase** (0.57% - 1.14%)	Lower	10,4	219	-	219	-	219
		Upper	20,8	439		439		439
2a.	**Rental income increase** (1% - 5.3%)	Lower	1,2	25	-	-	25	-25
		Upper	6,4	134			134	-134
2b.	**Building sales price increase** (2.5% - 6.5%)	Lower	100		100	[100]	[100]	-
		Upper	260		260	[260]	[260]	
3.	**CO_2 savings** (6 - 79 EUR/t)	Lower	0,3	6	-	6	-	6
		Upper	3,8	79		79		79
4.	**Maintenance cost savings** (2.1 - 3 EUR/m2/y)	Lower	2,1	44	-	44	44	-
		Upper	3,0	63		63	63	
5a.	**Energy cost savings project term** (25 years)	Lower	16,8	354	-	354	-	354
		Upper	16,8	354		354		354
5b.	**Add. energy cost savings over techn. lifetime** (40 y.)	Lower	16,8	157	-	157	-	[157]
		Upper	16,8	157		157		[157]
	Totals	Lower NPV:			100	780	69	554
		Upper NPV:			260	1092	197	738

Source: [Bleyl et al. 2017]

Discussion and conclusions (2/2)

1. **DERs can generate tangible and quantifiable benefits on the project level** (MPB), e.g. DER office building retrofit: Higher rents & real estate values, lower maintenance cost & CO_2 savings and higher work productivity
2. These MPBs can offer **meaningful contributions to make a DER business case more attractive**
3. However **‘split incentive’ requires differentiation between different types of investors and tenants**
4. MPBs can help to identify **strategic allies for DER project development and programs**

Literature reference and webinar

Bleyl, Jan W. et al.

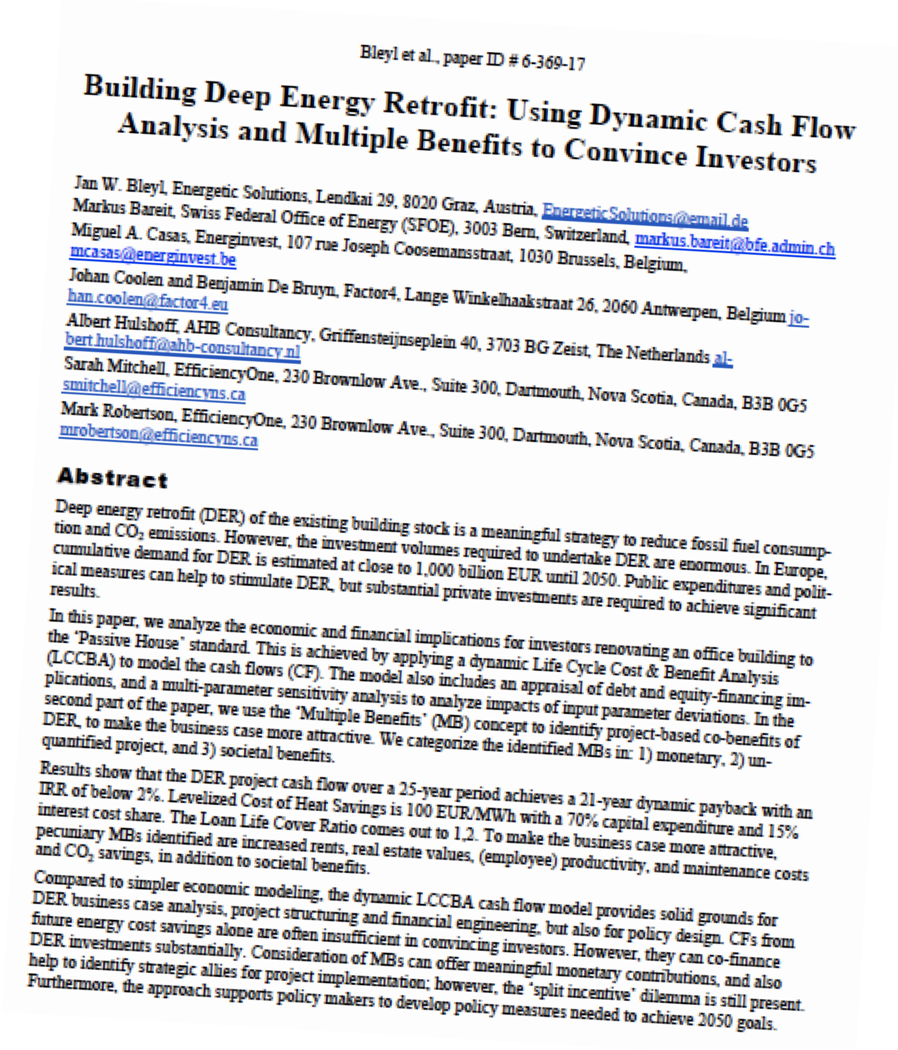
Building Deep Energy Retrofit: Using Dynamic Cash Flow Analysis and Multiple Benefits to Convince Investors

in ECEEE Summer Study, paper ID 6-369, Belambra Presqu'île de Giens, France June 2017

also accepted for publication in Energy Efficiency Special Journal 2018

Leonardo ENERGY Webinar:

https://www.youtube.com/watch?v=j344zdQTL4I&feature=youtu.be



Building Deep Energy Retrofit: Using Dynamic Cash Flow Analysis and Multiple Benefits to Convince Investors

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Abstract

Deep energy retrofit (DER) of the existing building stock is a meaningful strategy to reduce fossil fuel consumption and CO_2 emissions. However, the investment volumes required to undertake DER are enormous. In Europe, cumulative demand for DER is estimated at close to 1,000 billion EUR until 2050. Public expenditures and political measures can help to stimulate DER, but substantial private investments are required to achieve significant results.

In this paper, we analyze the economic and financial implications for investors renovating an office building to the 'Passive House' standard. This is achieved by applying a dynamic Life Cycle Cost & Benefit Analysis (LCCBA) to model the cash flows (CF). The model also includes an appraisal of debt and equity-financing implications, and a multi-parameter sensitivity analysis to analyze impacts of input parameter deviations. In the second part of the paper, we use the 'Multiple Benefits' (MB) concept to identify project-based co-benefits of DER, to make the business case more attractive. We categorize the identified MBs in: 1) monetary, 2) unquantified project, and 3) societal benefits.

Results show that the DER project cash flow over a 25-year period achieves a 21-year dynamic payback with an IRR of below 2%. Levelized Cost of Heat Savings is 100 EUR/MWh with a 70% capital expenditure and 15% interest cost share. The Loan Life Cover Ratio comes out to 1,2. To make the business case more attractive, pecuniary MBs identified are increased rents, real estate values, (employee) productivity, and maintenance costs and CO_2 savings, in addition to societal benefits.

Compared to simpler economic modeling, the dynamic LCCBA cash flow model provides solid grounds for DER business case analysis, project structuring and financial engineering, but also for policy design. CFs from future energy cost savings alone are often insufficient in convincing investors. However, they can co-finance DER investments substantially. Consideration of MBs can offer meaningful monetary contributions, and also help to identify strategic allies for project implementation; however, the 'split incentive' dilemma is still present. Furthermore, the approach supports policy makers to develop policy measures needed to achieve 2050 goals.

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ENERGETIC SOLUTIONS
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Thank you!

Questions, remarks and collaborations welcome!

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