


Economic and environmental performances of solar LED lanterns under the Clean Development Mechanism: The case of Cambodia

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FACULTEIT BEDRIJFSECONOMISCHE WETENSCHAPPEN

Overview

Introduction

Methodology

Case

Policy advice & conclusions

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Introduction: Clean Development Mechanism

- Market mechanism of the Kyoto protocol
  - Enables developed countries to implement sustainable projects in developing countries in turn for CER credits

- Two objectives:

CONTRADICTORY?

Introduction: Clean Development Mechanism

96%:
on-grid

Table 1 Trend of CERs issued according to project type as a percentage of the total amount of CERs issued/issuing

Year	Hydro	Wind	Solar	Biomass	HFC	N_2O	Methane	Other
2006	5.92%	3.49%	0.00%	13.75%	59.94%	7.80%	6.31%	2.79%
2007	2.51%	2.47%	0.00%	6.09%	46.27%	25.61%	5.15%	11.89 %
2008	3.53%	4.35%	0.00%	2.56%	56.43%	22.18%	7.39%	3.55%
2009	5.25%	5.98%	0.00%	2.65%	57.97%	19.25%	3.93%	4.97%
2010	8.63%	8.18%	0.00%	1.28%	36.07%	31.44%	4.80%	9.61%
2011	12.15%	8.78%	0.04%	1.40%	38.78%	20.93%	7.11%	11.16 %
2012	16.36%	12.98%	0.03%	2.59%	30.06%	15.31%	9.54%	13.12 %
2013	20.30%	16.49%	0.36%	4.53%	14.83%	12.43%	15.73%	15.77 %
Average	9.33%	7.84%	0.05%	4.36%	42.54%	19.37%	7.50%	9.11%

Introduction: TedX Camille van Gestel (Waka Waka)

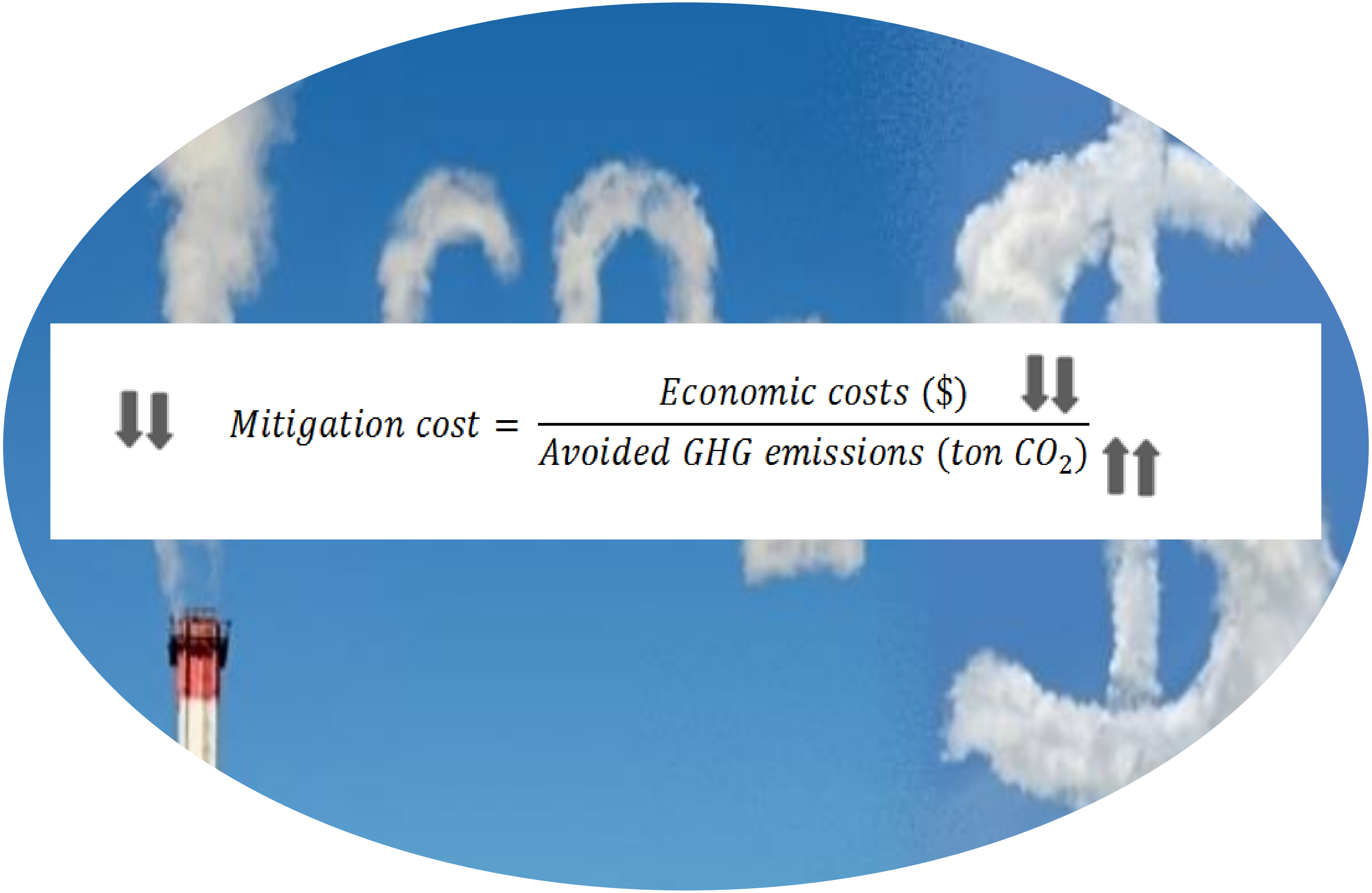
If, starting from now on, you had two hours per day less in your life, what would you do?

- Finish work?
- Spend time with family?
- Hobbies?

Implementation of solar LED lanterns (rather than kerosene lanterns):

- GHG emission reduction
- More lighting hours → increased (home)work performances
- Less injuries
- Less health problems
- Increased safety conditions

Methodology: Mitigation cost



$$Mitigation\ cost = \frac{Economic\ costs\ (\$)}{Avoided\ GHG\ emissions\ (ton\ CO_2)}$$

Methodology: Absolute mitigation cost

- "Absolute" mitigation cost (UNFCCC)

$$MC(absolute)_i = \frac{\sum_{t=1}^{cp} \frac{(C_{i,t} - R_{i,t})}{(1+r)^t} + I_{0,i}}{\sum_{t=1}^{cp} A_{i,t}} = \frac{\sum_{t=1}^{cp} \frac{(C_{i,t} - R_{i,t})}{(1+r)^t} + I_{0,i}}{\sum_{t=1}^{cp} E_{b,t} - E_{i,t}}$$

- $MC(absolute)_i$: absolute mitigation cost of project *i*
- *cp*: crediting period
- *C*: operating cost
- *R*: non-CER revenue
- *I* : initial investment
- *A* :expected emission reduction; difference between the baseline emissions (E_b) and the project emissions (E_i) (according to CDM methodology)
- *r* : discount rate

Methodology: Relative mitigation cost

- "Relative" mitigation cost

$$MC(relative)_i = \frac{\sum_{t=1}^{n} \frac{(C_{i,t} - R_{i,t})}{(1+r)^t} + I_{0,i} - \sum_{t=1}^{n} \frac{(C_{b,t} - R_{b,t})}{(1+r)^t} + I_{0,b}}{\sum_{t=1}^{n} A_t}$$

$$= \frac{\sum_{t=1}^{n} \frac{(C_{i,t} - R_{i,t})}{(1+r)^t} + I_{0,i} - \sum_{t=1}^{n} \frac{(C_{b,t} - R_{b,t})}{(1+r)^t} + I_{0,b}}{\sum_{t=1}^{n} \mathrm{E}_{b,t} - \mathrm{E}_{i,t}}$$

Differences:

- ~~*cp*: crediting period~~ → n: operational lifetime
- **Baseline costs are deducted from project costs**
- *A* :expected emission reduction; difference between the baseline emissions (E_b) and the project emissions (E_i) (according to LCA model)

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Case: Portable solar LED lanterns

- Cambodia (electrification rate 24%)

- Functional unit:
  - ✓ 100,000 households
  - ✓ 3.5 hours per day
  - ✓ 90 lumens
  - ✓ 365 days per year
  - ✓ period of 10 year

→ 114,975 million lumen hours over a 10 year time span

Case: Portable solar LED lanterns

	Portable solar LED lantern	Kerosene lantern
I_0	\$15 + \$5 per battery	\$0.70
n	Lamp: 10y Battery: 2y	2y
C	\$5 battery replacement	\$0.74/l; 0.03l/h \$0.125 per wick
cp	7y	2y
Light output	30lm	45lm
Light output over lifetime	383,250lmh	114,975lmh
Number of systems in FU	300,000	1,000,000

Case: Results

	Absolute (cp = 7y)	Absolute (cp = 10y)	Relative (cp = 10y)	Relative (cp =7y)
Project costs ($):	8,206,262	9,260,142	9,260,142	8,206,262
Baseline costs ($):	n.a.	n.a.	46,995,637	34,830,275
Additional project costs ($)	**8,206,262**	**9,260,142**	**-37,735,495**	**-26,624,013**
Project emissions (t CO_2 eq)	0	0	1,602	1,518
Baseline emissions (t CO_2 eq)	193,158	275,940	283,605	198,524
Emission reductions: (t CO_2 eq)	193,158	275,940	282,003	197,006
GHG mitigation cost ($/t CO_2 eq)	*42.48*	*33.56*	*-133.81*	*-135,14*

- Inclusion of baseline costs → major difference
- Use of crediting period (7y) versus operational lifetime (10y) → small difference
- Use of LCA methodology versus estimate of CDM → negligible difference

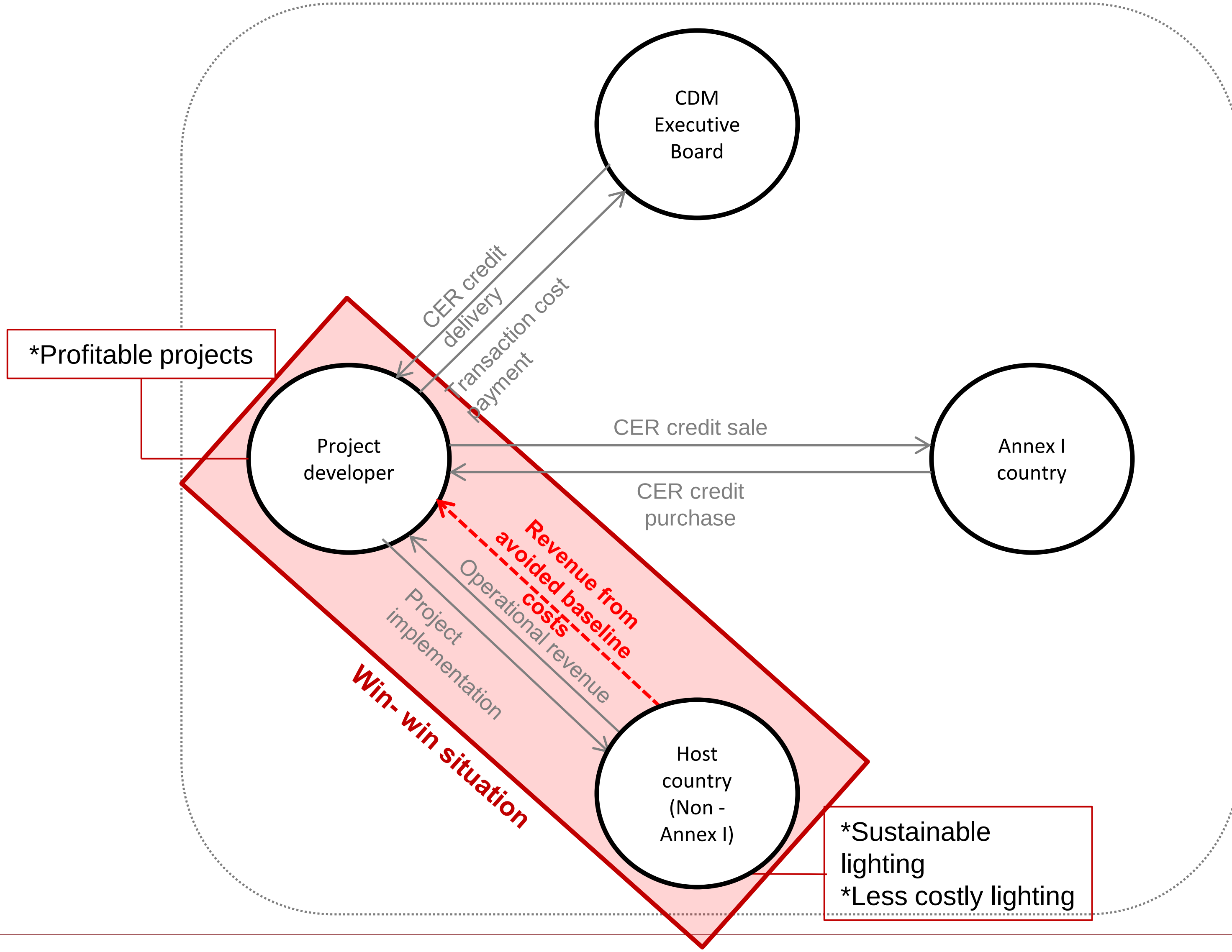
Policy recommendations

1) Use operational lifetime (rather than limited crediting period) to calculate emissions
   → Stimulate technological development

2) Continue using approximated baseline emissions, also for other cases (e.g. solar home systems)
   → Simplify procedures for project implementers

3) Create guidelines to provide revenue stream for investors from avoided baseline costs
   → Enhance profitability/attractiveness for project implementers

Policy recommendations



Conclusions

- **Relative** rather than absolute **mitigation costs** to assess attractiveness of CDM projects

- Large influence on **small-scale rural energy technologies**

- **"Lighting as a service"** model

→ **CDM twin objectives** more likely to be **reconcilable** rather than opposed

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Contact

Thank you for your attention!

Questions?

Feedback?

Suggestions?

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