

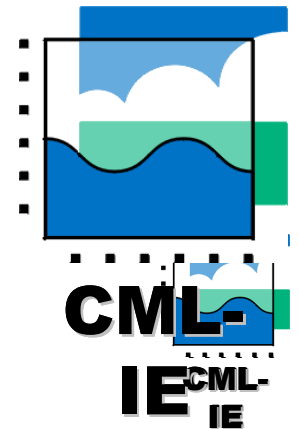
Policy dependent LCA outcomes, with examples on climate policy instruments

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Survey

1. Mechanism induced by technology change are at several System Levels
2. Climate policy instruments create and co-determine outcomes of mechanisms
3. In two case examples selected mechanisms are shown.
 1. Increased efficiency of coal fired power stations
 2. Bioethanol replacing gasoline
4. Conclusions: essential influence of choice of climate policy instruments on outcomes of consequential analysis in LC(S)A

Technology choices for sustainability

The ultimate question to be answered:

**Would the World get better
by making the Right Choice at hand?**

-environmentally,
-socially, etc.

- Technology relations prime in “old-fashioned” LCA
- **Replacement** reasoning to better link to choices
- Micro-Close-by
 - as a **proxy** to effects on the Macro-Global World
 - as a **first step** for better approaching effects on the Macro-Global World

Environmental effects of *decisions on technologies*

- Consequences of choices analyzed as:
 - Direct/Indirect or Primary/Secondary effects
 - Consequential LCA
 - Rebound
 - Life Cycle Sustainability Analysis (LCSA)
- Outside LCA as:
 - Impact Assessment, with all similar discussions, including on *rebound*
 - CBA; Integrated Assessment; etc.

Technology choices embedded

Technologies are embedded in:

- **Culture**

Eg: Will cheap lamps affect lighting behavior, as a rebound?

- **Institutions**

Eg: Will biofuel lead to deforestation in the tropics?

- **Policies**

Eg: Will emission savings of high efficiency lighting become zero under cap-and-trade policies?

- **Economics**

Eg: To what other purchases will the income effect of this cheap product lead?

Effect Mechanisms for Technology Choices *analyzed only partially*

- **Culture:**
Some direct/local rebound mechanisms
- **Institutions:**
Implicitly? Markets not a natural phenomenon
- **Policies:**
Biofuel as effect yes, but not as consequence:
instruments determining effect mechanisms
- **Economics:**
Some (relatively direct) market mechanisms
→ **Choice of instruments may determine outcomes**

Policy's double relation to environmental (and other) analysis of technologies

- In LCA, effect mechanisms only as induced by technology choice; *other things being equal*
- Ceteris paribus assumption “reasonable” if induced *mechanisms are independent from the choice* situation
- Climate policy is to induce technology choices, with *alternatives to be analyzed*

- Technology choices
depend on (climate) policy instruments
- Consequences of technology choices
depend on (climate) policy instruments

Here: **analysis of consequences of climate policy instruments**

Example 1: Efficient heat exchanger on coal fired power station

Efficiency increase of 1 percent point,
from 45% to 46%

Process level emissions down

from 0,84 to 0,82 ton CO₂ / MWh
→ -20kg/MWh

System level 1: full supply chain, technically, “old LCA”:
Also but not here:
fewer methane emissions at coal mining, etc.

Coal power efficiency: policy instruments considered

- ***No climate policy instruments***
Economic mechanisms lead to improvement
- ***Carbon pricing as Carbon Tax***
Adapted economic mechanisms lead to improvement
- ***Carbon pricing as Cap-and-Trade (ETS)***
Adapted economic mechanisms lead to improvement

System levels covering “consequences”: Coal

- **Process level:** Emissions down from 0,84 to 0,82 ton CO₂ / MWh (-20kg/MWh)
- **System level 1:** full supply chain, technically, “old LCA”
Fewer methane emissions from coal mining, etc.
- **System level 2:** product-specific “rebound”
Cheaper electricity: more electricity use
- **System level 3:** remaining general income effect, after ‘2’
Spending income on *anything else*
- **System level 4: directly induced market mechanisms**
Lower coal prices, etc. Here overlap with level 2
- **System level 5:** indirectly induced market mechanisms
Lower natural gas prices, etc.
- **System level 6:** induced changes in other activities
More electric cars, etc.
- **System level 7:** institutional and policy changes
Adaptation of Kyoto targets, acknowledging cheaper emission reduction costs

→ NO systematic approach to System Levels now available
→ Mechanisms per level to be independent

Efficient coal fired power station

*Assumed efficiency increase of 1 percent point,
from 45% to 46%*

• System level 4/5: (in)directly induced market mechanisms:

- Lower electricity prices, with higher volumes; related to elasticity of demand**
- Lower coal prices, with lower volumes; related to elasticity of supply**
- If ETS: Lower ETS trading prices, with higher volumes of other CO₂ emitting activities**

System improvement policy instrument dependent

Process level: *Technical analysis of installation*
Direct emission reduction ~ **20**kg/MWh

System level 4:

• Under no-climate-policy:
Indirect emission reduction ~ **10**kg/MWh

• Under carbon tax:
Indirect emission reduction ~ **10**kg/MWh

• Under cap-and-trade (ETS-type):
Indirect emission reduction ~ **00**kg/MWh

Example 2:

Bio-ethanol replacing gasoline

Bioethanol 100% (as in Brazil; in EU/US lower %)

System level 1: Supply chain to-the-wheels, CO_2 emissions

• ***Bioethanol:*** ***13g /L***

• ***Gasoline:*** ***63g /L***

(specific mass 0.9; carbon content 72% by mass; upstream emissions adding 10%)

Emission reduction: **50g/L**

System levels covering “consequences”: bioethanol replacing gasoline

- **Process level:** [no/hardly emission changes]
- **System level 1:** emission reduction of 50g CO₂/L
- **System level 2:** product-specific “rebound”
[see 4/5; negative rebound]
- **System level 3:** remaining general income effect, after ‘2’
[spending less income on *anything else*]
- **System level 4: induced direct market mechanisms**
[more expensive combustion car driving: less use]
- **System level 5:** indirectly induced market mechanisms
[lower natural gas prices; in CAP-and-Trade: lower permit prices; etc.]
- **System level 6:** induced changes in other activities
[more/fewer electric cars, depending on net effects of different mechanisms, etc.]
- **System level 7++:** Induced institutional and policy changes
[better and better implemented spatial policies in tropics]

Bioethanol replacing gasoline

System level 1 emission reduction: - 50g/L

• System level 4/5: (in)directly induced market mechanisms:

- Lower gasoline/oil prices, with higher volumes; related to elasticity of demand***
- Lower gasoline/oil prices, with lower volumes; related to elasticity of supply***
- [Not here: higher food prices; increased intensity in global agriculture, etc.]***

Bioethanol as car fuel: policy instruments considered

- **Obligatory percentage bioethanol**
(EU & US existing policies)
- **Carbon/ CO₂ tax** induced bioethanol
(generic instrument, as by upstream administered emission tax / carbon tax / carbon deposit)
- **Cap-and-Trade in CO₂ emission permits**
(generic instrument also on car driving, upstream administered, *not* as ETS now)

Bioethanol outcomes related to policy instruments

System level 1 reduction **50g CO₂/L**

Obligatory percentage bioethanol

Elasticity of S and D of fossil oil/gasoline
reduce ~ 50% of prime effect **25g CO₂/L**

Carbon/ CO₂ tax

Idem, ~ 50% of prime effect **25g CO₂/L**

Cap-and-Trade in CO₂ emission permits

Emission space filled to cap **0g CO₂/L**

Conclusions

1. Systematic views on adding most relevant consequences to technology LCA are lacking:
Anything goes
2. Climate policy instruments (help) create technical alternatives, to be analyzed in LC(S)A⁺⁺
3. Instruments of climate policy have very different consequences