Policy dependent LCA outcomes, with examples on climate policy instruments

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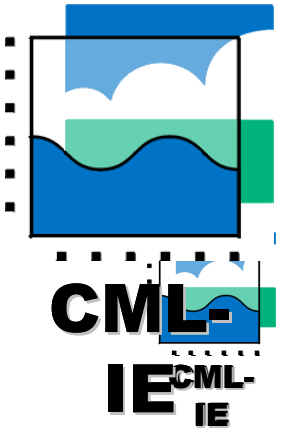

Survey

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

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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 **prox**y to effects on the Macro-Global World
  - as a **first step** for better approaching effects on the Macro-Global World

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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.

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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?

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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**

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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 instrumens**

Here: analysis of consequences of climate policy instruments

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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 CO_2 / MWh

➔ -20kg/MWh

System level 1: full supply chain, technically, “old LCA”:

Also but not here:

fewer methane emissions at coal mining, etc.

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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

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System levels covering "consequences": Coal

- **Process level:** Emissions down from 0,84 to 0,82 ton CO_2 / 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**

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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***

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System improvement policy instrument dependent

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

System level 4*:*

- **Under no-climate-policy:**
  Indirect emission reduction ***~ 10kg/MWh***
- **Under carbon tax:**
  Indirect emission reduction ***~ 10kg/MWh***
- **Under cap-and-trade (ETS-type):**
  Indirect emission reduction ***~ 00kg/MWh***

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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

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System levels covering "consequences": bioethanol replacing gasoline

- **Process level:** [no/hardly emission changes]
- **System level 1**: emission reduction of 50g CO_2/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]

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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.***

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Bioethanol as car fuel: policy instruments considered

- **Obligatory percentage bioethanol** (EU & US existing policies)
- **Carbon/ CO_2 tax** induced bioethanol (generic instrument, as by upstream administered emission tax / carbon tax / carbon deposit)
- **Cap-and-Trade in CO_2 emission permits** (generic instrument also on car driving, upstream administered, ***not*** as ETS now)

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Bioethanol outcomes related to policy instruments

System level 1 reduction **50g CO_2/L**

Obligatory percentage bioethanol

Elasticity of S and D of fossil oil/gasoline

reduce ~ 50% of prime effect **25g CO_2/L**

Carbon/ CO_2 tax

Idem, ~ 50% of prime effect **25g CO_2/L**

Cap-and-Trade in CO_2 emission permits

Emission space filled to cap **0g CO_2/L**

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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

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