INRAE

Chaire Énergie et Prospérité

Compte-rendu d'événement

Workshop

Extending the boundaries of environmental assessments: coupling Life Cycle Assessment with economic modelling

Coordinators: Sylvain Caurla (INRAE-BETA) and Guy Meunier (INRAE-ALISS)

May 10 2021 9h-13h

Online

Objectives of the workshop

Several methods are used to assess the environmental impacts of goods and services beyond the impacts generated by their use, most notably Life Cycle Assessment (LCA). These assessments fuel the public debate about the desirability of some "green goods" and influence environmental policies, by providing information to consumers (e.g. food labeling) or to help designing eco-efficient subsidies (e.g. bioenergies, electric vehicles). In this context, several important questions arise as to which method to use for which policy question and how to do it. In particular, current "hot topics" include the question of the definition of the system boundaries to account for feedbacks in the economic system, the inclusion of storage and de-storage of biogenic carbon in ecosystems during the production of biomass or the environmental impacts of changes in land use into account.

The workshop gathered researchers, industry experts, and policy makers from public, private, and civil society to expose their views and analysis on current issues and potential pitfalls of environmental assessmentss, and the questions raised by the extension of the boundaries of the system.

Summaries of presentations and links to slides and recording*

Session 1. Economic modeling and LCA. Chairman Sylvain Caurla (INRAE-BETA)

1. Integration of carbon dynamics within LCA – Ariane Albers (INSA Toulouse)

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> **Link to recording**

The LCA framework has continuously been developed, yet, still facing modelling challenges particularly regarding the temporal and spatial scopes of elementary flows and impacts (addressed as dynamic LCA).

Regarding the temporal dynamic: For biogenic CO2 emissions (e.g. biofuels), most models and policies rely on the hypothesis of carbon neutrality by ignoring the temporal carbon profiles, i.e. sequestration and storage (in the biomass and soils) and emission releases (combustion or decay), occurring at different points in time. Dynamic approaches were coupled with economic models and/or static LCA to assess the dynamic carbon flows. Examples included: prospective dedicated and residual biomass demand of the French transportation sector (link), including wood from managed forests (link) and related modelling challenges (link), energy crops (link), and palm oil-based biochemical (link).

Regarding the spatial dynamic: Ariane Albers and colleagues developed a framework to assess land-based negative emissions from soil carbon sequestration, relying on georeferenced products corresponding to the needs of macro-level global models. The modelling approach integrated the biophysical constraints (soil and climate) to identifying global target areas and their respective matches with specific plant species, contributing to negative SOC-CO2 emissions. It was applied to global SOC-deficient sinks (<50 t C/ha) on marginal lands (non-agricultural and non-forestry land covers). The results have shown that the land availability is reduced to 1% (from 2 714 to 28 Mha) due to soil constraints, and further reduced to 0.02 % (0.56 Mha) in the actual match with plant species. Thus, it was demonstrated that a key element is the biophysical limitation for identifying land availability and up-scalable net sequestration potentials, among further considerations such as: climate change trajectories (e.g. CMIP6 SSP126), yield variability, and LCA of biomass cultivation, including a dynamic carbon balance.

2. bioeconomic policies considering interactions at multiple scales. Application to the forest-based sector in the région Grand Est—Thomas Beaussier (Mines Paristech)

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* This summary has been realised by Maryam Sadighi

Economic activities linked to the bioeconomy, including the forestry sector, are characterized by strong local specificities, both in terms of resources and the organization of value chains. This characteristic calls for the development of territorial assessments of their economic and environmental performance, at the meso (sectoral and regional) level, between the micro and macro levels. At this scale, various mechanisms are likely to affect the assessments : interactions with the resource, substitution between products, interregional interactions, global interactions. There is a need to couple economic and LCA, and several methodologies have been proposed (link), the coupling of partial equilibrium with footprints from LCA performs best.

Beaussier and co-authors combine economic and environmental indicators produced in the form of different eco-regional efficiency indicators, integrating or not the substitution effects. Applied to the evaluation of regional wood energy development in the Grand Est region, our approach allows us to assess the integration of different interactions in a multi-criteria evaluation at the territory scale.

3. Assessing the efficiency of changes in land use for mitigation climate change – Patrice Dumas (CIRAD)

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Attributional LCA does not take into account the emissions associated with land use changes (LUC). There are two related LUC: clearing of vegetation (direct LUC) and reallocation of uses (indirect LUC). If only direct LUC is considered, the environmental assessment is influenced by past replaced vegetation if replacement occurs recently, and not by possible future vegetation if production were to stop.

Economic models represent the indirect emissions effects, but cannot easily disentangle the intrinsic biophysical advantages of the different options from the price effects, that are uncertain and should in general be considered as side effects of land use change policies.

Patrice Dumas presented a methodology to incorporate LUC into GHG emissions assessment, in order to analyze the optimal allocation of land among alternative uses (e.g. carbon sequestration, food production, biofuels). Production is treated as a benefit because it avoids to emit elsewhere, and demand is a cost because it requires emissions. A carbon value is attributed to every location and production and separates direct and indirect effects. The methodology has been applied to: the comparison of more or less intensive beef and soybean production systems in the Brazilian Cerrado (link), the comparison between organic and conventional production of peas and wheat in Sweden, and to the comparison of diets.

The model faces some uncertainty and challenges: uncertainty on carbon stocks parameters, sensibility to the discount rate and carbon price, technological change. The model is focused on carbon, other effects such as biodiversity, albedo, economic cost, health impacts are not evaluated.

4. Carbon substitution in the wood sector: What are the missing pieces? -- Aude Valade (CIRAD-Eco&Sol)

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> [Link to recording]

To study the carbon impact of wood products, usually a substitution coefficient is applied which is simply the difference between the life-cycle GHG emissions in the reference (fossil) scenario and the wood scenario. However, this coefficient is only related to the life cycle of a product and ignore the biogenic component of the wood product carbon cycle (forest growth and wood carbon emissions).

Aude Valade presented an analysis of several scenarios of the French wood sector. French forests are regrouped in four categories. Three scenarios have been developed with different harvesting strategies targeting each forest category, to satisfy a growing demand for wood products and compared to a reference scenario. By 2050, all of the scenarios have a lower quantity of carbon sequestered (in situ + wood products) than the reference scenario. These results are used to calculate an alternative substitution coefficient including both wood product's life cycle emissions and biogenic carbon, and defined as the difference in carbon balance per unit of additional wood use. A positive coefficient is obtained only for one scenario after 30 years, the other three exhibit negative coefficients, to be contrasted with the positive LCA-only coefficient.

The analysis has focused on harvest intensity, there are many other questions to be addressed: how the industry structure, climate change, innovation/technology, social change, and market-based mechanisms can affect each step of the LCA. A. Valade mentioned ongoing work to address these issues, in particular a systematic review to understand how each of these drivers can affect the substitution potential of wood use.

Session 2 – Technology choices and LCA. Chairman Guy Meunier (INRAE-ALISS)

5. Extending the Limits of the Abatement Curve – Jean-Pierre Ponssard (CNRS-Ecole Polytechnique)

> [Download his presentation]

> [Link to recording]

Marginal Abatement Cost Curves (MACC) are a popular but highly criticized tool to compare technologies and assess decarbonization scenarios. This on going work revisits and extends their applications along two directions: LCA and sector interactions. The idea is to combine both sector and global approaches. Both approaches have their own limitations. A sector approach allows the introduction of specific constraints such as inertia, endogenous technical change and ancillary benefits while a global approach allows the introduction of sector interactions through ad hoc simplifications. How to combine both approaches is illustrated by means of a simple economic model which features a fleet of vehicles and a power sector, both of which involve a dirty and a clean technology. Two issues are discussed: How to assess a proposed scenario of decarbonization for the mobility sector? How to coordinate the decarbonization of vehicles with the decarbonization of the power sector ?

It is shown that in a pure sector approach the benefit of a decarbonization scenario cannot be assessed as traditionnally done relative to a Business As Usual scenario. Given that the overall objective is to decarbonize the economy, any scenario which achieves this goal in the mobility sector should be implemented at once, its MAC is zero! The global scenario can be used to generate alternative sector scenarios which integrate interactions with other sectors, here the electricity sector.

In this methodology the abatement curve is used as a search process to dig out the "second best" sector scenario using:

- Selection of the relevant time horizon: time of complete decarbonization of all sectors in the economy instead of the project lifetime
- Irrelevance of a reference scenario such as Business As Usual: search for the second best decarbonization scenario
- Integration the relevant interactions for the sector scenario:
    - Vertical for the upstream sector
    - Horizontal: all mobility uses, infrastructures, LBD
    - Local Constrains: ancillary benefits and behavioral changes

Many hydrogen projects for mobility have been deployed nationally and internationally (EAS-Hymob, ZEV, Hype, Hygreen, FCEB, etc.). This methodology opens up the opportunities to take into consideration LCA and sector interactions in cost benefit analysis of the aforementioned projects.

6. Why LCA @ENGIE?– Jan Mertens (ENGIE- Chief Science Officer)

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> Link to recording

Life Cycle Assessment does not only focus on CO_2, but also critical raw materials and minerals as well as water resources are increasing important topics to be assessed with respect to new emerging energy technologies. A sustainable approach for raw materials extraction is needed given the exponentially growing need of these resources to reach carbon neutrality. Furthermore, we should not see CO_2 only as a problem, it can be a resource. One of the 23 thematic labs of ENGIE- Environment and Society- is fully dedicated to-assessing the sustainability of these new emerging energy technologies requires to reach carbon neutrality by 2050.

The IEA has recently published a report on the issue of critical materials (see link). According to this study, in the production of a conventional fossil-based car, much less critical materials is used (around 30 kg/vehicle) compared to an electric car (more than 200 kg/vehicle). Meeting primary demand in the Sustainable Development Scenario (SDS) of IEA requires strong growth in investment to bring forward new supply sources over the next decade. In parallel with the sustainable resource extraction, we need more recycling. Water is another crucial resource that needs more attention, especially with respect to the important role that hydrogen and e-fuels will play in our energy transition.

Today's gas system takes carbon from the Earth's crust and puts it into the atmosphere. Future gas system could take carbon from the atmosphere and put it into products (carbon capture and use (CCU)) or back into the crust (carbon capture and storage (CCS)). To reach carbon neutrality, we need in a first step continue our efforts in increasing energy efficiency and circularity and in a second step electrify as much as possible (far beyond just our cars!). However, for long-term energy storage or transport, heavy mobility and for some industrial processes (eg. high temperature heat), we need to rely on energy carriers in forms of molecules, and thus CO_2 may be seen as a resource. One of the examples of ENGIE projects to make use of CO_2 is the

Méthycentre project in which Biowaste is first gasified to produce biogas. The biogenic CO_2 is reacting with green hydrogen to produce synthetic methane (a process called “power-to-e-methane”).

For these new emerging technologies having LCA expertise at ENGIE is crucial.

More on sustainable technologies at ENGIE: link

7. LCA at ADEME, example of wood energy- Miriam Buitrago (ADEME- Direction Bioéconomie et Energie Renovelables)

> Download her presentation

> Link to recording

Miriam Buitrago started with presenting the use of LCA at ADEME studies as well as its advantages and limitations in the current methods. She brought up the example of the LCA in the wood energy. At the end, she raised some open questions on the role of LCAs for the forestry and wood sector.

ADEME use LCA methods for the environmental assessment of a product (good or service)/sector in three different directions : 1) Environmental information about a product/sector 2) Ecodesign of products/sectors, and 3) Decision support for public policies.

LCA methodology has been recognized by the scientific community and standardized at the international level. However, the methodology posses some limitations: Some environmental impacts (e.g. biodiversity, carbon variation in ecosystems) are still poorly taken into account by LCA. There is no social indicators (human and animal welfare, employment quality, etc.). It does not take into account the market-mediated effects (e.g. rebound effect, change in biomass use, changes in agricultural/forestry practices and land use, etc.).

ADEME is currently carrying out a study on LCA of collective and industrial wood energy.The methodology historically used in LCA assumes that wood combustion emissions are carbon neutral. With this assumption, the market-mediated effects and the impacts of forestry on biodiversity and carbon sink are not taken into consideration. ADEME is facing some challenges to take into account these impacts: a lack of standardized methodology biogenic carbon accounting in LCAs, numerous typical cases, and, a lack of data.

La Chaire Energie et Prospérité

La chaire Energie et Prospérité a été créée en 2015 pour éclairer les décisions des acteurs publics et privés dans le pilotage de la transition énergétique. Les travaux de recherche conduits s’attachent aux impacts de la transition énergétique sur les économies (croissance, emploi, dette), sur les secteurs d’activité (transport, construction, production d’énergie, finance) et aux modes de financement associés. Hébergée par la Fondation du Risque, la chaire bénéficie du soutien de l’ADEME, de la Caisse des Dépôts, d’Engie et de Renault.

Website http://www.chair-energy-prosperity.org/