How to account **ecosystem services** into **energy assessment** of agroecosystems and **bioeconomy?**

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INTRODUCTION

- **Agroecosystems** produce biomass by means of **external inputs** (**EI** ; based on fossil energy) and **ecosystem services** (**ES**; ecosystem processes supporting agricultural production)
- Current **energy assessments** of agroecosystem **do not take ES into account** (*e.g.* Guzman et al. 2018)

☞ **Need for a conceptual and methodological framework to assess energy and agroecological performance of agroecosystems, accounting for ES energy flows**

METHODS

ES energy flow (ESE) is estimated using replacement cost method

Example: The ES of Nitrogen (N) supply

Ecological processes (ES):

- ❖ Mineralization of N in soil
- ❖ N fixed by legumes in the crop rotation

External input replacement (EI):

- ❖ Mineral N synthetized using fossil energy
- ❖ Energy cost of 36,4 MJ / kg N

Energy flow of the ES of N supply is estimated as the **energy needed** to produce the **same quantity of mineral N** with **fossil energy**

Performance of the agroecosystem are assessed with 3 indicators :

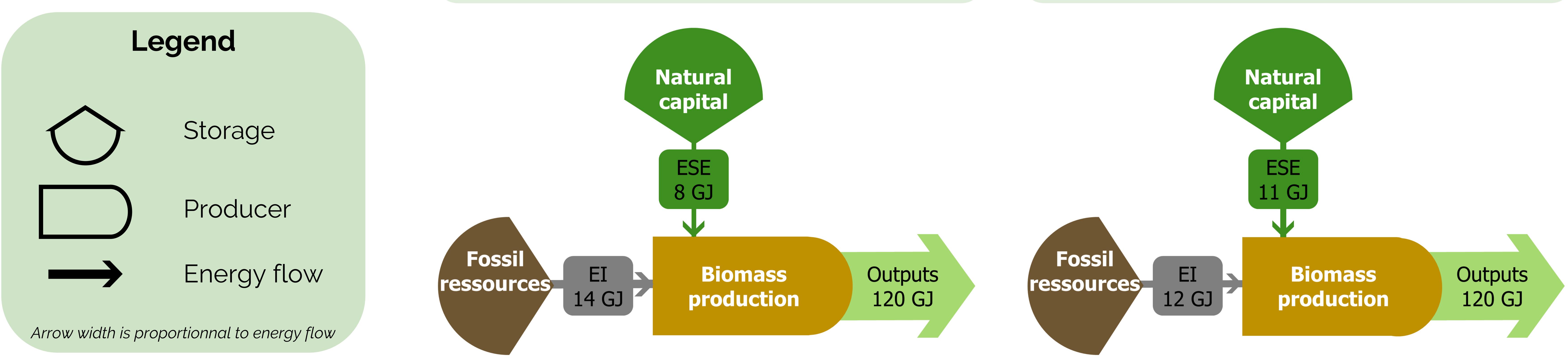
- Energy Return On Investment (**EROI**) without and with accounting ES (Harchaoui & Chatzimpiros, 2018)
- **Ratio of energy** coming from ES to energy coming from EI
- **Assessment for two farms** (Dardonville et al 2023)

☞ The following **ES** have been **accounted** in **ESE** : **N supply, soil structuration, erosion control** and **weed control**

RESULTS

Farm #1
Moselle, France – conventional farming
rapeseed, wheat, barley crop rotation

Farm #2
Aube, France – conservation agriculture
Diversified 9-year crop rotation



	Farm #1	Farm #2
I1: EROI without ES (Outputs / EI)	**8,14**	**9,89**
I2: EROI with ES (Outputs / (EI + **ESE**))	**5,24**	**5,21**
I3: Share of ES among inputs (ES /EI)	**0,55**	**0,90**

Farm #2 **I1 & I3:** ☞ is more efficient than Farm #1, due to less EI and more ESE. **I2 :** ☞ level of ESE may be increased

CONCLUSION

- Validation of the **proof of concept** in **two contrasted agroecosystems**
- **Other ES** such as water retention, phosphorus supply, pollination, etc. **will be taken into account**
- **More agroecosystems** will be assessed, including agroecosystems connected to **biogas plant**

References:
Dardonville et al., 2022. Ecosystem services, 54, 101415
Harchaoui & Chatzimpiros, 2018. Journal of Industrial Ecology, 23,412-425.
Guzman et al., 2018. Regional Environmental Change, 18, 995-1008

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