# Comparative Life Cycle Assessment of NARA BioJet Fuel

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## Background

Interest in the conversion of woody biomass into biofuels is continually growing [1]-[2]. One of the reasons is that, as countries seek ways to reduce their GHG emissions, forest based bioenergy is seen as an appealing alternative to fossil fuels. The Energy Independence and Security Act [3], signed into law in 2007, provides meaningful economic opportunity for the reduction of foreign oil dependence and greenhouse gas emissions through the use of clean renewable fuels. In order to meet the public procurement requirement, the overall greenhouse gas emissions of cellulosic bio-fuel have to be 60% lower than the carbon emissions generated during the production of fossil-based jet fuel [4]. Therefore an accurate and detailed evaluation of the environmental impacts of bio-jet fuel compared to fossil fuel is considered to be crucial to demonstrate regulatory compliance.

## Objectives

1. Perform a cradle-to-grave life cycle assessment of forest residue-based bio-jet fuel;
2. Compare the environmental impacts of bio-jet fuel with those of fossil fuel.

## System boundaries

- **Functional unit**: 1 GJ of energy produced by fuel combustion.
- **Cradle-to-grave approach** where "cradle" is defined as the natural forest regeneration ready to be harvested/thinned and "grave" is defined as the fuel combustion during flight in an aircraft.
- Feedstock harvest, collection, processing and transportation are included in the system boundary.
- **Three co-products are simultaneously produced in the plant**: Isoparaffin kerosene (IPK), Activated carbon (AC) and 50% Lignosulfonate (LS).

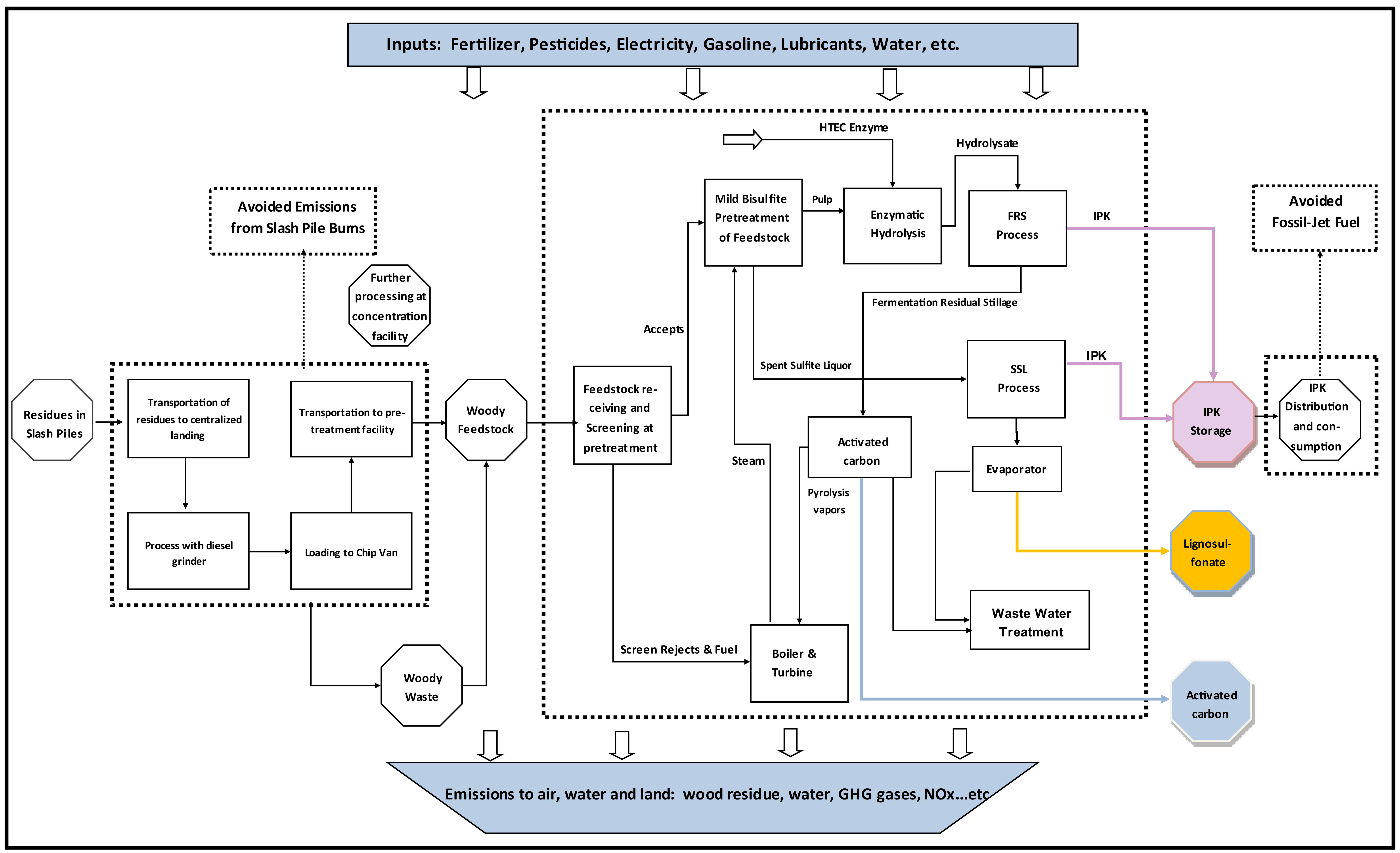


**Figure 1. System boundary of the study.**

## Assumptions

- Mass allocation: the environmental impacts are allocated to the three co-products based on their mass flows.
- The boiler produces all the steam required in the plant.
- Avoided emissions: 50% slash pile burn.
- Fossil fuel: data are taken from the Ecoinvent database.

## Results

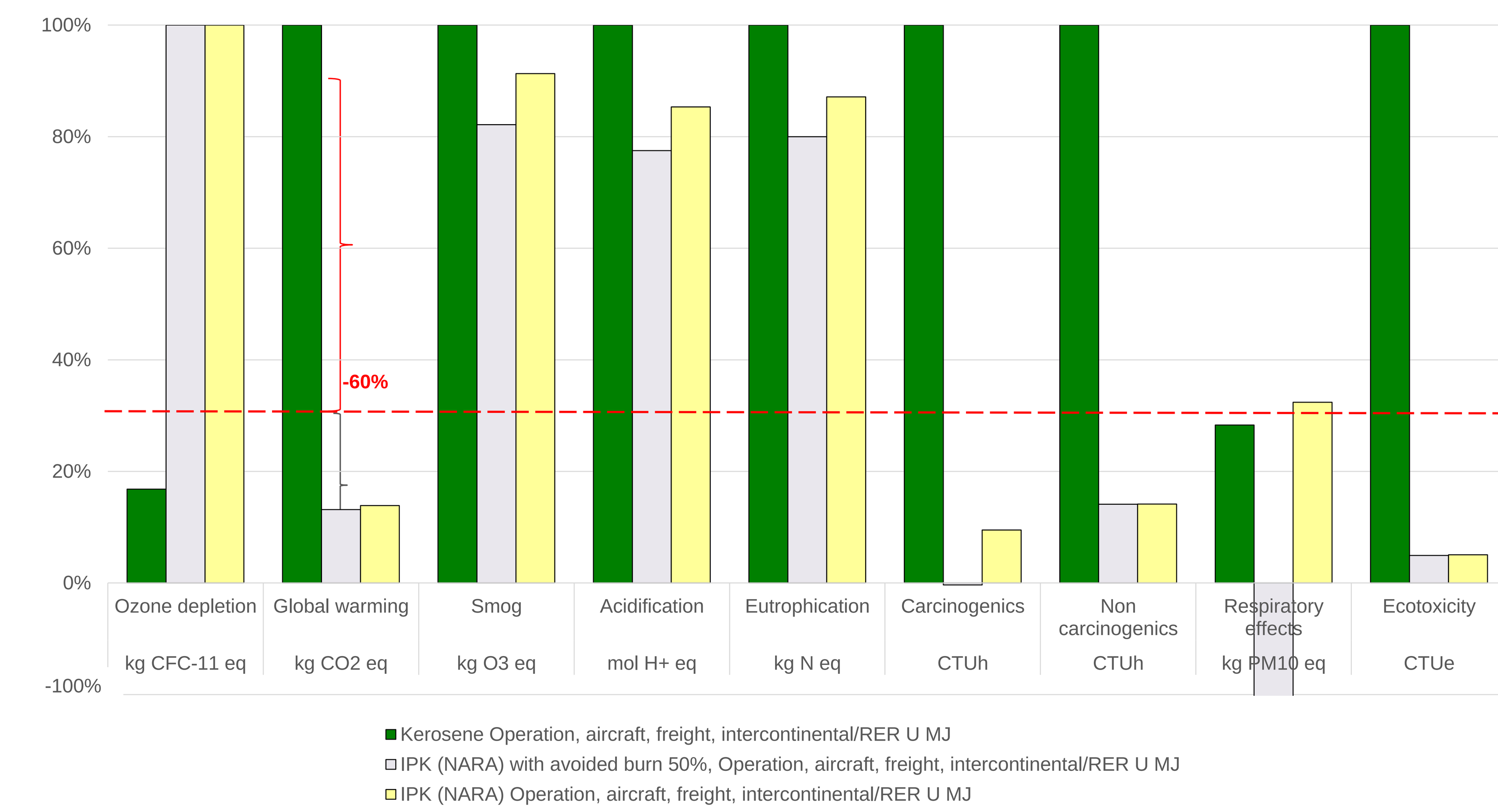


**Figure 2. Comparison of the LCA results between IPK, IPK with 50% avoided burn and fossil fuel (kerosene)**

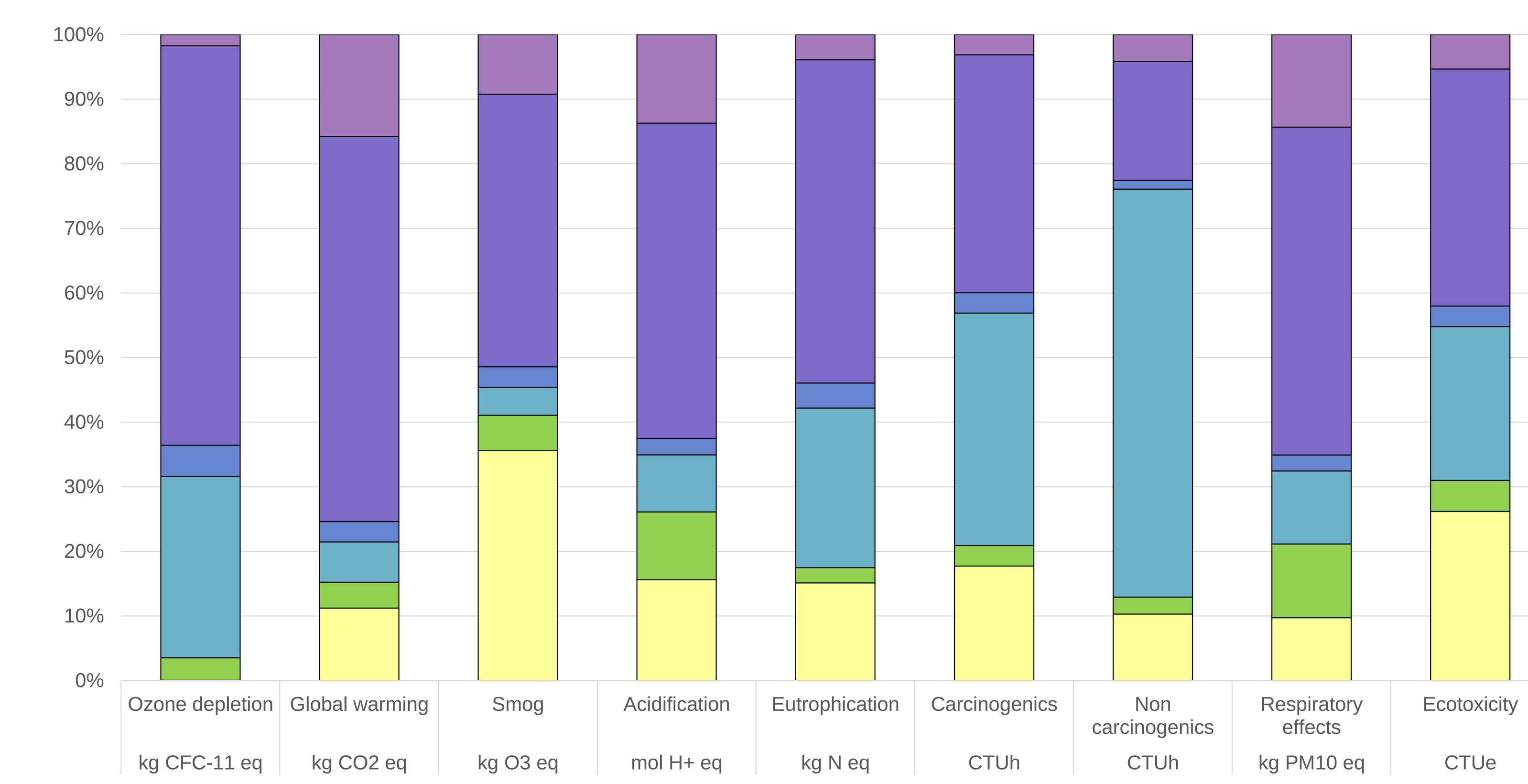


**Figure 3. Process contribution to the LCA of IPK**

## References

[1] K. Dutta, A. Daverey, and J.-G. Lin, "Evolution retrospective for alternative fuels: First to fourth generation," Renewable Energy, vol. 69, pp. 114–122, Sep. 2014.

[2] K. Sunde, A. Brekke, and B. Solberg, "Environmental impacts and costs of woody Biomass-to-Liquid (BTL) production and use — A review," Forest Policy and Economics, vol. 13, no. 8, pp. 591–602, Oct. 2011.

[3] U.S. Government, Energy Independence and Security Act. 2007.

[4] EPA, "Accounting framework for biogenic CO2 emissions from stationary sources. U.S. Environmental Protection Agency. Office of Atmospheric Programs Climate Change Division. Washington, DC." 2011.

NARA
Northwest Advanced Renewables Alliance

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