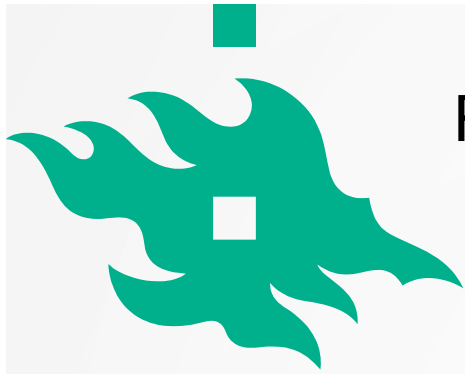




Sustainable forest-based bioeconomy: A case of biorefinery as a multi-product firm

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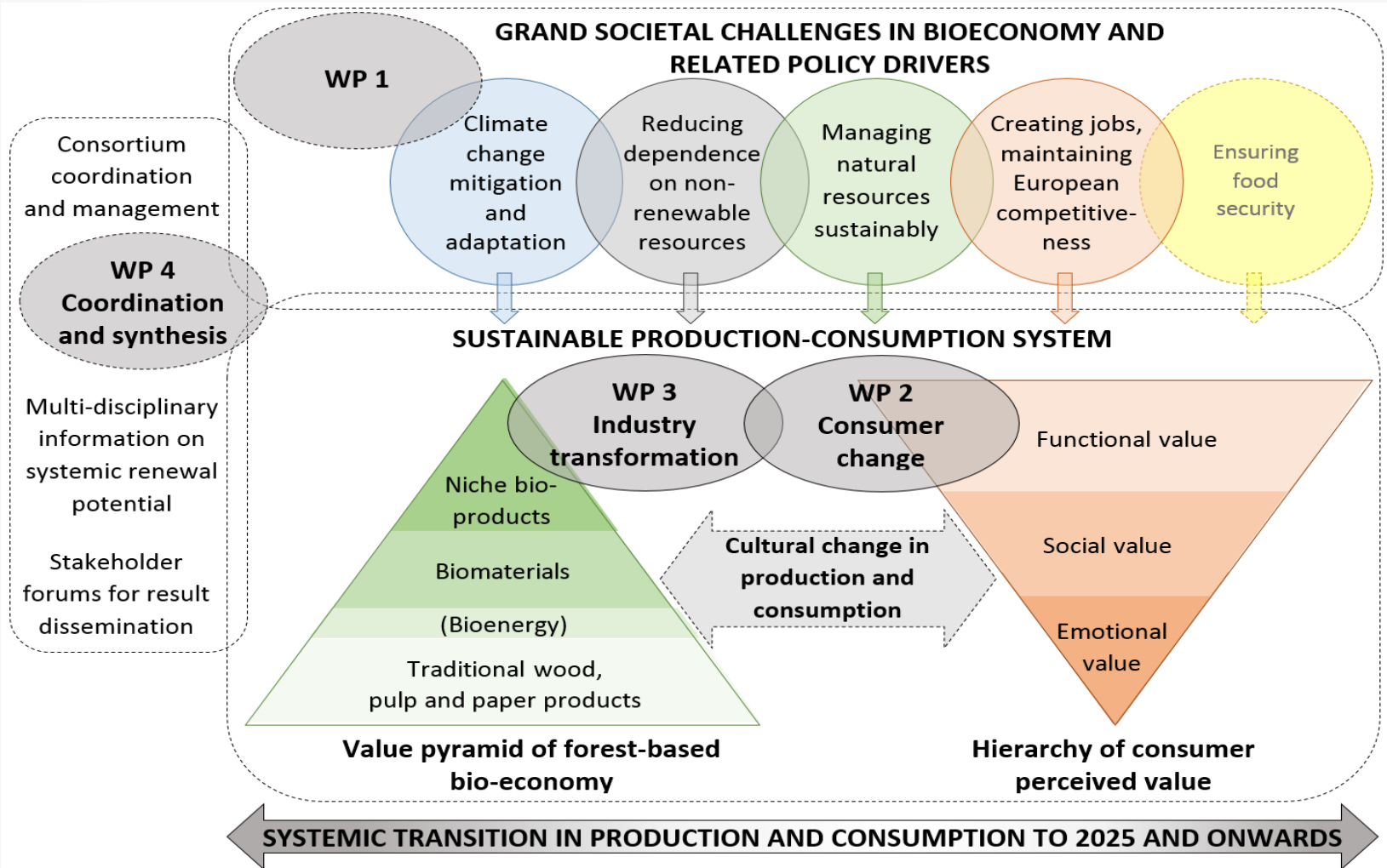
■ **Orchestrating sustainable user-driven bioeconomy: Policy, transformation and benefits (ORBIT)**

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Orchestrating sustainable user-driven bioeconomy: policy, transformation and benefits (ORBIT), 2017-2020





Research questions, WP 1

- 1. What kind of trajectories and trade-offs have to be acknowledged towards 2025 in order to move towards sustainable forest-based bioeconomy?*
- 2. What are the key policy means to overcome the potential obstacles and trade-offs and to reach the sustainable forest-based bioeconomy?*



Modeling work

- Core: a biorefinary model
 - An integrated multi-product industrial ecosystem built on traditional forest industry
 - Cellulose, lignin, hemicellulose and extractives as possible production platforms
- Forest bioeconomy model
 - Demand for wood and impacts of price development
 - Examination of synergies and conflicts among the alternative products
- Analytical and simulation work



Analytical model, a biorefinery as a multiproduct firm

$$\pi_i(x, k, e) = p_i f_i(\varepsilon_i x, k, e) - qx - wk - SE$$

$e = E +$ electricity produced in the biorefinery, $\pi =$ profits,

$i =$ number of final products, $x =$ amount of pulp wood, $k =$ amount of chemicals,

$e =$ amount of energy, $p =$ price of final product, $f =$ production function,

$q =$ price of pulpwood, $w =$ price of chemicals, $S =$ price of outside electricity bought,

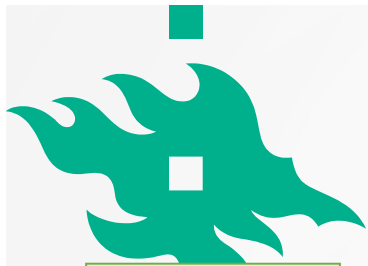
$\varepsilon_i =$ stream of raw material



Bioeconomy policy analysis

- **Climate instruments:** price of carbon, payments for long-living wood products replacing fossil C emissions, incentives for biofuels, **and instruments promoting research and development for new products**
- **Circular economy instruments:** new instruments facilitating the efficient use of all biowaste grades among single and multiple firms within the biorefinery
- **Coherence:** between general tax and other policies and instruments promoting the shift to a forest bioeconomy

An integrated multi-product industrial ecosystem



Traditional and new bioproducts

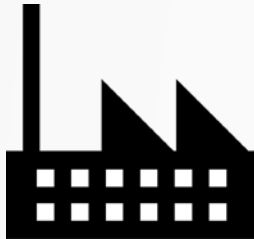


Biosludge

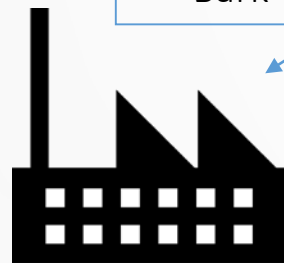
Pulpwood, woodchip, chemicals, energy sources



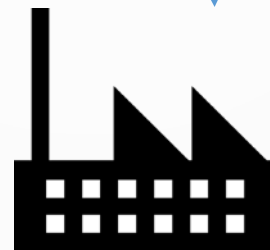
Traditional and new bioproducts



Lignin



Bark



Tall oil




Pulp

Traditional and new bioproducts

Traditional and new bioproducts

Traditional and new bioproducts



Thank you for your attention!

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