Hochschule Offenburg
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Master thesis:

Investigation of regional potentials of pyrolysis as a negative emission technology depending on regional biomass availability and CO2 sequestration capacity

Overview

With the new climate protection law, it was determined across all sectors that GHG emissions in Germany should be reduced by 65% by 2030 compared to 1990, by 100% in 2045, and that additional CO_2 should be removed from the atmosphere from 2050 on. Since the agricultural sector produces so-called unavoidable emissions from land use and livestock farming, the intrasectoral target for agriculture was softened to only a 30% reduction by 2030, which means that the energy sector will have to additionally compensate for these emissions.

The goal of the “Landgewinn” project is to design and implement a holistic intersectoral energy system model that provides regionally high-resolution results for increasing decarbonization of the agriculture sector in interaction with the other sectors. For this purpose, the PyPSA-Eur energy system model will be used and further developed. The challenge is to adequately represent the diverse and varied nature of the agriculture sector and to integrate 3 selected agriculture-based decarbonization technologies. The potential of these technologies will be investigated and evaluated in different scenarios up to the year 2050. At this point, the focus is on the first decarbonization technology, the production of biochar. The production of bio-char from biomass by pyrolysis is a promising negative emission technology whose potential in interaction with the entire energy system has not yet been explored.

In this Master thesis, the production of biochar as a CCS technology will be investigated in the context of the regionally limited ressource of biomass and the potentially limited storage capacity for bio-char. For this purpose, the technology is first modeled fully balanced in PyPSA-Eur. Furthermore, regional biomass availability and regional carbon sequestration limitations will be researched and implemented as well. Subsequently, with the help of suitable scenarios, it will be investigated how the regional potential of pyrolysis affects the decarbonization of the German energy system, what the system costs are and whether the technology can play a role in achieving the climate targets.

Structure of the Master thesis

- Literature review of the existing energy system modelling software: PyPSA, PyPSA-Eur and PyPSA-Eur-Sec
- Literature review of the technological specifications and economic and ecological characteristics of pyrolysis plants
- Literature review of regionally available biomass as a substrate for conversion to biochar and the regional sequestration potential.
- Modelling task:
    - Mapping of high resolved spatial regions (NUTS3) in the energy system model PyPSA-Eur
    - Modeling different pyrolysis plants based on different types of biomass within PyPSA-Eur
    - Integration of limits for biomass and the carbon sequestration potential for the NUTS3-regions
    - Coupling the biomass sources with other technologies which use biomass as a fuel as well
- Scenario analysis:

- Analysis the limitations of the production of biochar as a carbon capture technology
- Analysis of the impact of the production of biochar to other biomass conversion technologies
- Analysis of the impact of the negative emission technology pyrolysis onto the whole German energy system by making two to four scenarios. Scenarios should be based on the lastly government instructions for the energy transition.
- Analysis of the operational and expansion planning of generators and transmission grids until 2050

Requirements

- Programming language: Python
- German and English
- Energy system knowledge
- Energy economics knowledge

Contact details for an application

If you have interest in the master thesis position please e-mail anna.sandhaas@hs-offenburg.de and attach the CV and transcript of grades.
We will get in touch with you to set another meeting and talk with more detail about the task.