Modeling Bioenergy with Carbon Capture and Storage - A Scenario Assessment for Indonesia

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ABSTRACT

IPCC's AR5 sees negative emissions, i.e. through BECCS, as crucial for achieving compliance with the ambitious climate mitigation targets of stabilizing global warming at a maximum of 2°C. However, available literature on national and regional BECCS potentials is limited. This study aims to identify Indonesia's in-situ BECCS potential by assessing a suite of scenarios with the help of the techno-economic renewable energy optimization model BeWhere. Biomass co-firing seems to be a low-hanging fruit with respect to BECCS feasibility in Indonesia.

The latest IPCC Assessment Report (AR5, 2014) concludes achieving climate stabilization at levels regarded to be safe will require significant emission reductions beginning soon, and being sustained over the next century. However, during the past decade, emissions from fossil fuel burning and cement production have increased dramatically, with emissions in 2011 (9.5 ± 0.8 Pg C yr-1) being 54% above their 1990 value. Yet, a strong argument has been made that 2°C is still possible. At the same time, in order to do so, all options have to be put on the table. This includes – inter alia - a larger than previously envisioned role for negative emissions, e.g. through combining carbon-neutral, sustainable bioenergy with carbon capture - BECCS (c.f. Fuss et al. 2014). Even though these findings clearly call for an increased research activity in order to identify realistic and spatially explicit potentials and its boundaries, available literature on negative emissions/BECCS – especially with respect to detailed country studies - is rather limited (c.f. Kraxner et al. 2014).
Indonesia, on the one hand, is a tropical country with large biomass productivity and increasing oil and gas sector activities. On the other hand, it is the 6th largest GHG emitter globally and some 90% of its emissions are generated from massive land-use change, i.e. tropical

deforestation. At the same time, Indonesia has developed very ambitious climate targets aiming at 26% GHG emission reduction without foreign aid and even 41% with foreign aid by 2015. In addition, these targets need to be balance with an envisaged GDP growth by 7% and projected 5 times higher energy consumption in 2050 compared to 2010. The BECCS technology is seen as a promising tool to bridge between the various future challenges Indonesia is facing and at the same time deliver large quantities of negative emissions needed by the end of this century.
The objective of the presented BECCS case study is to analyze the in situ BECCS capacity for green-field bioenergy plants in Indonesia under different scenario assumptions. We examined the technical potential of bioenergy production from sustainably grown regional forest biomass. In a first step, IIASA's biophysical Global Forestry Model (G4M, www.iiasa.ac.at/g4m) was applied to estimate the biomass availability. In a second step, the results from G4M were used as input data to IIASA's engineering model BeWhere (www.iiasa.ac.at/bewhere), which optimizes renewable energy systems – in this case scaling and location of coupled heat and power plants (CHP). The geographically explicit locations and capacities obtained for forest-based bioenergy plants were then overlaid with a geological suitability map for carbon storage. From this, a theoretical potential for in situ BECCS was derived.
First results from the assessment indicate that the potentials vary substantially over the different scenario assumptions. It is demonstrated that sustainable production of biomass feedstock, energy demand and supply as well as competing industries and existing transport infrastructure are important input parameters in order to achieve an optimal BECCS solution for national and regional applications. The scenario on biomass co-firing in combination with CCS turns out to be one of the most promising – both in terms of the generated "BECCS/Negative Emissions – Effect" and the financial feasibility (see Fig. 1). The technical assessment is used to support a policy discussion on the suitability of BECCS as a mitigation tool.

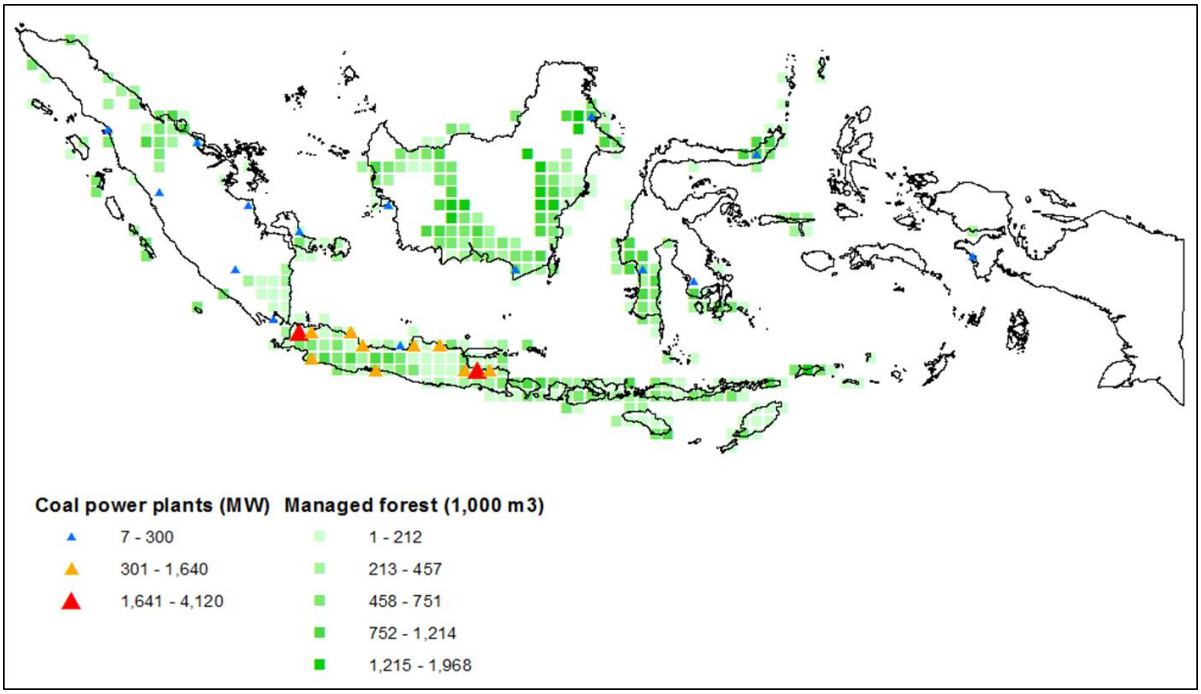

Figure1: 50% biomass co-firing scenario using biomass from managed forest only.