Supplementary S1. Estimating the broad-scale geographic distribution of forest residue biomass and the biomass amounts potentially available for a fossil fuel substitution.

We have estimated the amount of post-harvest forest residues that can be potentially available from Canadian forests using the following two-step approach. First, we identified the potential locations where the residual biomass could be accessible after harvest within the managed forests of the country. We started with maps of merchantable forest biomass volume and age distribution for generalized conifer and hardwood tree species groups (see [1]), excluding Prince Edward Island, Yukon, Northwest Territories, Nunavut, and southern agricultural areas of Ontario, as large scale harvesting does not occur in these regions. We then estimated the harvested wood consumption volumes from the list of wood processing facilities which accept harvested wood. This dataset included 393 mills with the latest wood consumption values available [2–4] and delineated the geographical extent of potential harvest sites. The total sum of wood consumption volumes across Canada was verified against the aggregate nationwide harvest levels from the National Forestry Database ([5], using 2010 as a reference year). Locations of individual mills, their reported annual volumes of processed wood, and the map of merchantable forest biomass estimates were then used to apportion timber harvests to local forested areas. To examine the implication of larger harvest levels, we also simulated scenarios with the nationwide harvest levels set to a 20-year Canadian average (approximately 22% larger than the 2010 harvest level). Next, the entire zone of industrial forest management was apportioned among individual mills and wood processing facilities, delineating the approximate locations of the potential harvest sites that could potentially deliver biomass to co-generation facilities [see [6] for further details].

Once the geographic extent of harvesting operations was established, we used the Canadian Forest Service Forest Bioeconomic Model (CFS-FBM) to estimate the amounts of forest residues in forest ecosystem pools before and after harvest. CFS-FBM has been used in previous studies to estimate costs of biomass supply and carbon offsets [7,8] and is described in more detail there; here, we only provide details germane to this study. Biomass partitioning and tracking carbon in CFS-FBM follows the general structure of forest biomass pools in earlier version of the carbon budget model CFS-CBM [9]. The assessment of postharvest residue amounts excluded biomass in stumps, roots, and standing dead trees. The allocation of biomass into ecosystem pools was based on biomass conversion equations from [10], which predict the accumulation of biomass in live and dead organic matter pools from estimates of merchantable stand volume and forest age. CFS-FBM also simulates the transfers of organic matter between ecosystem biomass pools similar to the approach reported in [9], and [11]. We assumed that the removal of residues from the harvest site would occur within the harvest year.

At the next step, we have estimated the cost of residual biomass supply to nearest co-generation facility including two major cost components of residue supply: (1) extraction costs at the harvest and landing sites and (2) the cost of hauling the biomass to the nearest co-generation facility. Biomass extraction from harvest sites has been previously studied for general forest types in the U.S. [12–14]. Here, we assumed the extraction of biomass from roadside residue piles after clear cutting and the use of a full-tree length harvesting method. These practices are common in Canada; clear cut harvesting systems are the most commonly implemented (approximately 93% [15]) and approximately 90% of harvest operations in Canada use the full tree to roadside system [16] in which trees are harvested and skidded to the landing site where trees are cut to specified dimensions and the non-merchantable portion is left to decay. Our analysis does not include harvest residues left on the harvest site itself (such as techniques described in [17] or [18]); the extraction of this type of biomass requires costly specialized equipment [19]. We also eliminated standing deadwood from our estimates of residual biomass supply, as standing dead trees are commonly required by provincial guidelines to remain on harvest sites for ecological reasons [20–22].

We have estimated residue extraction (including chipping) costs to be \$52 ODT^{-1} based on data from [23–25]. Extraction costs vary, depending on the type of machinery used, the processes involved, and the availability of personnel. Transportation cost estimates were based on the current road network and the locations of existing co-generation facilities in 2011. Information on the 89 cogeneration facilities across Canada used for this analysis is from the Canadian Industrial Energy End-Use Data and Analysis Centre data (CIEEDAC) [26]. We estimated the cost of transporting the biomass from each potential forest site to the nearest co-generation facility based on the transportation unit cost available from Forrester et al. [27]. Forrester et al. assessed fiber and biomass harvest transportation operations across Canada, and concluded separate prices for western and eastern provinces. Western provincial transportation costs (British Columbia, Alberta, Saskatchewan, and Manitoba) were estimated to be \$0.33 ODT^{-1} km^{-1} and eastern transportation costs (Ontario, Quebec, New Brunswick, Nova Scotia, and Newfoundland) were estimated at \$0.22 ODT^{-1} km^{-1}. An abundance of high-slope roads in the Canadian Rockies in western Canada explains the cost differences between eastern and western provinces. For each potential harvest site, the aggregated cost of biomass supply was estimated as a sum of on-site extraction and distance-dependent transportation costs.

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