

Biomass potentials in Northern Sweden

Forest biomass is a source of thermal heat and electrical generation in heat- and combined heat and power facilities, transportation fuels and a potential feedstock for many bio-based products. In this infosheet the potential amounts of forest biomass (roundwood, branches, foliage and stumps with attached roots) from final fellings and thinning are estimated for Northern Sweden. Three different levels of potential have been estimated.

HARVESTING PRODUCTS

Roundwood is the main product of harvesting operations, while branches, needles and tops (harvesting residues) and stumps with attached root system (stumps) are regarded as by-products of the forest operations.

The forest fuel availability in Sweden is 47 to 129 TWh according to previous estimations. About 12 TWh of forest fuels is extracted annually in Sweden, according to the official statistics. A previous study showed that the technical potential reaches about 43.7 TWh (Forest Impact Analyses 2008 (SKA 08)).

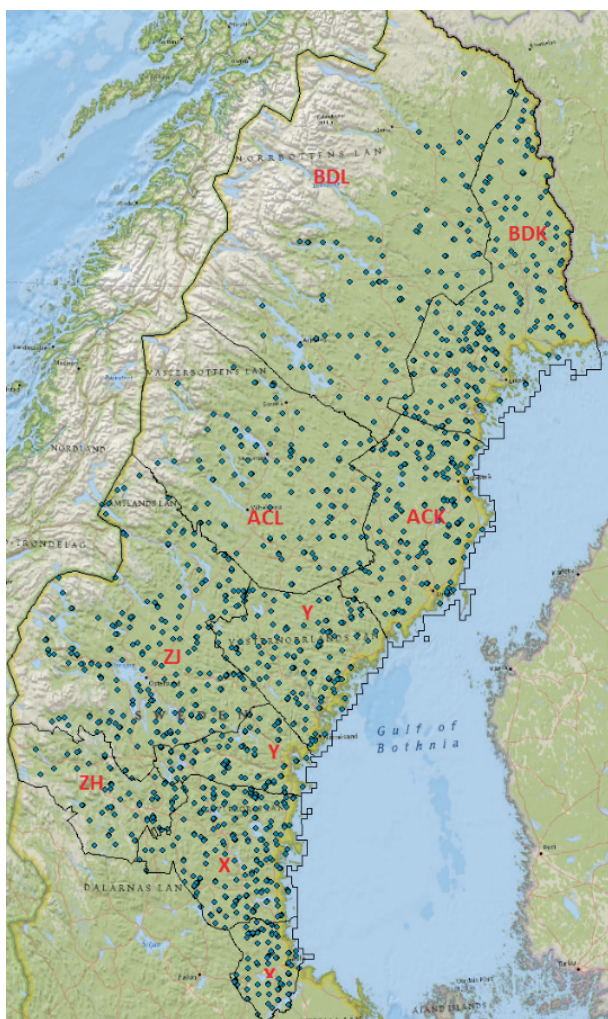
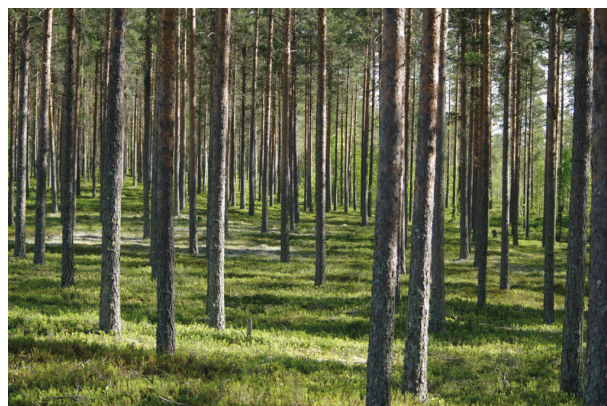


Figure 1. Swedish Forest Inventory (SFI) plots that were used for estimating the potentially available volumes of forest biomass in Northern Sweden.



METHODOLOGY

As a first step, the potentially available volumes and spatial distributions of roundwood, harvesting residues and stumps with roots larger than 5 mm in diameter are estimated. The inventoried region are Northern Sweden for the time period 2020–2024.

The estimations are based on Swedish Forest Inventory (SFI) plots that take into account all productive forests in Sweden, including areas within formally protected areas (e.g., national parks, nature reserves, etc.). The SFI plots (Fig. 1) describe the condition of the forest as it was in 2008–2012.

SIMULATION OF THREE LEVELS OF POTENTIAL FOREST BIOMASS OUTCOMES

In this study, we used a scenario which assumes that harvested volumes equal net growth in managed forest and that current management practices prevail. The climate scenario with a future average temperature rise of 2°C in 100 years is assumed (RCP 4,5).

1. Theoretical potential - Level 1

The maximum potential of forest biomass which can be considered theoretically available through harvesting operations

2. Ecological potential - Level 2

The fraction of the theoretical potential which is available after the application of ecological restrictions

3. Techno-economical potential - Level 3

The fraction of the ecological potential which is available after the application of techno-economical restrictions

4. Sawmill by-products

An estimation of the sawmill by-products that are currently produced in Northern Sweden

1. THEORETICAL POTENTIAL

The theoretical forest biomass potential is the total amount of forest biomass that potentially can be taken out of the forest if no consideration is taken to various ecological, technical, and economic constraints.

Table 1. Annual biomass potentials in Northern Sweden (Level 1; Theoretical potential).

		ACK	ACL	BDK	BDL	X	Y	ZH	ZI	Total
Pulpwood (km ³ fub)	Pine	682	538	864	683	884	482	277	565	4410
	Spruce	620	772	573	252	826	1254	169	1293	4466
	Birch	393	363	544	180	577	774	68	609	2899
	Total	1695	1673	1981	1115	2287	2510	514	2467	11775
Timber (km ³ fub)	Pine	911	678	915	895	1688	907	479	1020	6473
	Spruce	518	827	390	181	1048	1520	131	1407	4615
	Total	1429	1505	1305	1076	2736	2427	610	2427	11088
Bark (tonts)	Pine	51	40	59	51	81	44	25	49	351
	Spruce	59	90	55	29	80	129	17	145	459
	Birch	36	42	55	25	47	66	9	69	280
	Total	146	172	169	105	208	239	51	263	1090
Branches (tonts)	Pine	130	92	148	122	200	104	51	108	847
	Spruce	170	244	157	83	240	360	47	379	1301
	Birch	55	58	85	34	74	100	12	94	418
	Total	355	394	390	239	514	564	110	581	2566
Foliage (tonts)	Pine	47	41	54	52	69	38	25	46	326
	Spruce	103	141	97	51	151	213	27	215	783
	Birch	11	12	16	7	13	19	2	19	80
	Total	161	194	167	110	233	270	54	280	1189
Stumps and roots > 5 mm (tonts)	Pine	291	229	342	318	419	242	142	281	1983
	Spruce	285	432	260	135	402	632	81	681	2227
	Birch	120	133	189	81	151	214	27	216	915
	Total	696	794	791	534	972	1088	250	1178	5125
Wood under bark (tonts)	Pine	706	552	836	771	1098	620	357	715	5655
	Spruce	489	734	420	215	793	1171	150	1240	5212
	Birch	223	238	343	142	303	419	49	391	2108
	Total	1418	1524	1599	1128	2194	2210	556	2346	12975

2. ECOLOGICAL POTENTIAL

For level 2, a number of ecological restrictions were applied: Foliage, branches and stumps with roots attached were only taken out after final felling operations (with or without seed tree detainment).

Areas in soil moisture classes wet and moist, peat soils as well as areas with soil particle sizes fine silt, coarse silt and clay, were not considered for extraction of foliage, branches or stumps. For the rest of the areas the amount of extractable foliage, branches and stumps was reduced by 20% and no hardwood stumps were considered.

The quantities for pulpwood, timber, bark and wood under bark are the same as in Table 1 due to the fact that pulpwood and timber are taken out anyway while bark follows with.

3. TECHNO-ECONOMICAL POTENTIAL

The extraction of the whole techno-economical potential depends on the willingness of the forest owners to take out forest residues and stumps as well as on the use of supply chains that are designed and managed in such a way that are profitable.

Table 2. Annual biomass potentials in Northern Sweden (Level 2; Ecological potential).

		ACK	ACL	BDK	BDL	X	Y	ZH	ZJ	Total
Branches (tonts)	Pine	45	41	71	63	88	56	25	36	380
	Spruce	56	104	78	37	91	168	21	125	624
	Birch	-	-	-	-	-	-	-	-	-
	Total	101	145	149	100	179	224	46	161	1004
Foliage (tonts)	Pine	16	17	25	27	28	20	13	14	144
	Spruce	34	60	46	23	55	95	12	69	360
	Birch	-	-	-	-	-	-	-	-	-
	Total	50	77	71	50	83	115	25	83	504
Stumps and roots > 5 mm (tonts)	Pine	106	105	170	165	192	135	71	98	936
	Spruce	97	184	135	61	158	305	38	230	1111
	Birch	-	-	-	-	-	-	-	-	-
	Total	203	289	305	226	350	440	109	328	2047

Table 3. Annual biomass potentials in Northern Sweden (Level 3; Techno-economical potential).

		ACK	ACL	BDK	BDL	X	Y	ZH	ZJ	Total
Branches (tonts)	Pine	33	31	52	46	62	41	18	26	276
	Spruce	41	77	57	28	64	120	7	85	438
	Birch	-	-	-	-	-	-	-	-	0
	Total	74	108	109	74	126	161	25	111	714
Foliage (tonts)	Pine	12	13	18	20	20	14	9	10	104
	Spruce	24	45	34	17	39	69	4	46	254
	Birch	-	-	-	-	-	-	-	-	0
	Total	36	58	52	37	59	83	13	56	358
Stumps and roots > 5 mm (tonts)	Pine	78	79	125	120	136	99	50	71	680
	Spruce	70	136	98	45	109	219	11	158	776
	Birch	-	-	-	-	-	-	-	-	0
	Total	148	215	223	165	245	318	61	229	1456

Table 4. Current production of sawmill by-products in Northern Sweden.

Product	ACK	ACL	BDK	BDL	X	Y	ZH	ZJ	Total
Sawn wood produced (km³_{sawn})	1400	200	618	0	1235	1317	100	486	5 356
Timber needed (km³_{sub})	2800	400	1235	0	2470	2634	200	988	10 727
Timber needed (m³_{sob})	3146	449	1388	0	2775	2959	225	1110	12 052
Wet Chips (km³_{loose})	2100	300	926	0	1853	1936	150	732	7 997
Dry chips (km³_{loose})	224	32	99	0	198	202	16	84	855
Sawdust (km³_{loose})	1470	210	648	0	1297	1455	105	501	5 686
Bark (km³_{loose})	840	120	371	0	741	745	60	293	3 170
Total (km³_{loose})	4634	662	2044	0	4089	4338	331	1610	17 708
To Pulpmills (km³_{loose})	1680	240	741	0	1482	930	120	270	5 463
Used in the sawmill (km³_{loose})	588	84	259	0	519	326	42	95	1 913

4. SAWMILL BY-PRODUCTS

An estimation of the sawmill by-products that are currently produced in Northern Sweden is provided in Table 4. Producing energy from sawmill by-products creates an additional value to the traditional sawmill products. The foreseen anticipated production of advanced biofuels in bio-refineries through e.g. gasification, fermentation and hydrolysis will initially have sawmill by-products as a raw material.



CONCLUSIONS

- There is an important potential of forest biomass in Northern Sweden that can be used for heat and electricity production and also at biorefineries for production of biofuels and biomaterials.
- The highest part of the potential, is stumps but currently no stumps are extracted after final felling operations in Sweden.
- The techno-economic potential is roughly 30% of the theoretical potential when it concerns branches. This means that a big part of the branches remain for different reasons in the forest area after cutting.
- With an increasing demand for sawmill products such as planks and boards more by-products will be produced and less forest fuel will be needed for heat and electricity production.

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