



**EFORWOOD**  
Sustainability Impact Assessment  
of the Forestry - Wood Chain



Project no. 518128

EFORWOOD

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<b>PP</b>	Restricted to other programme participants (including the Commission Services)	
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## **Abstract**

Under the technology scenario several new or improved technologies are combined to increase the use efficiency of raw materials in saw milling and to produce higher quality sawn timber products that are tailored to the needs of consumers, which results in less use of raw material and/or an increased value added of the products. Two levels of the scenario will be applied on top of the A1 reference future in sawmilling processes in the Scandinavian Case. In the first level, although the new technologies provide better products with increased added value, the demand of wood products remains unchanged as compared to the reference future A1. The increased material efficiency, ensures that this demand can however be met with a reduced amount of sawn timber. In the second level, the increased quality of products enhances an increased demand in (high value added) wood products. Because there is also an increased material efficiency, the increased demand can be met with less volumes of sawn timber as if compared to a similar increased demand under the reference situation. This report includes a complete scenario description and an overview of quantitative scenario impacts on economic indicators (EFI-GTM runs).

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Effect on indicators, quantitative EFI-GTM results

## **1. Introduction**

The technology scenario is implemented in the Scandinavian Case. The scenario comprises a set of new technologies in the wood products value chain that will increase the efficiency of using of raw materials and/or at the same time increase the quality of end products, including the production of more value added wood components and the upgrading of sawn timber.

This document comprises a full overview of the technology scenario, including a description of the scenario (content), the boundary conditions and the two different levels under which the scenario is studied. Most importantly, the document provides an overview of impacts of two levels of the scenario on several key drivers of the FWC. Results can be used by data collectors in providing indicator values related to the two levels of this scenario

### *Reading guide:*

In chapter 2, a description of the scenario is given, including the two different levels that are applied. The boundary conditions under which the scenario will be studied are discussed and a brief overview of the technologies (a more detailed overview of the selected technologies is given in Appendix A) is given.

In chapter 3, results of the EFI-GTM runs are provided in graphs and tables.

## 2. Scenario description (see also PD 4.1.11)

The technology scenario is implemented in the Scandinavian Case. The scenario comprises a set of new technologies in the wood products value chain that will increase the efficiency of using of raw materials and/or at the same time increase the quality of end products, including the production of more value added wood components and the upgrading of sawn timber.

The technology scenario will be implemented:

- only in the Scandinavian Case
- only under the Reference future A1
- on 2 different (impact) levels

The “*Scandinavian regional case*” was appointed a forest-defined case, in comparison to the Iberian and the Baden-Württemberg, which are consumption defined and region-defined, respectively. This means that the case deals with the whole forest chain from the production and harvesting of the trees to the end-user of the forest product produced with the origin of the wood from Västerbotten.

A schematic overview of the material flows related to the wood products processing (M3, M4 and M5) in the Scandinavian case (from PD 2.0.5) is shown in figure 1.

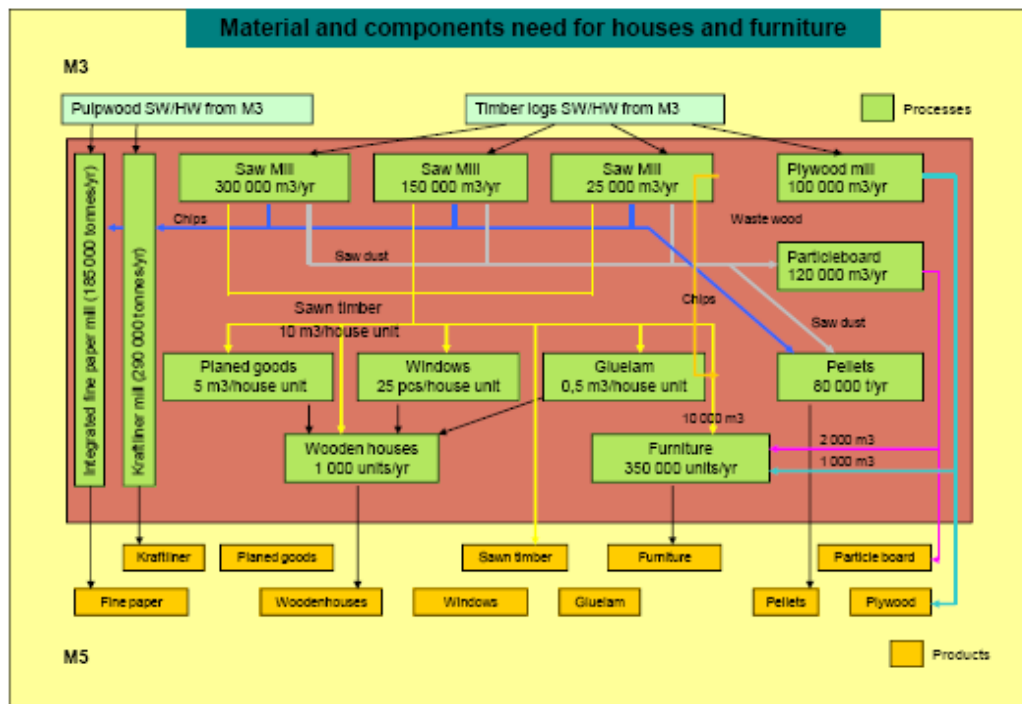


Figure 1. Overview of material flows related to wood products processing (M3, M4 and M5) in the Scandinavian Case (source: PD 2.0.5)

*The reference future A1* on which the technology scenario is built, describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. In general public awareness concerning environmental issues is low. (IPCC SRES).

### *Overview of technologies*

Under the technology scenario, several new or improved technologies are combined to increase the use efficiency of raw material and produce higher quality products that are tailored to the needs of consumers, which results in less use of raw material and/or an increased value added of the products. In fact, we study the combined effect of 4 different types of new technologies. The technologies are described individually and in detail in Appendix A. In short we characterise the different technologies below. In Figure 2, we also indicate the position of the technologies in the Scandinavian Chain:

- 1) Scanning of internal properties of stems and logs for optimizing sawing operations
- 2) Measuring systems for characterization and grading of sawn timber as well as supporting secondary conversion.
- 3) Information system and intelligent material flow control → not impacting the chain as such. It will be possible to track origin of wood however and it ensures the linkage of information between (1) and (2)
- 4) Value added components and upgrading of sawn timber into components with flexible and adaptive manufacturing systems for sawmills. Could be simplified and modelled as increased added value (and/or demand) in existing product groups (see figure 2)

### **Two impact levels:**

Two levels of the technology scenario will be explored.

#### ***Level 1:***

In the first level we assume that, although the new technologies in Scandinavian saw mills provide better products with increased added value, the demand of wood products in the EU remains unchanged as compared to the reference future A1. This means that the material flows to M5 remains unchanged as compared to reference future A1. The increased material efficiency, however, ensures that this demand can be met with a reduced amount of sawn timber, meaning that less timber logs will be needed from M3. Due to the decreased amount of timber logs and the decreased amount of sawmilling by-products (sawdust, bio-energy) from sawing, the pellet-, particle board, and pulp mills will receive less raw material from this source.

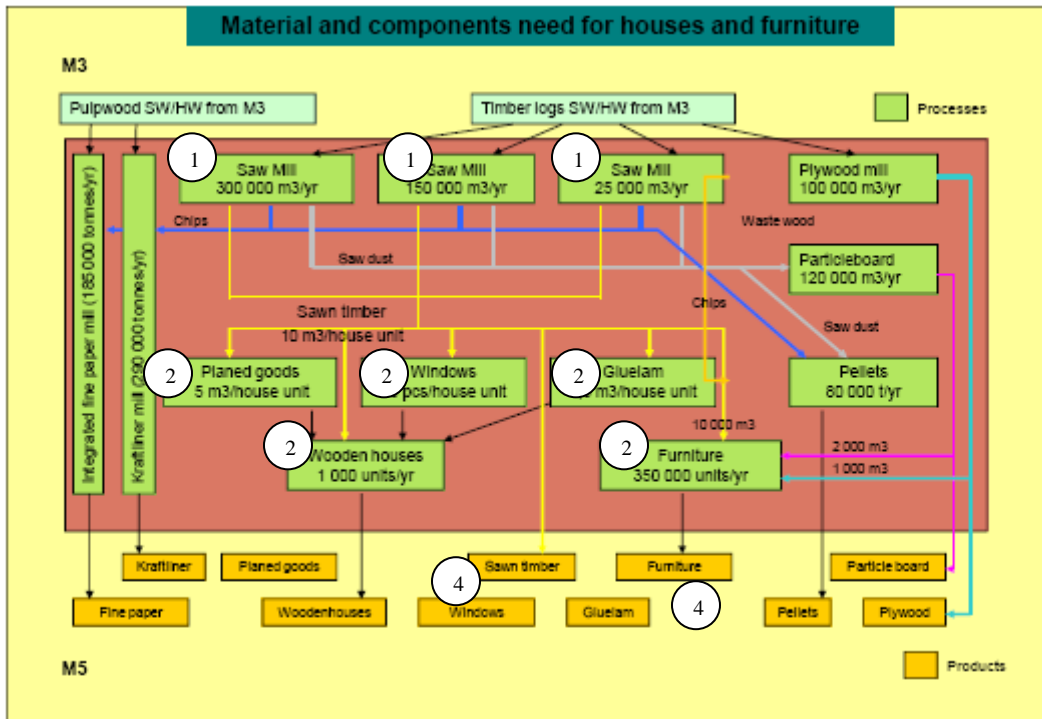


Figure 2. Overview of material flows and position of technologies in the wood products processing (M3, M4 and M5) in the Scandinavian Case (source: PD 2.0.5)

**Level 2:**

In the second level, apart from the new technologies with increased material efficiencies in Scandinavian saw mills (level 1), also the increased quality of products enhances a 50% increased demand in sawn wood products in the whole EU. This means that the wood product flow in M5 increases as compared to reference future A1. M4 needs to produce more timber products. Because there is also an increased material efficiency, the increased demand can be met with less volumes of sawn timber as if compared to a similar increased demand under the reference situation.

Basic assumptions in Scandinavia that were taken into account when running EFI-GTM:

- 2% increase in transportation costs (due to smaller batches and customer orientation)
- 5% increase in investment costs (due to new technology) in saw mills
- Increased share of sawn wood in output products (**OLD**: 50% sawn wood, 35% chips, 15% saw dust), (**NEW**: 55% sawn wood, 32% chips, 13% saw dust).

→ Level 2 further assumes a 50% increased demand in sawn wood products in the EU.



### 3. Results

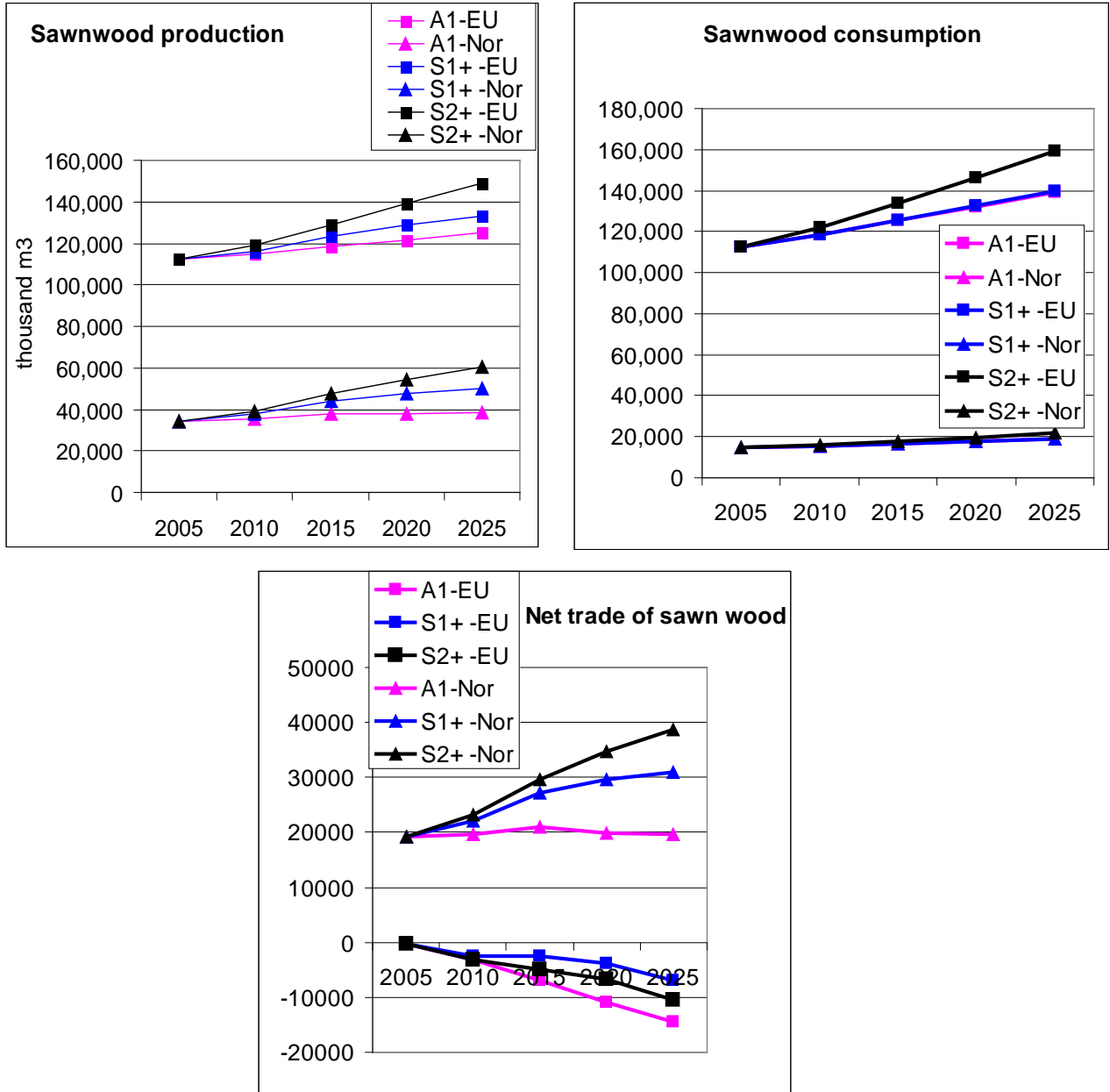


Figure 3. Effects of scenario on sawn wood production, consumption and net trade

In level 1 of the scenario there is an increased sawn wood production as compared to reference future A1, this effect is even higher in scenario level 2. The consumption of sawn wood is only increasing in level 2 of the scenario and this effect is much larger in the EU than in the Scandinavian countries. This gives the following results on the net trade of sawn wood:

Whereas in the reference future A1, the net trade in the Nordic countries is expected to be at similar levels as in 2005, in level 1 of the scenario there will be an increased export of sawn wood products from Scandinavian countries. This is because the production grows much faster than the consumption. This effect is even larger in scenario 2.

In the EU countries the net trade in reference future A1 is expected to decrease and more sawn wood product will be imported from outside EU. Both scenario level 1 and 2 have a positive impact on the trade balance (level 1 being more positive than level 2) although the net trade in both levels remains negative. The reason for this is the increased production from Scandinavian countries.

Table 1. Sawn wood production, consumption and net trade in Nordic countries and EU27 in reference future A1, scenario level 1 and scenario level 2.

Sawn wood	Reference future A1			Level1+(Scand. Tech)			Level2+(Scand. Tech+EUdemand)		
	Production								
Region	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	112,100	118,246	125,018	112,100	123,154	133,041	112,100	128,684	148,909
NORDIC	33,895	37,765	38,631	33,894	43,994	50,081	33,894	47,560	60,557
Consumption									
REGION	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	112,454	125,262	139,411	112,454	125,608	139,942	112,454	133,687	159,428
NORDIC	14,698	16,712	19,071	14,698	16,772	19,183	14,698	17,847	21,802
Net trade									
REGION	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	-354	-7,016	-14,392	-354	-2,455	-6,900	-354	-5,004	-10,519
NORDIC	19,197	21,053	19,561	19,196	27,222	30,899	19,196	29,713	38,755

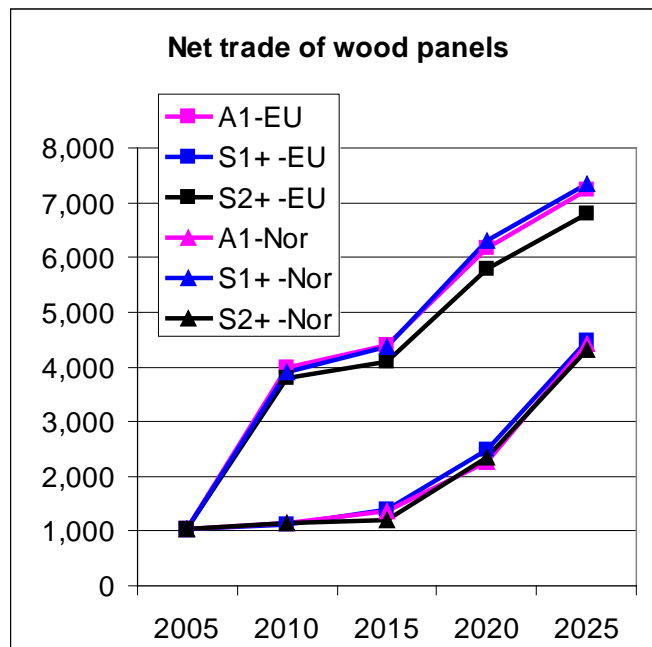
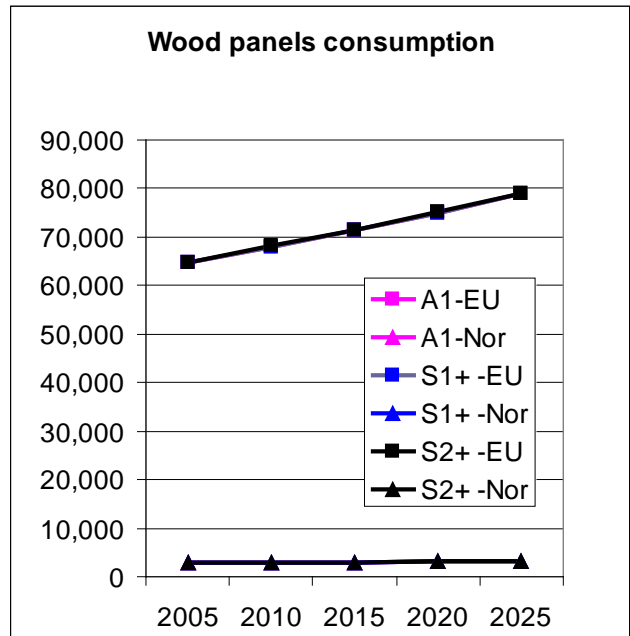
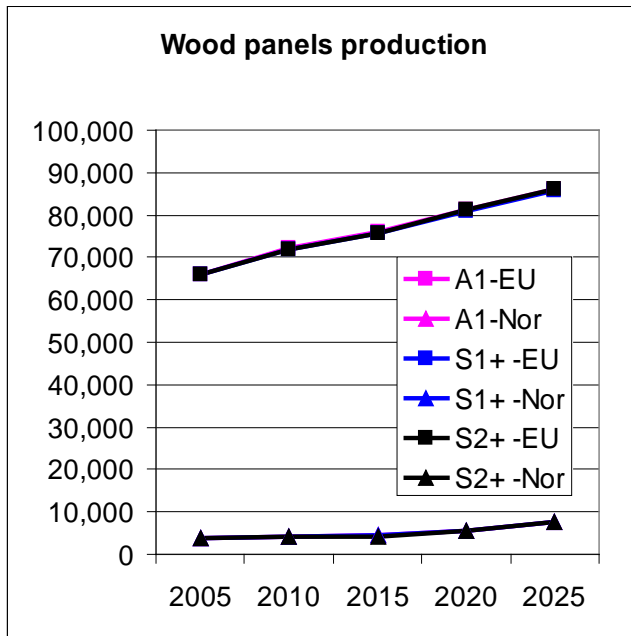


Figure 4. Effects of scenario on wood panels production, consumption and net trade

No significant changes in wood panels consumption are observed as compared to reference future A1. The production of wood panels in the Nordic countries decreases slightly in both scenario's, but a little more in scenario 2. The EU production of wood panels decreases slightly in level 1 and increases as little in level 2. The net trade of wood panels in the EU (positive in A1) decreases in level 1 and increases in level 2. The reason is that in level 1 less, and in level 2 more, wood panels are produced in the EU than in ref. A1. The trade balance of the Scandinavian countries decreases a little under both scenario's mostly in level 2.

Table 2. Wood panels production, consumption and net trade in Nordic countries and EU27 in reference future A1, scenario level 1 and scenario level 2.

Wood Panels	reference future A1			Level1+(Scand. Tech)			Level2+(Scand. Tech+EUdemand)		
	2005	2015	2025	2005	2015	2025	2005	2015	2025
<b>Production</b>									
Region	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	65,899	75,879	86,083	65,899	75,559	85,620	65,899	75,854	86,194
NORDIC	3,827	4,414	7,786	3,827	4,387	7,721	3,827	4,233	7,605
<b>Consumption</b>									
REGION	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	64,855	71,476	78,840	64,855	71,463	78,823	64,855	71,478	78,849
NORDIC	2,798	3,032	3,296	2,798	3,032	3,295	2,798	3,033	3,298
<b>Net trade</b>									
REGION	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	1,044	4,403	7,243	1,044	4,096	6,797	1,044	4,376	7,344
NORDIC	1,030	1,381	4,490	1,030	1,356	4,427	1,030	1,200	4,307

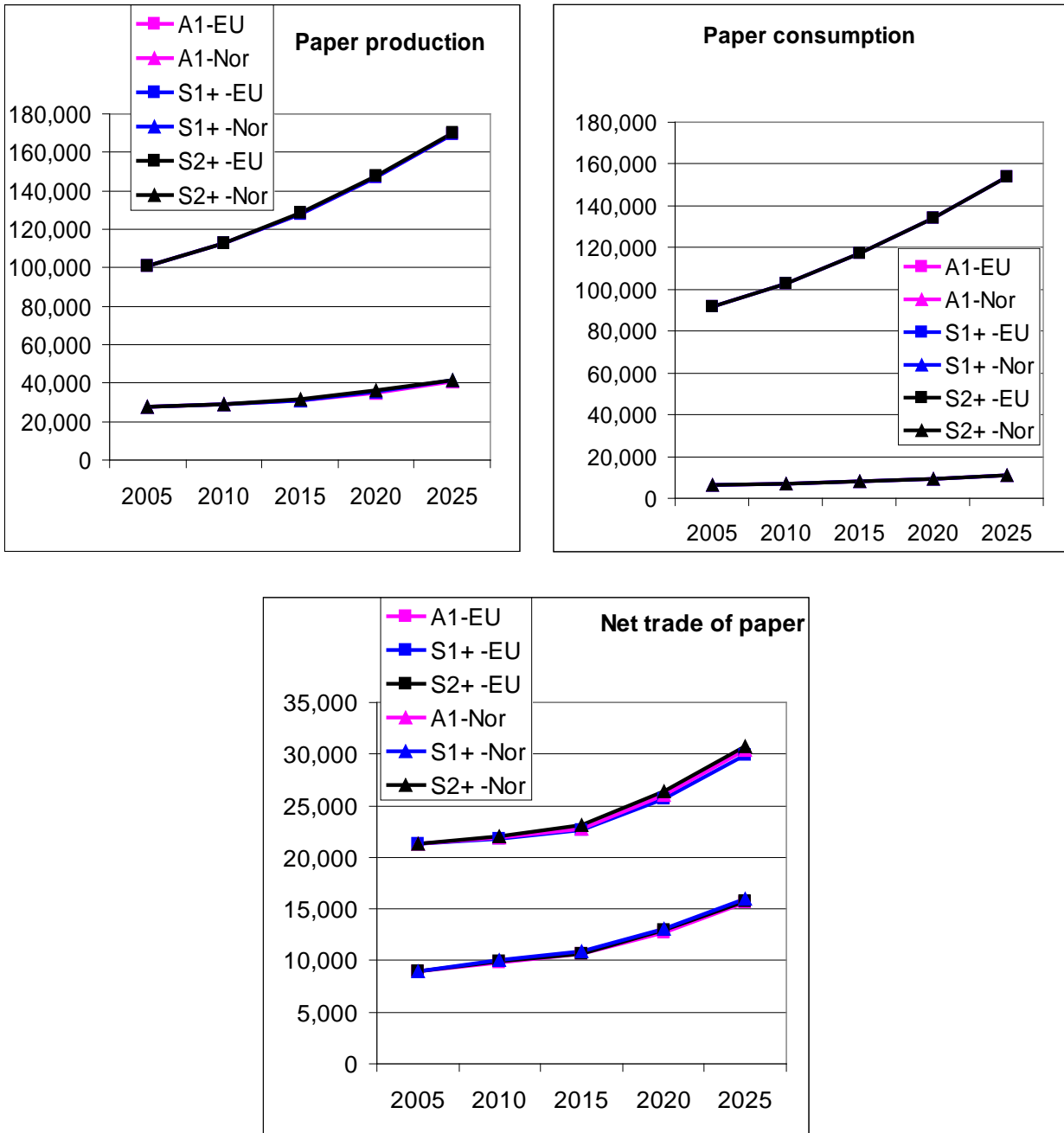


Figure 5. Effects of scenario on paper production, consumption and net trade

No significant changes in paper consumption are observed as compared to reference future A1. The production of paper in both the Nordic countries as well as in the total EU increases however, very slightly in both scenario's, mostly in scenario 2 (+/- 2%). The effect on the net trade is therefore positive in both Nordic countries as well as in the total EU. Effects are very small in general however.

Table 3. Paper production, consumption and net trade in Nordic countries and EU27 in reference future A1, scenario level 1 and scenario level 2.

Paper	reference future A1			Level1+(Scand. Tech)			Level2+(Scand. Tech+EUdemand)		
	2005	2015	2025	2005	2015	2025	2005	2015	2025
<b>Production</b>									
Region	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	100,763	128,110	169,483	100,763	128,212	169,603	100,763	128,355	169,784
NORDIC	27,586	30,932	40,880	27,586	31,004	41,323	27,586	31,327	41,708
<b>Consumption</b>									
REGION	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	91,835	117,495	153,816	91,835	117,495	153,813	91,835	117,511	153,849
NORDIC	6,300	8,235	10,970	6,300	8,236	10,969	6,300	8,238	10,973
<b>Net trade</b>									
REGION	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	8,928	10,615	15,667	8,928	10,717	15,789	8,928	10,844	15,935
NORDIC	21,286	22,697	29,910	21,286	22,768	30,353	21,286	23,089	30,734

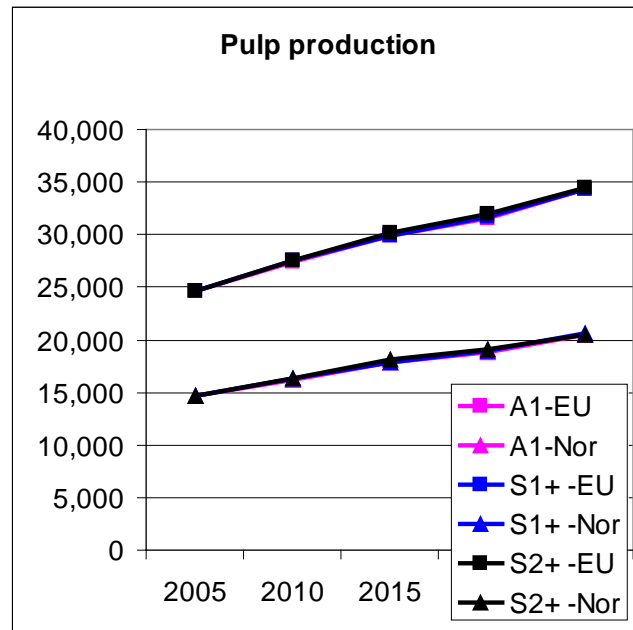


Figure 5. Effects of scenario on pulp production.

No large effects of the scenario on pulp production are found, only small ones. In the EU pulp production decreases slightly in level 1 and increases slightly in level 2. This is exactly the other way around in the Nordic countries.

Table 4. pulp production in Nordic countries and EU27 in reference future A1, scenario level 1 and scenario level 2.

Pulp	reference future A1			Level1+(Scand. Tech)			Level2+(Scand. Tech+EUdemand)		
	2005	2015	2025	2005	2015	2025	2005	2015	2025
Region	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	24,647	29,946	34,278	24,647	29,913	34,257	24,647	30,162	34,475
NORDIC	14,662	17,894	20,515	14,662	17,888	20,561	14,662	18,091	20,495

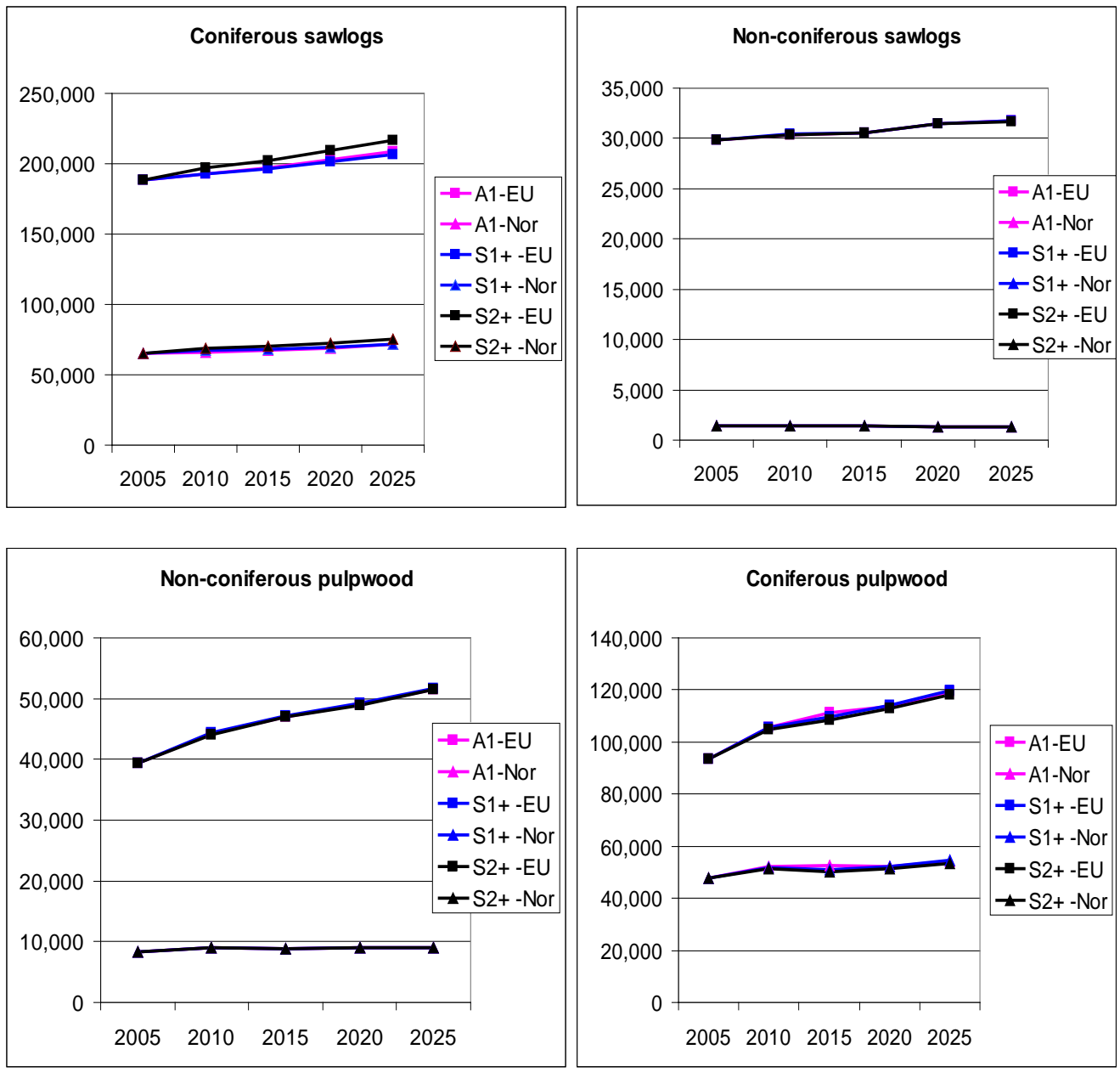


Figure 5. Effects of scenario on harvesting levels of non-coniferous and coniferous saw logs and pulpwood.



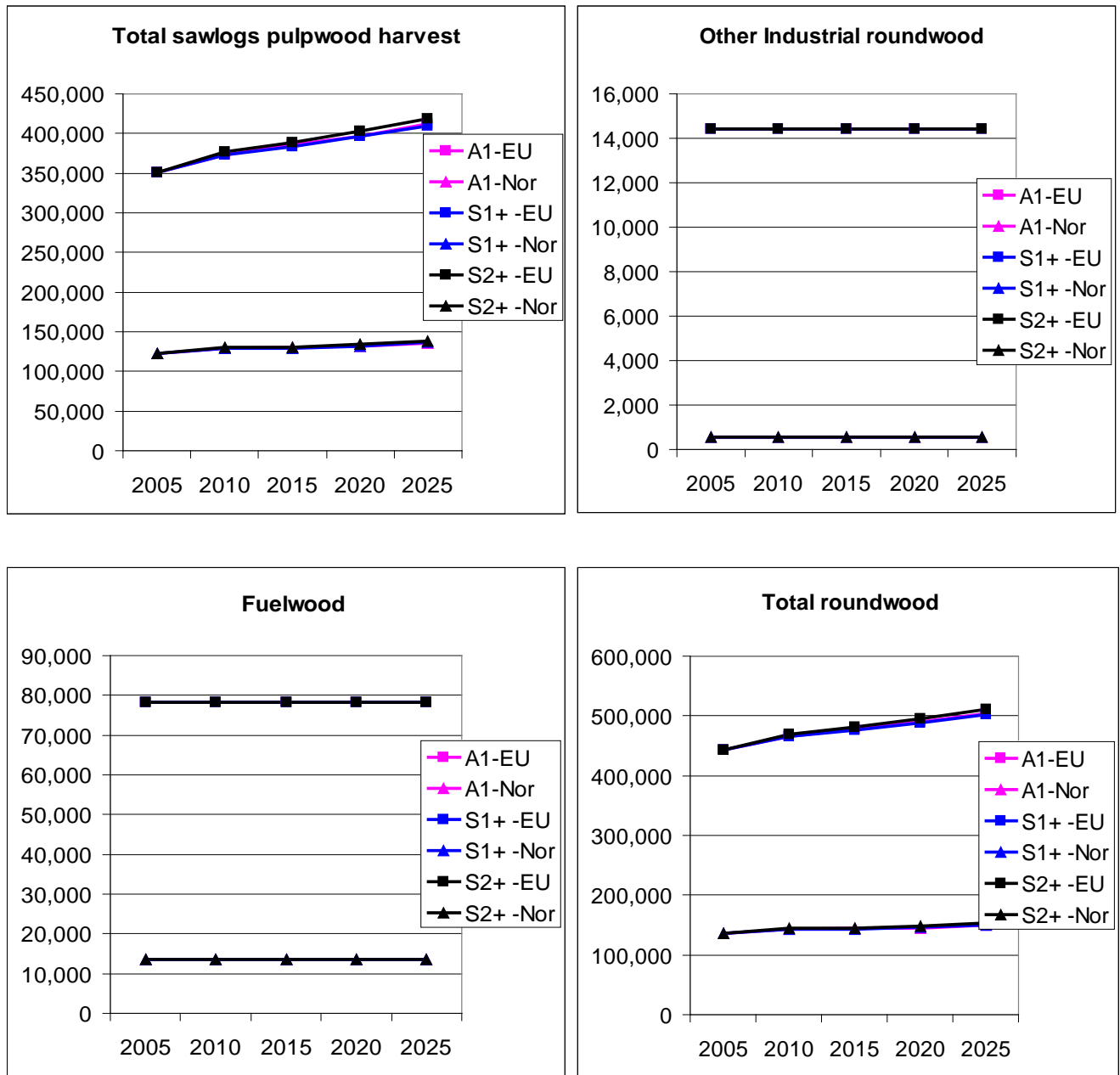


Figure 6. Effects of scenario on harvesting levels of total saw logs and pulpwood, fuelwood, other industrial roundwood and total roundwood.

Table 5. Harvesting levels of several types in EU 27, in reference future A1,scenario level and scenario level 2

REGION	EU27			EU27			EU27		
	A1			Level 1			Level 2		
PERIOD	2005	2015	2025	2005	2015	2025	2005	2015	2025
Coniferous sawlogs	188,479	197,097	208,920	188,478	196,329	206,673	188,478	202,356	216,770
Non-coniferous sawlogs	29,863	30,569	31,734	29,863	30,571	31,715	29,863	30,551	31,696
Non-coniferous pulpwood	39,364	47,034	51,557	39,364	47,156	51,695	39,364	46,944	51,492
Coniferous pulpwood	93,441	111,240	119,325	93,441	109,624	119,691	93,441	108,454	118,312
Total sawlogs & pulpwood harvest	351,148	385,939	411,536	351,146	383,681	409,774	351,146	388,305	418,270
Other Industrial roundwood	14,407	14,407	14,407	14,407	14,407	14,407	14,407	14,407	14,407
Fuelwood	78,215	78,215	78,215	78,215	78,215	78,215	78,215	78,215	78,215
Total roundwood	443,770	478,561	504,158	443,768	476,303	502,396	443,768	480,927	510,892

Table 6. Harvesting levels of several types in Nordic countries, in reference future A1, scenario level and scenario level 2

REGION	NORDIC			NORDIC			NORDIC		
	A1			Level 1			Level 2		
PERIOD	2005	2015	2025	2005	2015	2025	2005	2015	2025
Coniferous sawlogs	65,006	67,147	71,509	65,005	67,940	71,718	65,005	70,412	75,070
Non-coniferous sawlogs	1,414	1,407	1,313	1,414	1,409	1,313	1,414	1,408	1,313
Non-coniferous pulpwood	8,349	8,787	8,952	8,349	8,809	8,972	8,349	8,774	8,936
Coniferous pulpwood	47,849	52,735	54,397	47,849	50,910	54,615	47,849	50,096	53,476
Total sawlogs & pulpwood harvest	122,617	130,077	136,170	122,616	129,068	136,617	122,616	130,690	138,794
Other Industrial roundwood	549	549	549	549	549	549	549	549	549
Fuelwood	13,472	13,472	13,472	13,472	13,472	13,472	13,472	13,472	13,472
Total roundwood	136,639	144,098	150,191	136,638	143,089	150,638	136,638	144,711	152,816

Effects on harvesting levels seem to be highest with coniferous saw logs. The harvesting level increases in level 2 and decreases in level 1. The level of harvesting of coniferous pulpwood in 2015 is lower than in A1 but this effect is invisible in 2025. The same can be said for non-coniferous pulpwood although the absolute effect is so small that it probably can be ignored. No effects on harvesting of non-coniferous saw logs, fuel wood and other industrial round wood can be observed.

Total saw log and pulpwood harvest in the EU is lower in level 1 as compared to reference future A1 and higher in level 2. In the Nordic countries harvesting levels in levels 2 are higher than in A1. In scenario level 1, harvesting levels are first slightly lower, but in 2025 also here harvesting levels are higher than in reference future A1.

The effect of scenario levels 1 and 2 on total round wood harvesting in the Nordic countries are both positive, although more round wood is harvested under level 2. In the total EU, a little less round wood is harvested in level 1. In level 2 with increased demands of wood products, more round wood harvesting is expected in the EU.

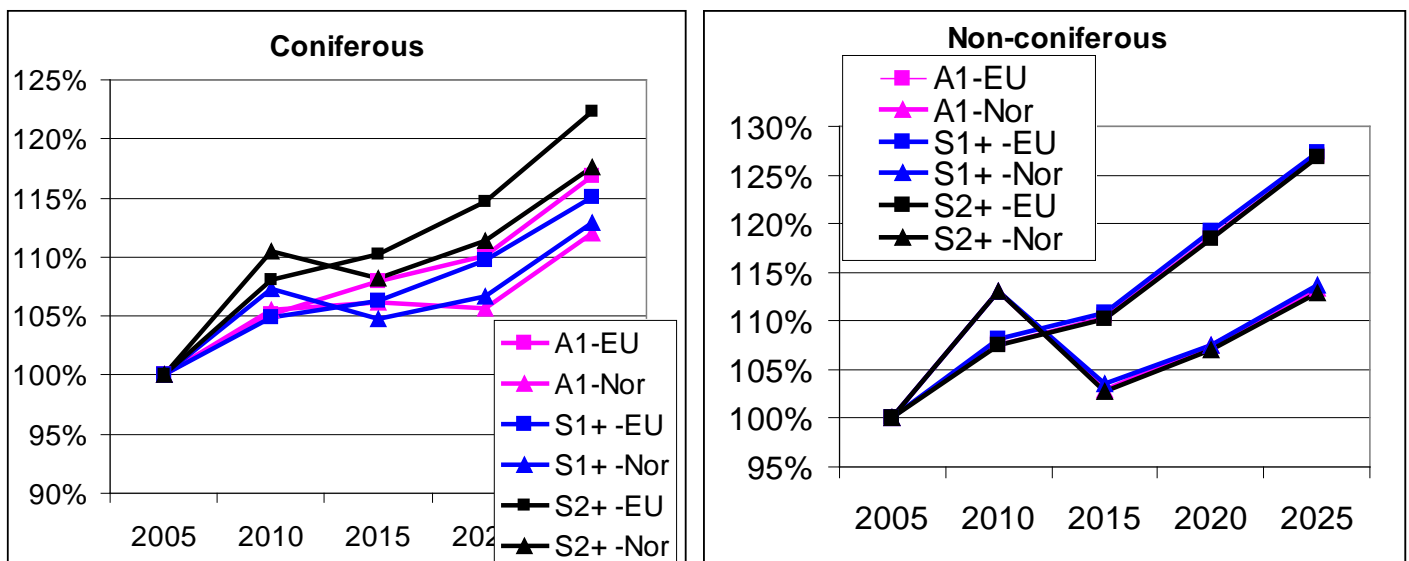


Figure 7. Effects of scenario on coniferous and non-coniferous industrial round wood prices.

Coniferous industrial round wood prices in the Nordic countries increase under both scenario levels, but much higher in level 2. In the EU, prices increase in level 2 and slightly decrease in level 1. The scenario has hardly any impact on non-coniferous industrial round wood prices in both EU and Nordic countries.

Table 7. Coniferous and non-coniferous industrial roundwood price developments in Nordic countries and EU 27, for reference future A1, scenario level and scenario level 2

**Coniferous industrial roundwood price development (2005 - 100%)**

REGION	A1			Level 1			Level 2		
	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	100%	108%	117%	100%	106%	115%	100%	110%	122%
NORDIC	100%	106%	112%	100%	105%	113%	100%	108%	118%

**Non-coniferous industrial roundwood price development (2005 - 100%)**

REGION	A1			Level 1			Level 2		
	2005	2015	2025	2005	2015	2025	2005	2015	2025
EU27	100%	111%	127%	100%	111%	127%	100%	110%	127%
NORDIC	100%	103%	113%	100%	104%	114%	100%	103%	113%

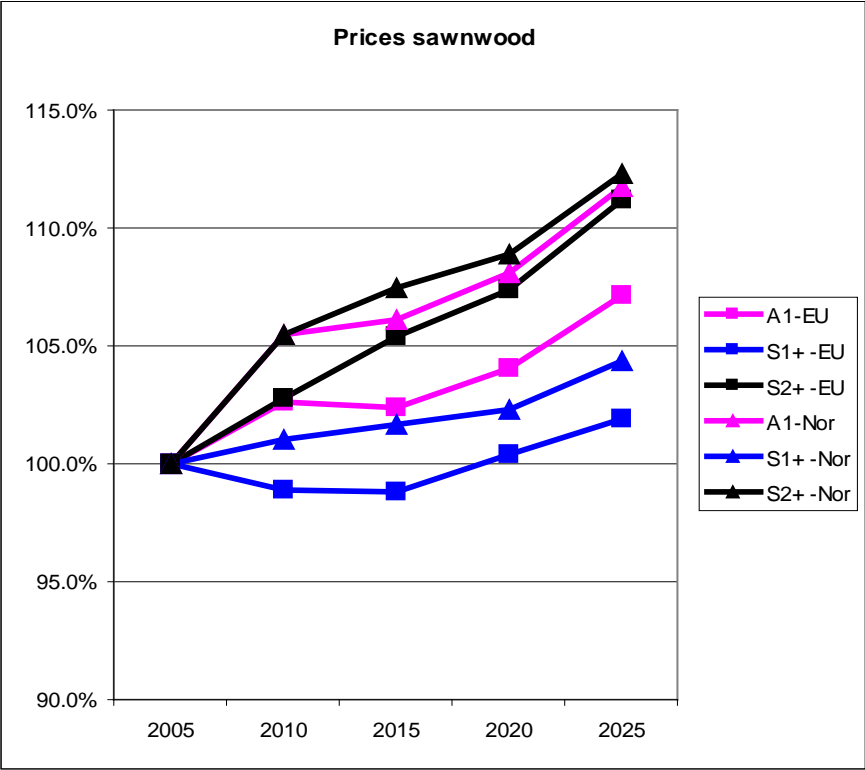
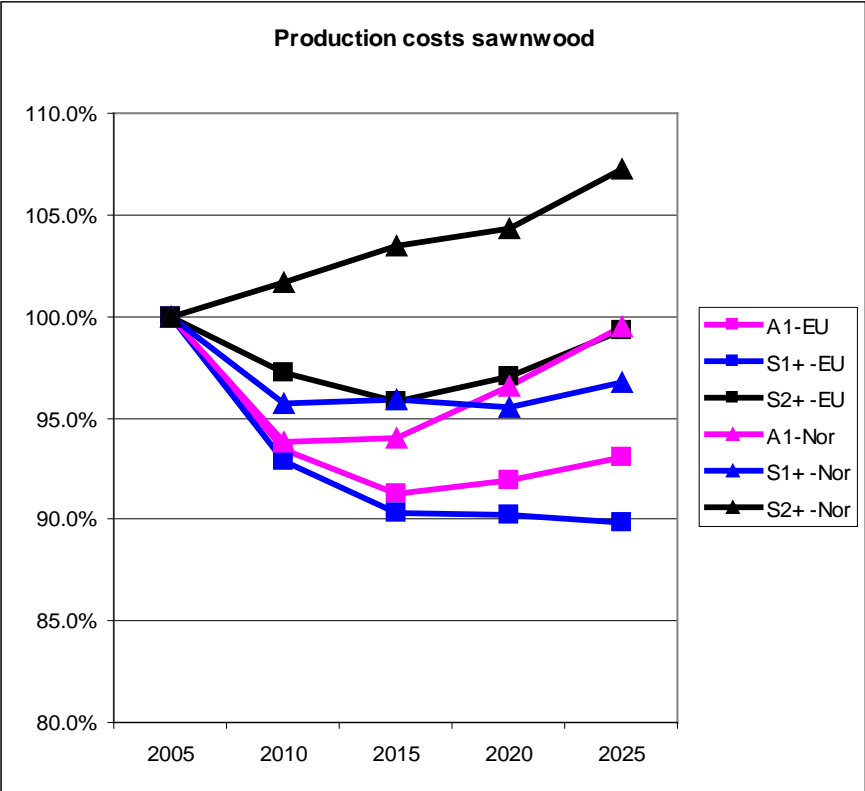


Figure 8. Effects of scenario on production costs and prices of sawn wood.

Figure 8 shows the effect of the scenario on production costs and prices of sawn wood. Under the A1 reference future, the production costs of sawn wood would decrease in 2025 with 6.9% in the EU and with 0.5% in the Nordic countries. In level 1 of the scenario, there will be a further reduction in costs for both Nordic countries and EU27. In level 2, however the production costs increase as compared to A1. This causes even a net raise in production costs of sawn wood in the Nordic countries with 7.2% as compared to 2005.

Sawn wood prices are expected to increase in the reference future A1 (7.1% in EU and 11.7 % in Nordic countries). Level 1 of the scenario has a negative effect on sawn wood prices in both EU and Nordic countries. The result is only a small prices increase in 2025 (1.9 % in EU27 and 4.4. in Nordic area) as compared to 2005. In level 2 of the scenario prices increase further than in the reference future, 11.2 % in EU 27 and 12.3% in the Nordic countries, as compared to 2005.

Table 8. Sawn wood production costs and price developments in Nordic countries and EU 27, for reference future A1, scenario level and scenario level 2

	Production costs sawn wood				Prices sawn wood		
	2005	2015	2025		2005	2015	2025
A1-EU	100.0%	91.2%	93.1%	A1-EU	100.0%	102.4%	107.1%
S1+ -EU	100.0%	90.3%	89.9%	S1+ -EU	100.0%	98.8%	101.9%
S2+ -EU	100.0%	95.8%	99.3%	S2+ -EU	100.0%	105.4%	111.2%
A1-Nor	100.0%	94.0%	99.5%	A1-Nor	100.0%	106.1%	111.7%
S1+ -Nor	100.0%	95.9%	96.7%	S1+ -Nor	100.0%	101.7%	104.4%
S2+ -Nor	100.0%	103.4%	107.2%	S2+ -Nor	100.0%	107.4%	112.3%

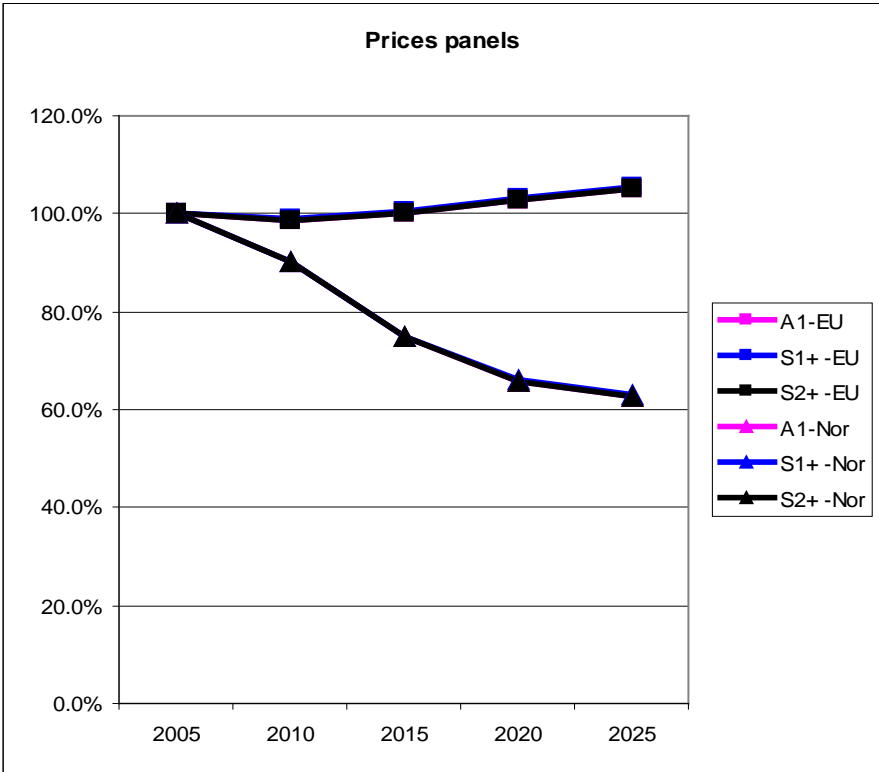
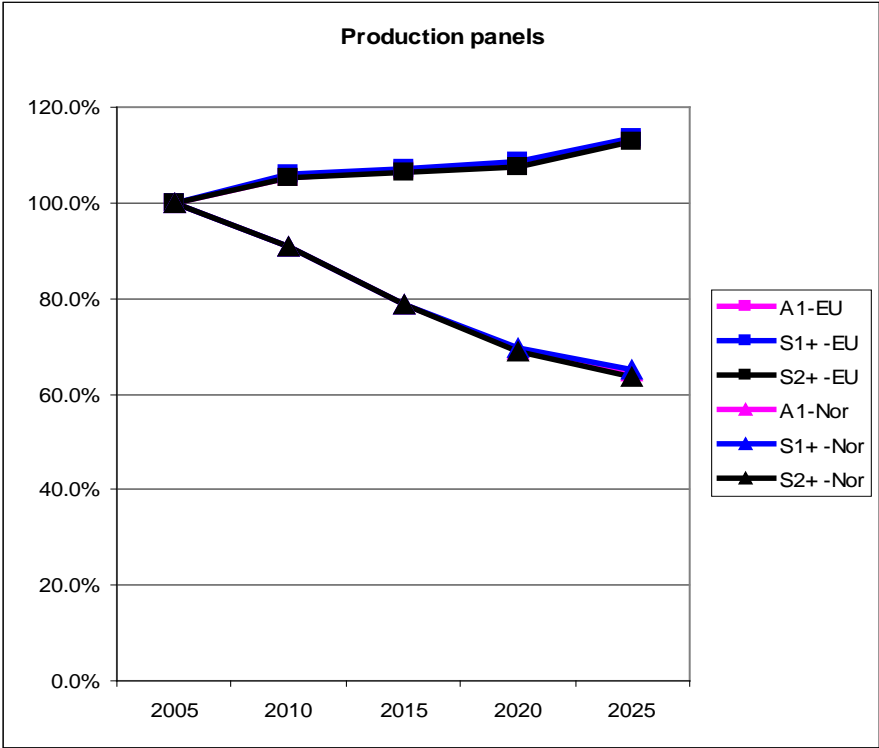


Figure 9. Effects of scenario on production costs and prices of wood panels.



The effect of the scenario levels 1 and 2 on the production costs and prices of panels is only very small. Level 1 has a slight increasing effect on both production costs and prices of panels in the EU27 and in the Nordic countries, level 2 has a slight decreasing impact.

Table 9. Panel production costs and price developments in Nordic countries and EU 27, for reference future A1, scenario level and scenario level 2

	Production costs panels				Prices panels		
	2005	2015	2025		2005	2015	2025
A1-EU	100.0%	106.7%	113.2%	A1-EU	100.0%	100.3%	105.1%
S1+ -EU	100.0%	107.1%	113.6%	S1+ -EU	100.0%	100.5%	105.3%
S2+ -EU	100.0%	106.4%	112.9%	S2+ -EU	100.0%	100.2%	104.9%
A1-Nor	100.0%	78.8%	64.8%	A1-Nor	100.0%	74.9%	62.9%
S1+ -Nor	100.0%	78.8%	65.2%	S1+ -Nor	100.0%	75.0%	63.0%
S2+ -Nor	100.0%	78.6%	63.6%	S2+ -Nor	100.0%	74.8%	62.6%

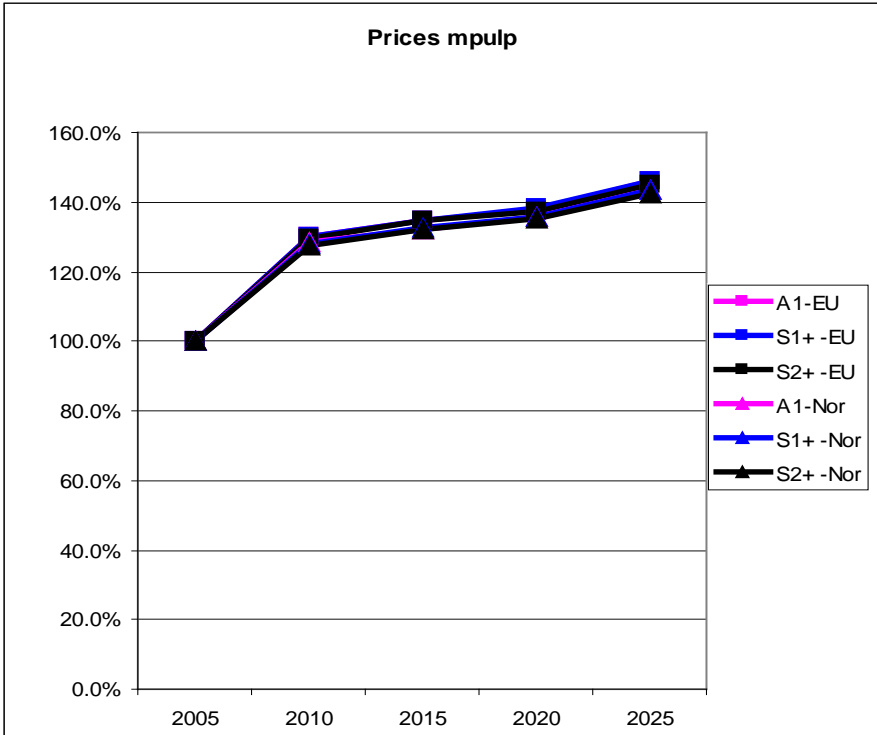
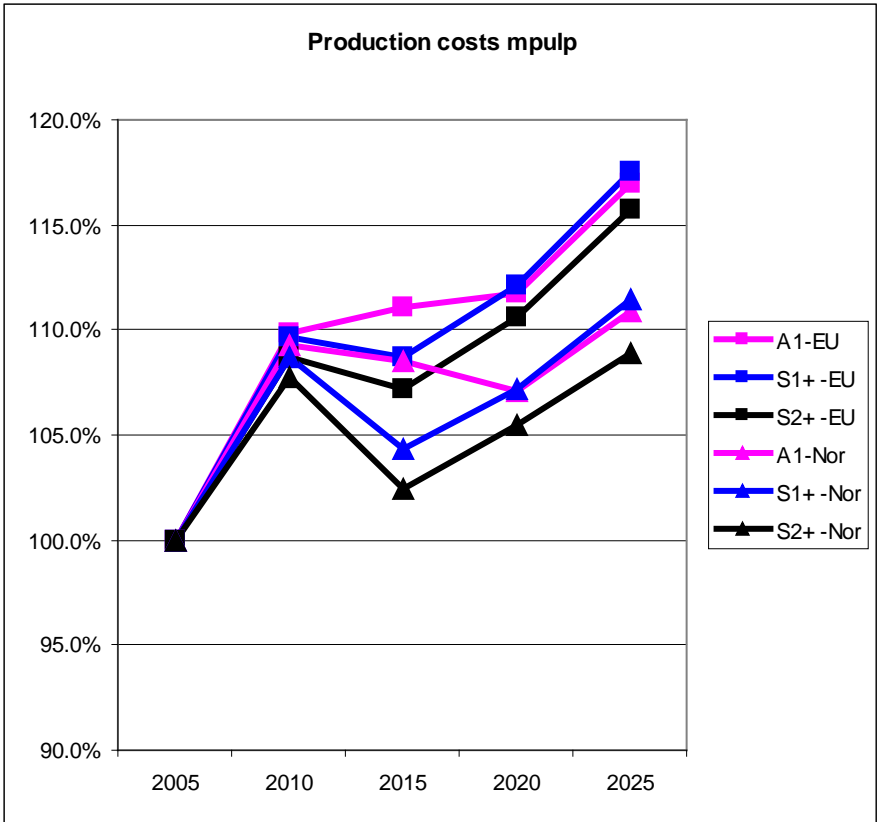


Figure 10. Effects of scenario on production costs and prices of market pulp.

Pulp production costs appear to increase quite drastically both in Nordic countries and in EU27 in reference future A1. The increase is slightly enhanced under scenario 1. In scenario 2, the pulp production costs decrease somewhat as compared to A1.

Pulp prices increase with almost half the price of 2005 according to the results in reference future A1. Our scenario level 1 contributes to the increase a little bit more whereas scenario 2 has a slightly decreasing effect on price increases.

Table 10. Pulp production costs and price developments in Nordic countries and EU 27, for reference future A1, scenario level and scenario level

	Production costs mpulp				Prices mpulp		
	2005	2015	2025		2005	2015	2025
A1-EU	100.0%	111.1%	117.0%	A1-EU	100.0%	134.6%	145.9%
S1+ -EU	100.0%	108.7%	117.6%	S1+ -EU	100.0%	134.9%	146.2%
S2+ -EU	100.0%	107.2%	115.7%	S2+ -EU	100.0%	134.5%	144.9%
A1-Nor	100.0%	108.5%	110.9%	A1-Nor	100.0%	132.3%	143.4%
S1+ -Nor	100.0%	104.3%	111.5%	S1+ -Nor	100.0%	132.5%	143.7%
S2+ -Nor	100.0%	102.4%	108.9%	S2+ -Nor	100.0%	132.1%	142.3%

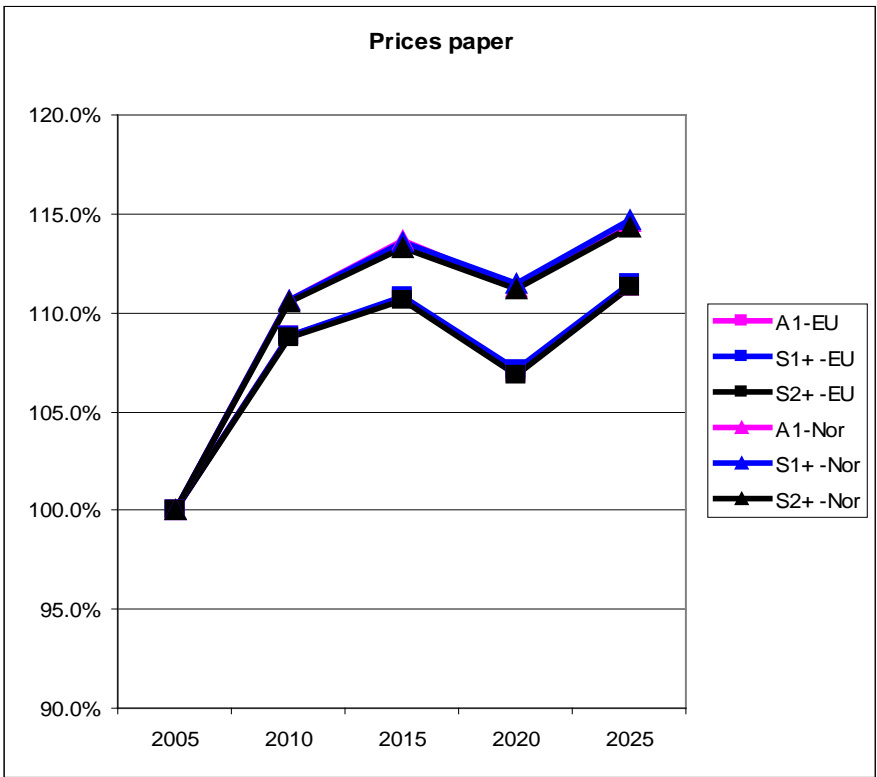
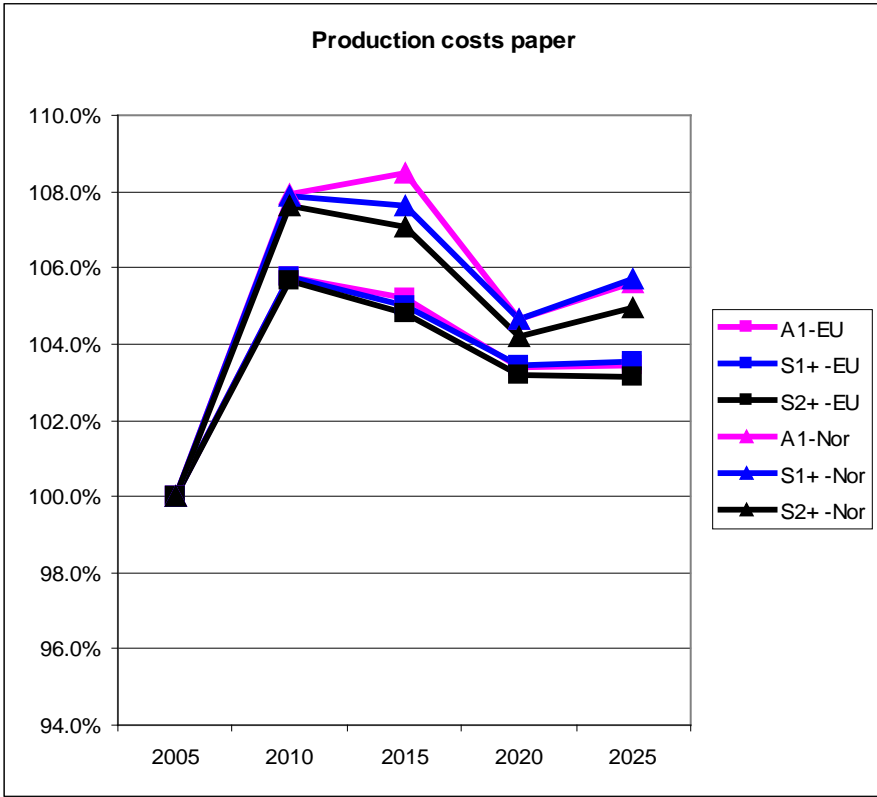


Figure 11. Effects of scenario on production costs and prices of market pulp.

The effect on paper production costs and prices is shown in Figure 11 and Table 11. Paper production costs are expected to increase with 3.4 % in EU and with 5.6% in te Nordic countries in reference future A1 (2025). Scenario level 1 has a minor increasing effect on the production costs as compared to A1. In level 2, production costs tend to decrease somewhat as compared to A1. Prices of paper appear to increase considerably in reference future A1 (2025). This effect is both in EU27 and Nordic countries, slightly enhanced in scenario level 1 and slightly diminished in level 2.

Table 11. Paper production costs and price developments in Nordic countries and EU 27, for reference future A1, scenario level and scenario level

	Production costs paper				Prices paper		
	2005	2015	2025		2005	2015	2025
A1-EU	100.0%	105.2%	103.4%	A1-EU	100.0%	110.7%	111.3%
S1+ -EU	100.0%	105.0%	103.5%	S1+ -EU	100.0%	110.8%	111.5%
S2+ -EU	100.0%	104.8%	103.1%	S2+ -EU	100.0%	110.6%	111.2%
A1-Nor	100.0%	108.5%	105.6%	A1-Nor	100.0%	113.6%	114.6%
S1+ -Nor	100.0%	107.6%	105.7%	S1+ -Nor	100.0%	113.6%	114.7%
S2+ -Nor	100.0%	107.1%	104.9%	S2+ -Nor	100.0%	113.3%	114.3%