European Network of
Transmission System Operators
for Electricity

NORDIC HVDC UTILIZATION AND UNAVAILABILITY STATISTICS 2013

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REGIONAL GROUP NORDIC

1 SUMMARY

This report presents the availability and utilization of HVDC links connected to the Nordic power system in 2013, with an emphasis on disturbance outages.

In the past four years, the HVDC statistics was a chapter in the Nordic Grid Disturbance Statistics. They have now been separated into two reports. The original statistics continue to report the disturbances of the AC grid while this concentrates on the HVDC systems.

In 2013, 34.3 TWh of electric energy was transmitted through the Nordic HVDC links. 65 disturbance outages were registered, preventing 2.7 TWh of potential energy transmission. Three disturbance outages, with the duration of approximately two months each, was the main reason for this loss in transmission capacity. Fenno-Skan 1 had a cable fault near the Finnish coast in February, The Baltic Cable had a cable fault in July and the NorNed link had a disturbance in the converter station in Eemshaven, Netherlands, in October.

Maintenance outages caused 2.2 TWh and limitations caused 3.5 TWh of reduced transmission capacity.

This report presents methods and definitions and statistics for 2013: An overview of availability and utilization for all links, a closer look on the disturbances and separate presentations of the performance of each HVDC link.

2 INTRODUCTION AND BACKGROUND

The total HVDC power transmission capacity connected to the Nordic power systems is 6620 MW. Internally in the synchronous system, Fenno-Skan 1 and 2 provides an HVDC power transmission capacity of 1350 MW between Sweden and Finland. See Figure 2.1.

FIGURE 2.1 PART OF THE NORDIC GRID MAP SHOWING THE HVDC LINKS. THE ARROW INDICATES THE DIRECTION OF EXPORT

The total annual HVDC energy transmission capacity is 69 TWh, which makes HVDC links important components for the stable operation of the Nordic power system, and the essential infrastructure for commercial power trade in the European energy markets. Hence, the advantages of keeping HVDC links in operation as much of the time as possible are obvious.

Disturbances do happen, but high quality hardware components, thorough installation routines, and fault analysis combined with preventive maintenance are means to limit the number of such unfortunate events. Planned outages and limitations due to maintenance work are necessary, but should be planned and conducted as efficient as possible. The result is more available capacity for energy transmission through HVDC links.

Therefore, mapping the availability capacity, including the reasons for unavailability, is of vital interest for the utilization of this infrastructure. Furthermore, the utilization of the links is of interest in itself since this is the action which actually realizes the value through energy trade.

3 Scope

The scope of these statistics differs from the scope of the CIGRÉ HVDC statistics, which concentrate on the outages, faults and disturbances of the HVDC links, including the converter stations.

The main interest of the DISTAC HVDC statistics is a macro view on the *availability* and *utilization* of the HVDC links, including total outages and limitations. Disturbance outages are more thoroughly examined than other events.

4 METHODS, DEFINITIONS AND CALCULATIONS

This chapter explains the categories of the DISTAC HVDC statistics. Interesting details in the collected data will be emphasized.

The utilization of HVDC link capacities can be calculated by using the data received from SCADA, grid operation, market departments, Urgent Market Messages (UMMs) of the Nord Pool Spot and measurements on each side of a link.

The process of collecting and sorting data for these statistics will be described in the guidelines of this report. This chapter describes how the collected data is defined and used in the calculations.

The technical capacity E_{max} of the HVDC link is the maximum energy that can be transmitted from the AC grid to the converter station on the exporting side, including all HVDC link losses, if there are no outages or limitations:

$$E_{\mathrm{max}} = P_{\mathrm{R}} \times 24 \times d \qquad (3.1)$$

P_R is the rated power capacity and d is the number of days in the reported time period (month or year). The column in Figure 4.1describes the nine main categories of these statistics, as well as aggregated categories used for simplified presentations.

In Figure 4.1, E_{max} is represented as the total height of the column. This section explains the mutual exclusivity and mathematical consistence of all categories used in the DISTAC HVDC statistics.

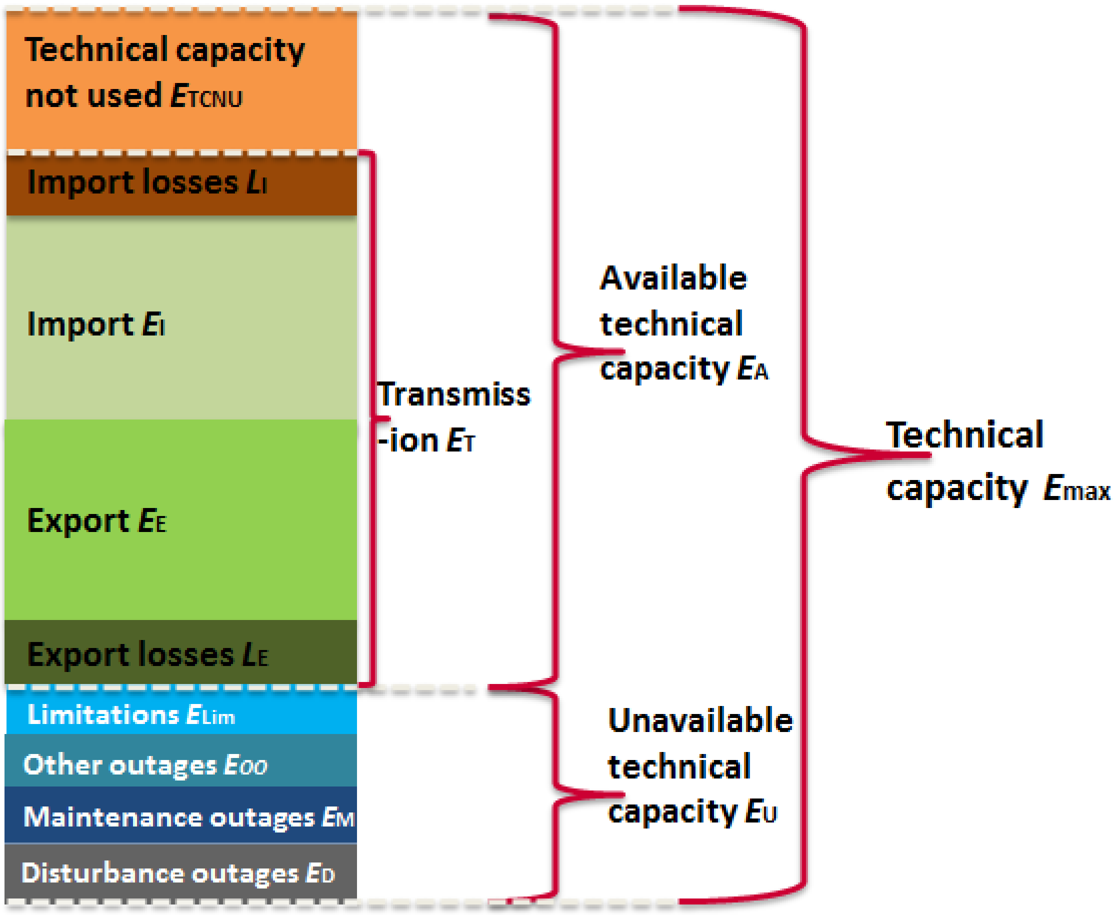

FIGURE 4.1 THE CATEGORIES USED IN THE DISTAC HVDC STATISTICS. DEFINITIONS AND CALCULATIONS ARE EXPLAINED IN CHAPTER 4. EVERY VALUE IS AN ENERGY VALUE AND REPRESENTS A PART OF THE AVAILABLE OR UNAVAILABLE TECHNICAL CAPACITY. THE NINE CATEGORIES OF THE COLUMN TO THE LEFT ARE INTERNALLY EXCLUSIVE AND THEIR SUM AMOUNTS TO THE TOTAL TECHNICAL CAPACITY.

The technical capacity of the link is a theoretical value and can be divided into **available (E_A) or unavailable (E_U) technical capacity**. The unavailable technical capacity E_U is due to outages or limitations.

An **outage** is *any* state when a component is disconnected from the system and the transfer capacity is reduced to zero. There are different types of outages:

- **Disturbance outages (E_D)** are *total outages* due to a fault on the HVDC link or in the AC grid causing a *total outage* of the link.
- **Maintenance outages (E_M)** are *total outages* due to all technically motivated actions on the HVDC link or in the AC grid intended to retain an entity in, or restore it to, a state where it can perform its required function.
- **Other outages (E_{OO})** are *total outages* due to any other reason except those mentioned above.

The energy transfer E_D, E_M and E_{OO} made unavailable due to disturbance, maintenance and other outages are calculated by multiplying the **rated power P_R** by the duration of the outage, respectively h_D, h_M and h_{OO}:

$$E_D = P_R \times h_D \quad (3.2)$$

$$E_{\mathrm{M}} = P_{\mathrm{R}} \times h_{\mathrm{M}} \tag{3.3}$$

$$E_{\mathrm{OO}} = P_{\mathrm{R}} \times h_{\mathrm{OO}} \tag{3.4}$$

A limitation (E_{Lim}) is a condition when the transmission capacity of an HVDC link is limited, i.e. the power transmission capacity of the link is less than the rated power. The limitation is always motivated from a technical perspective, but not always concerning the link itself. The most common causes of limitations are:

- faults on any HVDC link component as long as they do not cause a total outage;
- faults, congestions or outages in the AC grid causing a limitation in the transmission capacity of the link;
- seasonal variations on the transmission capacity of the HVDC link;[1]
- link capacity reserved as power reserves.

Limitations lasting less than ten minutes should not be reported. In the scope of this statistics report, these limitations are too small to have an actual significance on the presented data. Hence, short ramping limitations and commutation failures are not cases included in this category.

Limitations are calculated by multiplying the **limited power capacity (P_{Lim})** by the **duration of the limitation in hours (h_{Lim})**:

$$E_{\mathrm{Lim}} = P_{\mathrm{Lim}} \times h_{\mathrm{Lim}} \tag{3.5}$$

This allows a mathematical description of the **unavailable technical capacity E_U** as the part of technical capacity that is *not* available for transmission due to outages (disturbance, maintenance, other) and limitations:

$$E_U = E_{\mathrm{D}} + E_{\mathrm{M}} + E_{\mathrm{OO}} + E_{\mathrm{Lim}} = P_{\mathrm{R}} \times (h_{\mathrm{D}} + h_{\mathrm{M}} + h_{\mathrm{OO}}) + P_{\mathrm{Lim}} \times h_{\mathrm{Lim}} \tag{3.6}$$

The counterpart to E_U is the **available technical capacity E_A**, which consists of the remaining of the **maximum technical capacity E_{max}**. This equals the capacity used for **transmission (E_T)** and **technical capacity not used E_{TCNU}.**

$$E_{\mathrm{A}} = E_{\mathrm{max}} - E_{\mathrm{U}} = E_{\mathrm{T}} + E_{\mathrm{TCNU}} \tag{3.7}$$

Transmission E_T is the sum of exported and imported energy including losses:

$$E_{\mathrm{T}} = E_{\mathrm{E}} + L_{\mathrm{E}} + E_{\mathrm{I}} + L_{\mathrm{I}} \tag{3.8}$$

Imported energy E_I is energy transferred from the HVDC link to the importing AC side. It does not include **import losses L_I**; energy losses in any of the HVDC link components during import.

[1] The transmission capacity of some links is limited during the summer season due to less convection of heat from transmission losses. Full capacity is as rated by the manufacturer, and is given for all links in Table 5.1.

Exported energy E_E and **export losses L_E** are explained likewise, with an opposite point of view. E_E from one side of the link equals E_I considered from the opposite side of the link.

Technical capacity not used E_{TCNU} can now be calculated:

$$E_{\mathrm{TCNU}} = E_{\max} - E_{\mathrm{U}} - E_{T} = \\ E_{\max} - (P_{\mathrm{R}} \times (h_{\mathrm{D}} + h_{\mathrm{M}} + h_{\mathrm{OO}}) + P_{\mathrm{Lim}} \times h_{\mathrm{Lim}}) - (E_{\mathrm{E}} + L_{\mathrm{E}} + E_{\mathrm{I}} + L_{\mathrm{I}}) \quad (3.9)$$

Technical capacity not used (E_{TCNU}) is what remains when all other categories are mapped and calculated. The content of this category is complex and consists of both technical and market related details. The most important of these are:

- When bidding differences between the markets on each side of the HVDC link are too small to promote transmission, in spite of technical availability. The link is still available and can be used for balancing or transmitting emergency power, and hence not disconnected.
- Any limitations lasting less than ten minutes (does not include total outages):
    - Ramping time: When the power flow is changed the capacity is fully released to the market. Note that, depending on the type of converter technology, the nominal voltage, and hence the full transmission capacity, may not be obtained immediately.
    - Commutation failures may interrupt the power transmission. In the CIGRÉ statistics, commutation failures are categorized as 'transient disturbances'.
    - Emergency power is not usually used for more than ten minutes for a given event. Longer lasting disturbances will be registered as outages or limitations.

5 Technical details of the HVDC links

Tables 5.1 and 5.2 present the main properties of the HVDC links covered in the statistics. Capacities are given as power flow *to* the links from the exporting side.

Table 5.1 Technical details of the HVDC links

Name of the link	Commissioning year	Market connection (Y/N)	Type of HVDC converter	Rated power, monopolar (MW)	Parallel monopolar capacity (MW)	Bipolar capacity (MW)	Defined positive power direction (N–S, E–W)
Baltic Cable	1994	Y	LCC	600/600			N–S
Estlink 1	2006	Y	VSC	350			N–S
Fenno-Skan 1	1989	Y	LCC	550 / 550	1350/1350	1350/1350	E–W
Fenno-Skan 2	2011	Y	LCC	800/800			E–W
Kontek	1986	Y	LCC	600/600			N–S
Konti-Skan 1	2008	Y	LCC	370 / 370	740/740		E–W
Konti-Skan 2	1988	Y	LCC	370 / 370			E–W
NorNed	2008	Y	LCC	730 / 730			N–S
Skagerrak 1	1976–1977	Y	LCC	250 / 250	1000 / 1000	1000 / 1000	N–S
Skagerrak 2		Y	LCC	250 / 250			N–S
Skagerrak 3	1993	Y	LCC	500 / 500			N–S
Storebaelt	2010	Y	LCC	600/600			E–W
SwePol	2000	Y	LCC	600/600			N–S
Vyborg Link	1981, 1982, 1984, 2000			1400			E–W

Table 5.2 Technical details of the HVDC links

Name of the link	Total length of the link (km)	Length of mass cable (km)	Length of PEX cable (km)	Length of DC overhead line (km)	Length of DC back-to-back connection (km)
Baltic Cable	262	250		12	
Estlink 1	105		105		
Fenno-Skan 1	233	200		33	
Fenno-Skan 2	299	196		103	
Kontek	160		160		
Konti-Skan 1	150	89		61	
Konti-Skan 2	150	89		61	
NorNed	580	580			
Skagerrak 1	240	128.5		111.5	
Skagerrak 2	240	128.5		111.5	
Skagerrak 3	240	128.5		111.5	
Storebaelt	57		57		
SwePol	254	254			
Vyborg Link	< 1				< 1

6 Presentation of the Results for 2013

6.1 Introduction

The following sections in this chapter present the availability and utilization of each link. The unavailable technical capacity (E_U) due to disturbance outages, the origins that triggered the events, and the performance of all the HVDC links connected to the Nordic power system in 2013 are presented and explained.

During 2013 there were 65 disturbance outages affecting the HVDC links connected to the Nordic power system. The disturbances caused a capacity reduction that corresponds to 2.68 TWh (3.8%) of the total technical HVDC energy transmission capacity.

Maintenance outages amounted to 2.17 TWh (3.1%), and limitations reduced the transmission capacity by 3.5 TWh (5.0%) of the total technical HVDC energy transmission capacity.

6.2 OVERVIEW

Figure 6.2.1 presents the overview of the HVDC statistics at an aggregated level. This enables a comparison between the connections. It should be noted that the usages of the links show big variations. Most links are market dependent, some are mostly used only in one direction, and some are used for technical reasons to control power flow for system stability according to agreements.

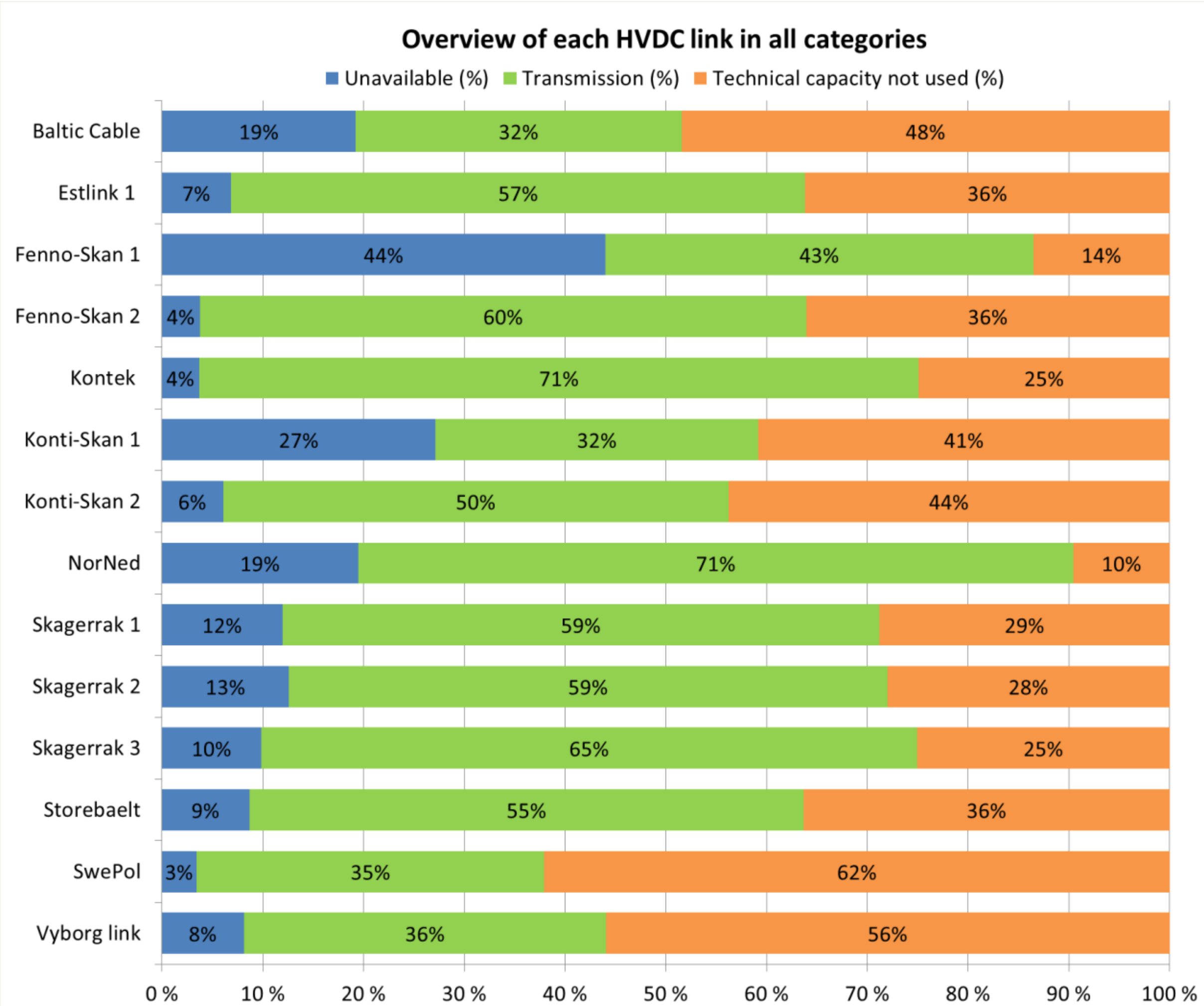

FIGURE 6.2.1 ANNUAL OVERVIEW OF EACH HVDC LINK IN 2013. THE CATEGORIES REFER TO CHAPTER 4 'METHODS, DEFINITIONS AND CALCULATIONS' FOR AN EXPLANATION TO THEM.

Figure 6.2.2 presents the percentage unavailable technical capacity (E_U) of the annual technical capacity E_{max} due to the disturbance outages. The comments are added below.

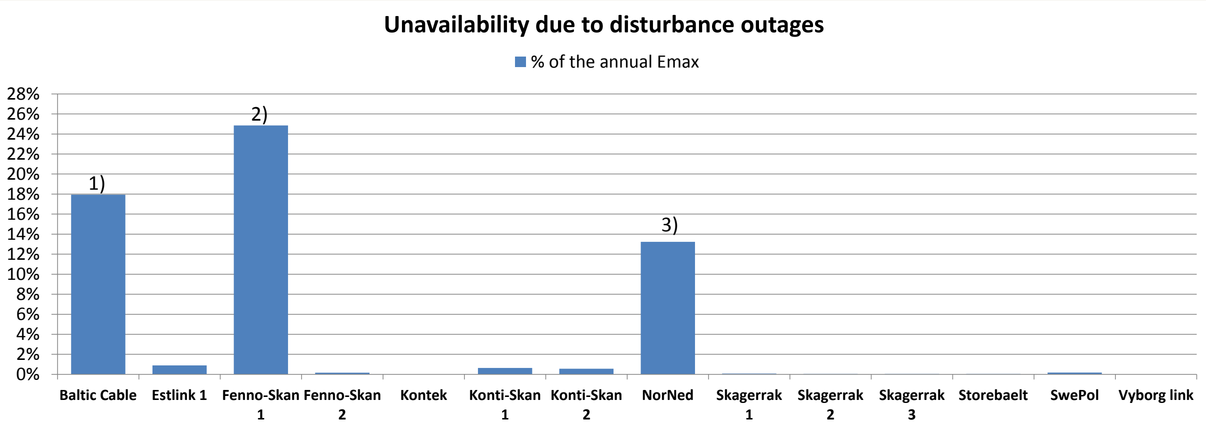

FIGURE 6.2.2 PERCENTAGE DISTRIBUTION OF UNAVAILABLE TECHNICAL CAPACITY E_U DUE TO DISTURBANCE OUTAGES FOR EACH LINK IN 2013

1) There were 5 minor disturbances and one 65-day long outage caused by a cable fault.

2) A major disturbance outage, caused by a cable fault near the Finnish coast, took place between February 12 and April 12.

3) In the evening of October 28, hard wind tore off the roof of the converter station at Eemshaven substation in Netherlands exposing the power electronic components to rain. This caused a disturbance outage and a long-lasting repair. The NorNed HVDC link was back in operation on December 18.

Figure 6.2.3 presents all disturbance outages according to 'origin of event', as shown in Appendix A.

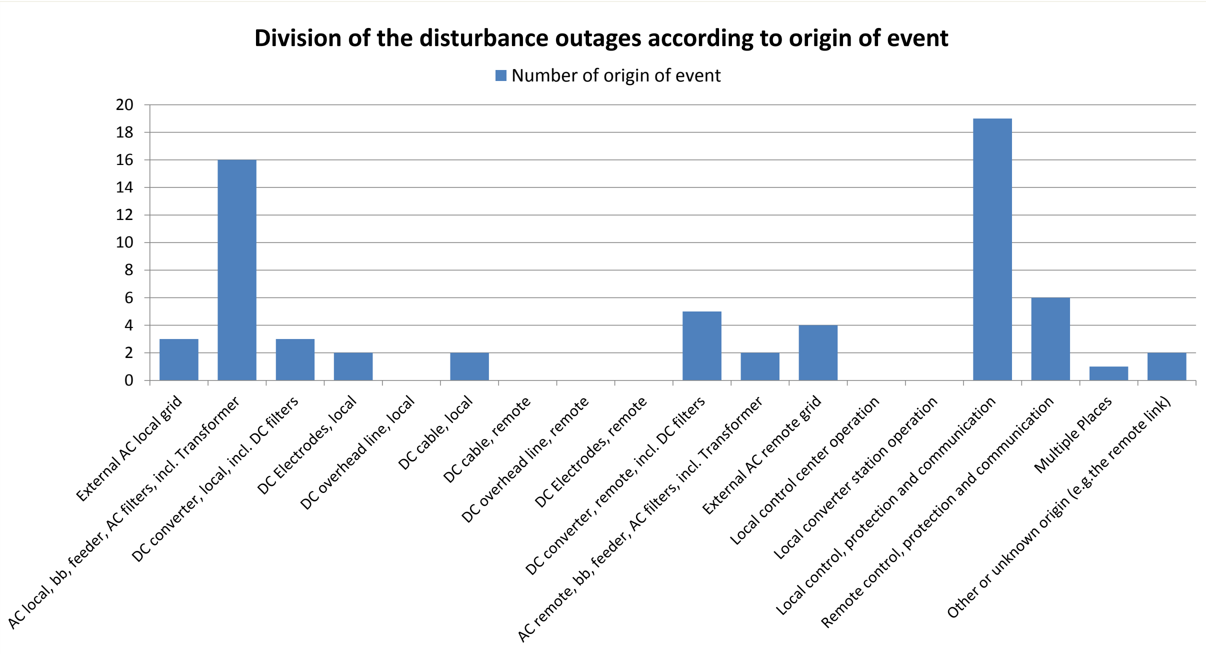

FIGURE 6.2.3 THE TOTAL NUMBER OF DISTURBANCE OUTAGES DIVIDED ACCORDING TO ORIGIN OF EVENT IN YEAR 2013

6.3 SEPARATE PRESENTATIONS OF ALL LINKS

This section presents the performance of each HVDC link. The categories used in the following presentations of each separate HVDC link are presented and defined in Chapter 4.

Note that the sums in the tables for each link show a technical capacity E_{max} higher than the E_{max} stated in the diagram. This is due to power flow over the rated technical power capacity of the links. Other times, when power flow is under the rated technical capacity (and there is no limitation reported), the difference is registered in the category 'technical capacity not used'.

6.3.1 THE BALTIC CABLE

Figure 6.3.1 presents the results of The Baltic Cable for 2013. The Baltic Cable is connected between southern Sweden (bidding zone SE4) and Germany (bidding zone DE-TenneT). The operations started in 1994 and the transmission capacity is 600 MW.

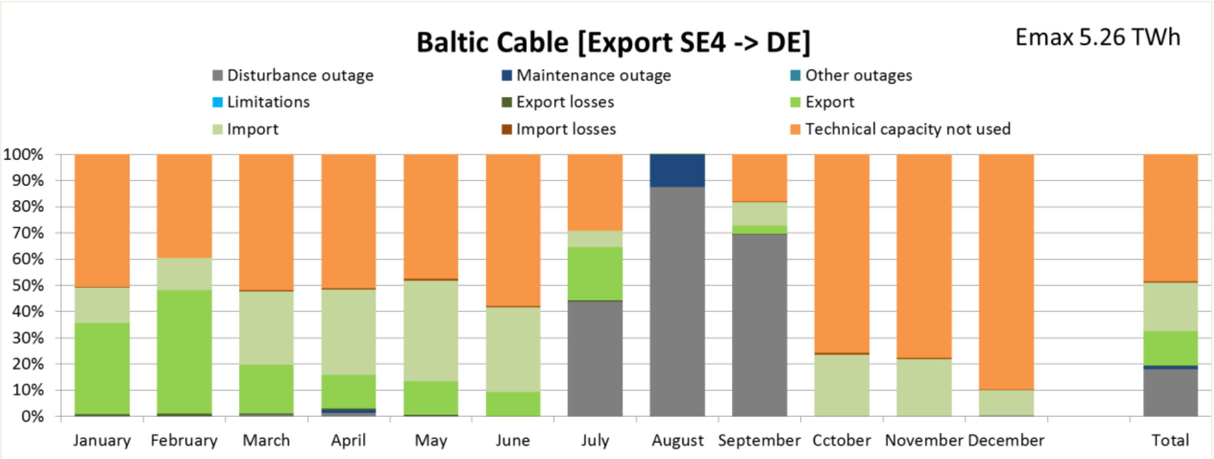

FIGURE 6.3.1 PERCENTAGE DISTRIBUTION OF THE CATEGORIES DEFINED IN CHAPTER 4 ACCORDING TO MONTH AND YEAR FOR THE BALTIC CABLE IN 2013

Baltic Cable had an available technical capacity of 81%. The technical capacity not used was 48%. Totally 0.7 TWh (13% of the capacity) was exported from Sweden to Denmark and 1.0 TWh (19% of the capacity) was imported.

There were 6 minor disturbances and one 65-day long outage, caused by a cable fault. Limitations were frequent due to high wind power in-feed in the German grid.

The annual maintenance outages lasted 5 days in August.

Table 6.3.1 presents the numerical values behind Figure 6.3.1.

TABLE 6.3.1 MONTHLY DIVISION OF THE CATEGORIES DEFINED IN CHAPTER 4 FOR THE BALTIC CABLE IN 2013

Baltic Cable [SE4 -> DE]	January	February	March	April	May	June	July	August	September	Cctober	November	December	% (of Emax)
Disturbance outage [MWh]	340	0	2880	5750	0	0	196610	446400	305380	0	0	2050	17.9
Maintenance outage [MWh]	0	0	0	5830	0	0	0	63600	0	0	0	0	1.3
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Export losses [MWh]	3827	4678	2041	1322	2957	967	2073	0	332	0	0	0	0.3
Export [MWh]	156558	191492	83725	56619	57324	39363	89994	15	13843	0	0	0	12.9
Import [MWh]	60468	49966	124913	142897	172615	139699	28139	0	39506	106051	94131	42455	18.7
Import losses [MWh]	1107	902	2406	2651	3511	2667	496	0	1107	3182	2824	1274	0.4
Technical capacity not used [MWh]	227664	160526	231636	223762	213630	250590	130348	0	79034	338483	335378	400831	48.4
Emax (600 MW)	449965	407564	447601	438831	450037	433286	447661	510015	439202	447715	432333	446609	100.0

6.3.2 ESTLINK 1

Figure 6.3.2 presents the results of Estlink 1 for 2013. Estlink 1 has been in operation since 2006 and is the first HVDC connection between Finland and Estonia. In Finland (bidding zone FI) it is connected to Espoo substation and in Estonia (bidding zone EE) it is connected to Harku substation. The transmission capacity is 350 MW.

EstLink 2 (650 MW) was commissioned in February 2014 and is connected to Anttila in Finland and to Püssi in Estonia.

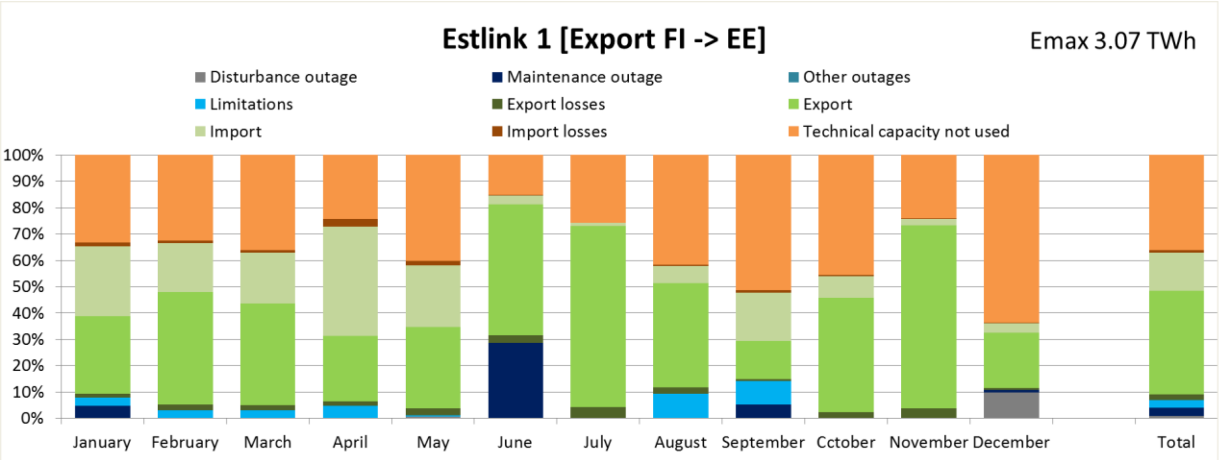

FIGURE 6.3.2 PERCENTAGE DISTRIBUTION OF THE CATEGORIES DEFINED IN CHAPTER 4 ACCORDING TO MONTH AND YEAR FOR ESTLINK 1 IN 2013

In 2013, Estlink 1 had an available technical capacity of 93%. The technical capacity not used was 36%. Totally 1.2 TWh (39% of the capacity) was exported from Finland to Estonia and 0.5 TWh (14% of the capacity) was imported.

The longest disturbance outage lasted 67 hours and was caused by a broken valve and a stop in the valve cooling. Estlink 1 had 35 times limitations due to the Estonian AC grid investments and 5 disturbance outages.

Maintenance outages took place in January 8–9 and in September 21–22 due to works in Espoo substation and in June 10–18 due to the annual revision of Estlink 1.

Table 6.3.2 presents the numerical values behind Figure 6.3.2.

TABLE 6.3.2 MONTHLY DIVISION OF EMAX IN ESTLINK 1 IN 2013

Estlink 1 [FI -> EE]	January	February	March	April	May	June	July	August	September	Cctober	November	December	**% (of Emax)**
Disturbance outage [MWh]	0	0	0	0	1458	362	0	0	0	0	0	25959	0.9
Maintenance outage [MWh]	12950	0	0	0	0	73500	0	0	13300	0	0	2100	3.3
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	8280	7714	8400	12641	1564	0	0	24354	22530	0	0	0	2.7
Export losses [MWh]	3804	4889	4922	4075	7040	7556	10967	6368	2069	5963	9968	2219	2.2
Export [MWh]	80587	105655	104011	65275	81080	128073	181259	104388	36852	114227	178402	55161	39.4
Import [MWh]	72249	45588	51525	108493	61434	8691	3144	17254	47110	21534	6446	9257	14.4
Import losses [MWh]	3690	2359	2727	7628	4357	666	205	1163	2524	1480	458	619	0.9
Technical capacity not used [MWh]	90275	80382	97089	63275	105240	39056	67916	110194	130633	119176	62088	167444	36.2
Emax (350 MW)	271835	246587	268674	261386	262173	257904	263491	263720	255017	262379	257362	262759	100.0

6.3.3 FENNO-SKAN 1

Figure 6.3.3 presents the results of Fenno-Skan 1 for 2013. Fenno-Skan 1 has been in operation since 1989 and is the first HVDC connection between Finland and Sweden. In Finland (bidding zone FI) Fenno-Skan 1 is connected to Rauma and in Sweden (bidding zone SE3) to Dannebo. The transmission capacity is 500 MW during summer and 550 MW during winter.

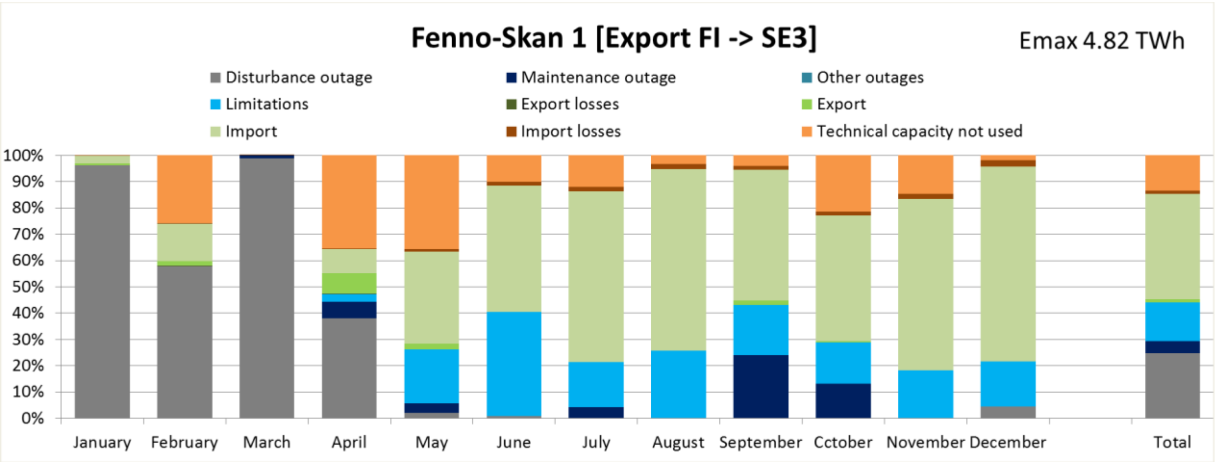

FIGURE 6.3.3 PERCENTAGE DISTRIBUTION OF THE CATEGORIES DEFINED IN CHAPTER 4 ACCORDING TO MONTH AND YEAR FOR FENNO-SKAN 1 IN 2013

In 2013, Fenno-Skan 1 had an available technical capacity of 56%. The technical capacity not used was 14%. Totally 61 MWh (1% of the capacity) was exported from Finland to Sweden and 2.0 TWh (40% of the capacity) was imported. The direction of the transmission was almost all of the time to Finland (97% of the transmitted energy).

The number of disturbances of Fenno-Skan 1 was 8. The fire on October 6, 2012 in the thyristor hall of Fenno-Skan 1 on the Swedish side caused damage to the fiber optic control cables, among others. The repair works and testing of Fenno-Skan 1 link continued also during January 2013. Another major disturbance outage took place between February 12 and April 12, 2013 and was caused by a cable fault near the Finnish coast. As a result of the cable fault there were 2 Fenno-Skan 1 limitations. The first was from 500 MW to 400 MW and started April 26 and ended November 30. The second limitation was from 550 MW to 450 MW and lasted from December 1 to December 31.

The annual maintenance outage was between September 23 and October 6.

Table 6.3.3 presents the numerical values behind Figure 6.3.3.

TABLE 6.3.3 MONTHLY DIVISION OF EMAX IN FENNO-SKAN 1 IN 2013

Fenno-Skan 1 [FI -> SE3]	January	February	March	April	May	June	July	August	September	Cctober	November	December	**% (of Emax)**
Disturbance outage [MWh]	409191	214115	408650	153450	9020	3617	0	0	458	779	0	18352	24.9
Maintenance outage [MWh]	0	0	4950	24750	14850	0	17600	0	101200	53350	0	0	4.4
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	0	0	0	11900	84350	157550	71200	107050	80400	64800	71998	71200	14.7
Export losses [MWh]	184	151	10	648	255	0	0	0	341	78	14	0	0.0
Export [MWh]	3701	6585	10	31160	9635	0	0	0	7356	1870	755	0	1.2
Import [MWh]	12240	52654	0	36608	144689	191057	270501	287012	210764	197241	257669	306665	40.2
Import losses [MWh]	305	1024	0	800	3632	5135	6830	7686	5736	5159	7242	9385	1.1
Technical capacity not used [MWh]	0	95138	0	142771	147781	40187	50175	13761	17015	88442	58371	8095	13.5
Emax (550 MW)	425622	369666	413620	402087	414211	397547	416306	415508	423270	411720	396049	413697	100.0

6.3.4 Fenno-Skan 2

Figure 6.3.4 presents the results of Fenno-Skan 2 for 2012. Fenno-Skan 2 has been in operation since 2011 and is the second HVDC connection between Finland and Sweden. In Finland (bidding zone FI) Fenno-Skan 2 is connected to Rauma and in Sweden (bidding zone SE3) to Finnböle (about 100 km from the Swedish coast line). The transmission capacity is 800 MW.

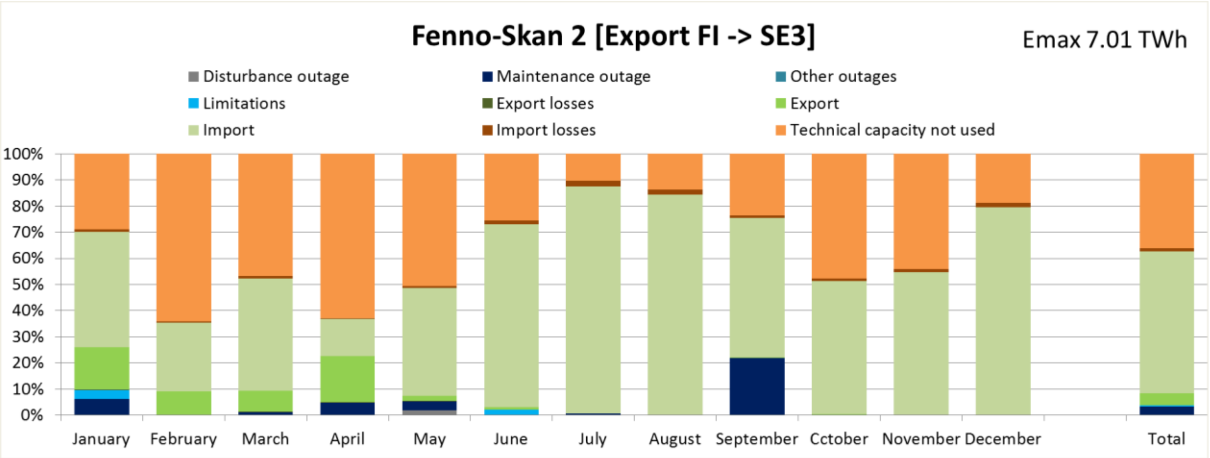

Figure 6.3.4 Percentage distribution of the categories defined in chapter 4 according to month and year for Fenno-Skan 2 in 2013

In 2013, Fenno-Skan 2 had an available technical capacity of 96%. The technical capacity not used was 36%. Totally 0.3 TWh (5% of the capacity) was exported from Finland to Sweden and 3.9 TWh (54% of the capacity) was imported. The direction of the transmission was almost all of the time to Finland (92% of the transmitted energy).

The number of disturbances of Fenno-Skan 2 was 4 and all of them caused minor consequences. There was one bipolar fault of Fenno-Skan 1 and Fenno-Skan 2 in June 2013 as a result of the maintenance of auxiliary supply and automation system fault in Rauma substation. Limitations were caused because of projects on the Swedish AC networks between June 3 and August 3

The annual maintenance outage was between September 23 and 29. There were several shorter maintenance outages during the year due to bipolar tests of the Fenno-Skan 1 and Fenno-Skan 2.

Table 6.3.4 presents the numerical values behind Figure 6.3.4.

Table 6.3.4 Monthly division of Emax in Fenno-Skan 2 in 2013

Fenno-Skan 2 [FI -> SE3]	January	February	March	April	May	June	July	August	September	Cctober	November	December	% (of Emax)
Disturbance outage [MWh]	0	213	0	0	10693	560	0	0	0	0	0	0	0.2
Maintenance outage [MWh]	39200	0	7200	27200	21600	0	3200	0	126400	0	0	0	3.2
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	20000	0	0	0	0	11600	400	0	0	0	0	0	0.5
Export losses [MWh]	2292	856	919	2166	225	106	0	0	29	56	0	0	0.1
Export [MWh]	100673	47288	47514	103188	12433	4925	0	0	1439	2673	0	0	4.5
Import [MWh]	273270	142517	256219	82952	249515	408049	527885	509436	309704	304360	317457	481985	54.4
Import losses [MWh]	6660	2500	5713	1338	5012	8790	12310	11676	6816	6329	6671	10505	1.2
Technical capacity not used [MWh]	179524	345126	279291	368712	305497	148557	62876	81869	136386	285893	255784	112898	36.1
Emax (800 MW)	621620	538500	596855	585556	604976	582587	606671	602981	580773	599311	579912	605388	100.0

6.3.5 KONTEK

Figure 6.3.5 presents the results of Kontek for 2013. Kontek has been in operation since 1986. In Denmark (bidding zone DK2) it is connected to Bjaeverskov and in Germany (bidding zone DE-TenneT) to Bentwisch. The transmission capacity is 600 MW.

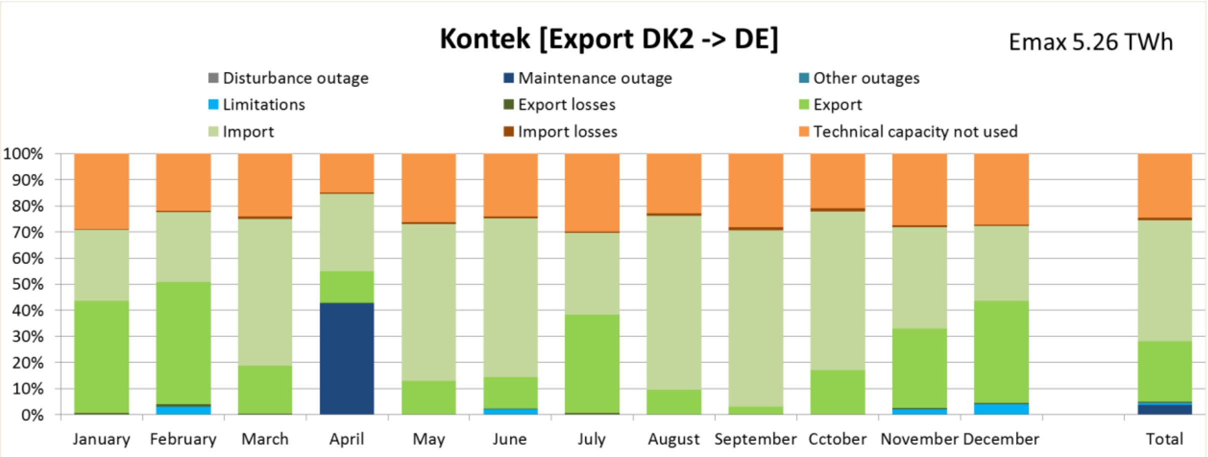

FIGURE 6.3.5 PERCENTAGE DISTRIBUTION OF THE CATEGORIES DEFINED IN CHAPTER 4 ACCORDING TO MONTH AND YEAR FOR KONTEK IN 2013

In 2013, Kontek had an available technical capacity of 95%. The technical capacity not used was 25%. Totally, 1.2 TWh (23% of the total technical capacity) was exported from Denmark to Germany and 2.4 TWh (46%) was imported.

There were no disturbances in 2013.The unavailable technical capacity *(E_U)* was mainly caused by limitations due to work in both the Danish and German AC grid.

The annual maintenance outage was in April.

Table 6.3.5 presents the numerical values behind Figure 6.3.5.

TABLE 6.3.5 MONTHLY DIVISION OF EMAX IN KONTEK IN 2013

Kontek [DK2 -> DE]	January	February	March	April	May	June	July	August	September	Cctober	November	December	% (of Emax)
Disturbance outage [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Maintenance outage [MWh]	0	0	0	193800	0	0	0	0	0	0	0	0	3.7
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	0	12825	0	0	0	9295	0	0	0	0	9000	17850	0.9
Export losses [MWh]	3377	3274	1457	916	1089	971	3096	650	204	980	1666	2883	0.4
Export [MWh]	192058	189575	82432	54249	56612	52180	168124	42102	13083	74802	131743	175433	23.3
Import [MWh]	121659	108929	251198	135725	268493	262402	140451	297415	292263	272813	168293	129843	46.3
Import losses [MWh]	1952	1769	4165	2208	3969	3801	2024	4968	5316	5023	3192	2202	0.8
Technical capacity not used [MWh]	128987	88635	107338	67045	116803	103694	133909	101684	121710	93749	119098	122107	24.7
Emax (600 MW)	448032	405007	446590	453944	446967	432343	447604	446820	432575	447367	432990	450317	100.0

6.3.6 Konti-Skan 1

Figure 6.3.6 presents the results of Konti-Skan 1 for 2013. In south-western Sweden (bidding zone SE3) it is connected to Lindome and in Denmark (bidding zone DK1) to Vester Hassing. It has been in operation since 1965. Today the transmission capacity is 370 MW and the upgraded converter stations were commissioned in 2008.

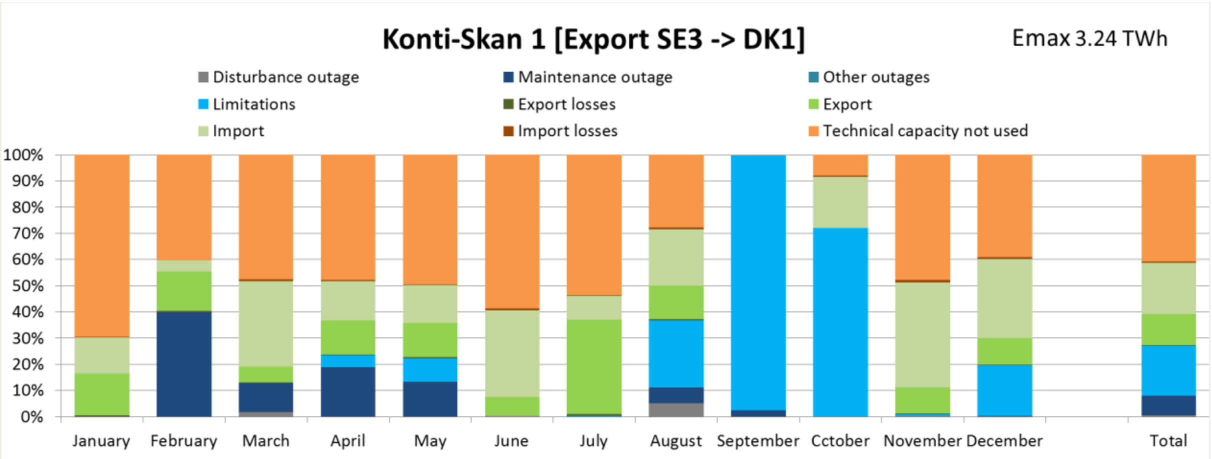

Figure 6.3.6 Percentage distribution of the categories defined in chapter 4 according to month and year for Konti-Skan 1 in 2013

In 2013, Konti-Skan 1 had an available technical capacity of 73% and the technical capacity not used was 41%. Totally, 0.4 TWh (12% of the total technical capacity) was exported from Sweden to Denmark and 0.6 TWh (20%) was imported. The availability of the link is 2% lower in comparison with 2012.

In 2013, there were 11 disturbances, of which none caused long-lasting outages.

The unavailable technical capacity *(E_U)* was mainly caused by maintenance outages and limitations due to work AC lines on both sides.

Table 6.3.6 presents the numerical values behind Figure 6.3.6.

Table 6.3.6 Monthly division of Emax in Konti-Skan 1 in 2013

Konti-Skan 1 [SE3 -> DK1]	January	February	March	April	May	June	July	August	September	Cctober	November	December	% (of Emax)
Disturbance outage [MWh]	370	0	4668	0	0	616	0	14553	0	395	543	0	0.6
Maintenance outage [MWh]	0	99530	31080	54082	37000	0	0	16489	6259	0	0	1104	7.5
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	0	0	0	12826	24660	0	455	71330	260170	198320	1949	57800	19.0
Export losses [MWh]	939	879	378	935	1296	465	2172	810	6	17	651	675	0.3
Export [MWh]	44128	37319	16791	37077	36493	18959	99686	35844	0	148	26639	30478	11.6
Import [MWh]	37738	10689	89724	42683	39894	88237	24908	60065	14	53830	106810	90884	19.6
Import losses [MWh]	1011	267	2315	1269	1032	2458	696	1735	14	1541	2864	2436	0.5
Technical capacity not used [MWh]	191768	100193	131244	136051	137301	156343	147810	77075	310	21573	127367	117556	40.8
Emax (370 MW)	275954	248876	276199	284923	277677	267078	275728	277901	266773	275823	266823	300932	100.0

6.3.7 KONTI-SKAN 2

Figure 6.3.7 presents the results of Konti-Skan 2 for 2013. Konti-Skan 2 is connected between Sweden and Denmark in parallel to Konti-Skan 1. It has a transmission capacity of 370 MW and has been in operation since 1988.

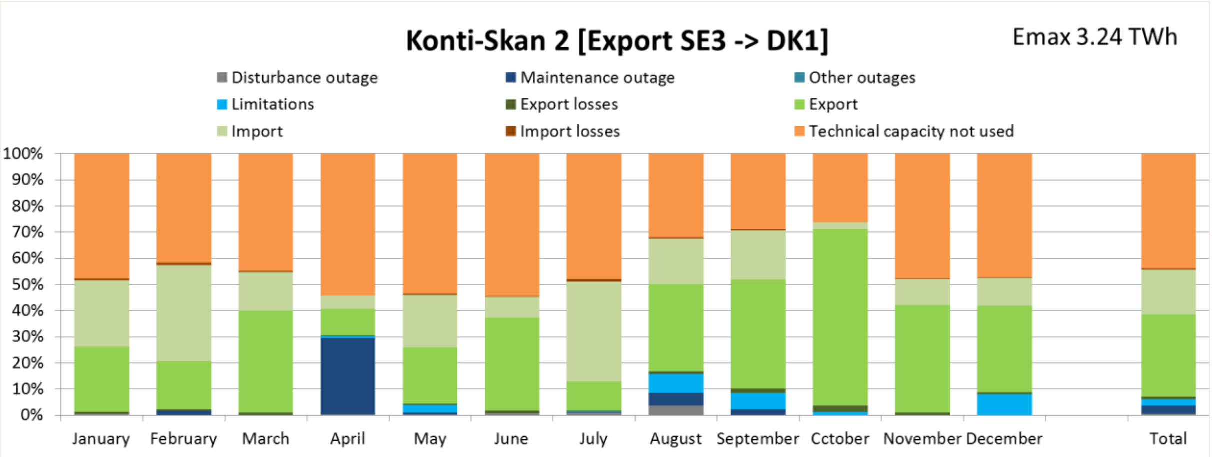

FIGURE 6.3.7 PERCENTAGE DISTRIBUTION OF THE CATEGORIES DEFINED IN CHAPTER 4 ACCORDING TO MONTH AND YEAR FOR KONTI-SKAN 2 IN 2013

In 2013, Konti-Skan 2 had an available technical capacity of 94%. The technical capacity not used was 44%. Totally 1.0 TWh (32% of the total technical capacity) was exported from Sweden to Denmark and 0.6 TWh (17%) was imported. The availability of the link is 18% lower in comparison with 2012.

In 2013, there were 14 disturbances, of which none caused long-lasting outages.

The unavailable technical capacity (E_U was mainly caused by maintenance outages and limitations due to work on the AC lines on both sides.

Table 6.3.7 presents the numerical values behind Figure 6.3.7.

TABLE 6.3.7 MONTHLY DIVISION OF EMAX IN KONTI-SKAN 2 IN 2013

Konti-Skan 2 [SE3 -> DK1]	January	February	March	April	May	June	July	August	September	Cctober	November	December	% (of Emax)
Disturbance outage [MWh]	1758	0	0	548	709	2239	2615	10489	0	0	0	0	0.6
Maintenance outage [MWh]	0	4440	0	78317	2220	0	956	13690	6259	0	0	0	3.2
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	0	0	0	2400	7655	0	845	20019	16935	3780	20	22639	2.3
Export losses [MWh]	1662	1256	2582	615	1756	2446	747	2813	4302	6127	2585	2118	0.9
Export [MWh]	68826	45694	107400	26822	59621	95214	30436	93913	112427	186827	110461	92921	31.5
Import [MWh]	70465	91881	41148	13863	55682	22045	106085	48989	51031	7460	26486	30048	17.3
Import losses [MWh]	1715	2521	1091	319	1397	542	2808	1492	1715	242	662	711	0.5
Technical capacity not used [MWh]	132235	104177	123780	144894	148725	146066	132731	89510	77667	72403	127325	132982	43.8
Emax (370 MW)	276660	249969	276001	267777	277765	268551	277223	280915	270335	276839	267539	281419	100.0

6.3.8 NORNED

Figure 6.3.8 presents the results of NorNed for 2013. NorNed has been in operation since 2008, and is, with a length of 580 km, the longest HVDC link connected to the Nordic power system. In Norway on the southwestern coast (bidding zone NO2) it is connected to Feda substation and in Netherlands (bidding zone APX NL) to Eemshaven. The transmission capacity is 730 MW.

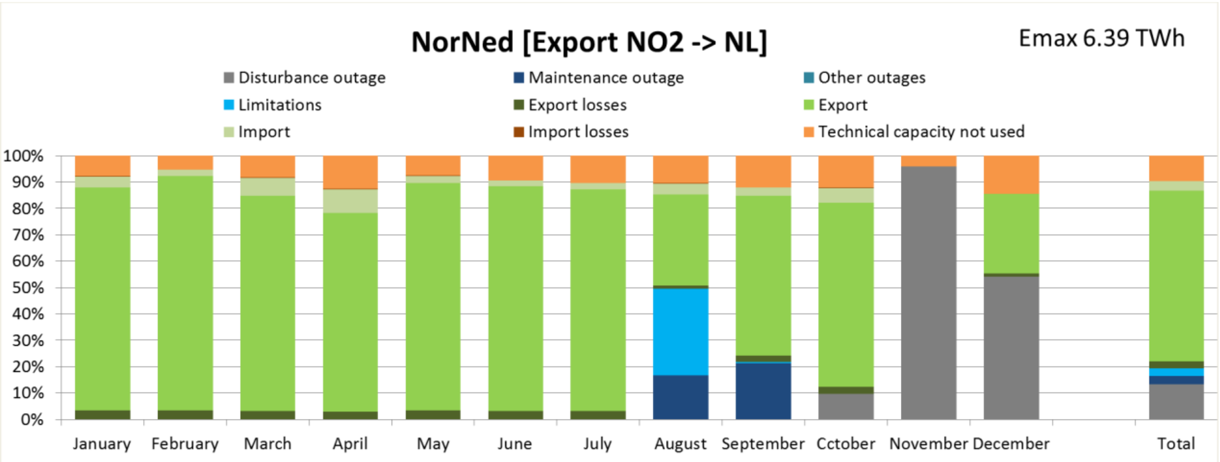

FIGURE 6.3.8 PERCENTAGE DISTRIBUTION OF THE CATEGORIES DEFINED IN CHAPTER 4 ACCORDING TO MONTH AND YEAR FOR NORNED IN 2013

In 2013 NorNed had had an available technical capacity of 81%. The technical capacity not used was 9%. Totally 4.2 TWh (65%) was exported from Norway to the Netherlands and 0.2 TWh (4%) was imported.

In 2013, there were 2 disturbances. The unavailable technical capacity (E_U) was mostly caused by an autumn storm in late October causing water intrusion at the converter station in Eemshaven. This disturbance outage lasted for 52 days. There were also some limitations due to maintenance work in the in the Norwegian AC grid.

The annual maintenance outage lasted for 13 days in August and September.

Table 6.3.8 presents the numerical values behind Figure 6.3.8.

TABLE 6.3.8 MONTHLY DIVISION OF EMAX IN NORNED IN 2013

NorNed [NO2 -> NL]	January	February	March	April	May	June	July	August	September	Cctober	November	December	% (of Emax)
Disturbance outage [MWh]	0	0	373	0	0	0	0	0	0	52407	504000	294222	13.3
Maintenance outage [MWh]	0	0	0	0	0	0	0	95667	112443	0	0	0	3.2
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	0	0	0	0	0	0	0	189390	2372	0	0	0	3.0
Export losses [MWh]	18107	17260	17429	15317	18215	17288	17687	6395	12533	15053	0	6394	2.5
Export [MWh]	459605	436420	443458	397142	468499	448319	456168	199590	319410	379519	0	164180	65.1
Import [MWh]	23225	11204	35537	46402	15166	10886	13017	23932	15753	31207	0	0	3.5
Import losses [MWh]	877	402	1352	1740	548	367	463	843	583	1144	0	503	0.1
Technical capacity not used [MWh]	41844	25629	44955	65479	41153	49069	56163	79310	58012	63073	0	65533	9.2
Emax (730 MW)	543658	490915	543105	526081	543581	525929	543499	595127	521106	542402	504000	530833	100.0

6.3.9 SKAGERRAK 1

Figure 6.3.9 presents the results of Skagerrak 1 for 2013. Skagerrak 1 and 2 have been in operation since 1976 and are the oldest HVDC links in operation in the Nordic countries. In Norway on the south coast (bidding zone NO2) it is connected to Kristiansand and in Denmark (bidding zone DK1) to Tjele, approximately 15 km east of the town of Viborg in the northern part of Jutland. The transmission capacity is 250 MW.

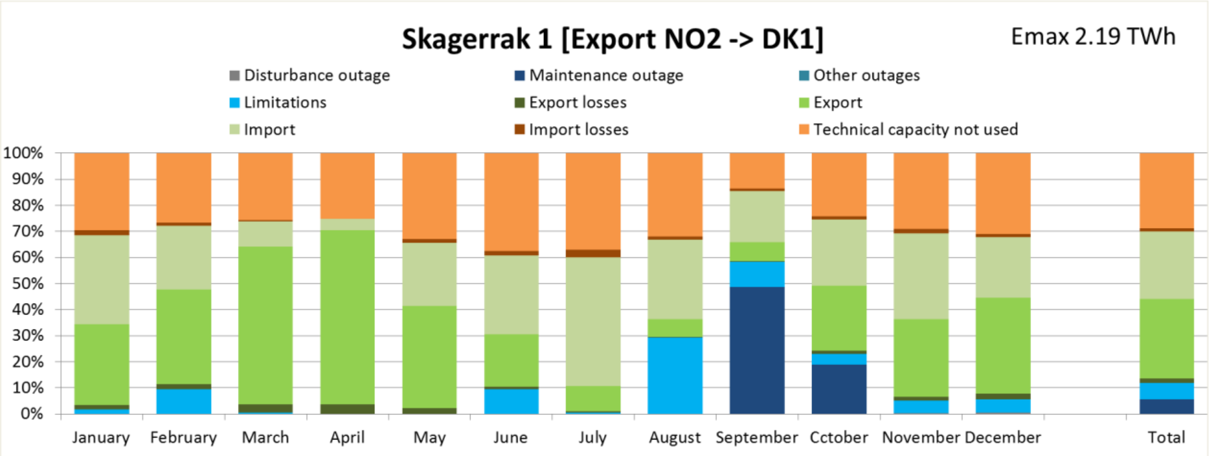

FIGURE 6.3.9 PERCENTAGE DISTRIBUTION OF THE CATEGORIES DEFINED IN CHAPTER 4 ACCORDING TO MONTH AND YEAR FOR SKAGERRAK 1 IN 2013

In 2013 Skagerrak 1 had an available technical capacity of 88%. The technical capacity not used was 29%. Totally 0.7 TWh (31%) was exported from Norway to the Denmark and 0.6 TWh (26%) was imported. This is a significant change compared with the export-dominated year of 2012.

In 2013, there were 4 disturbances, none of which caused long-lasting outages. The unavailable technical capacity *(E_U)* was mainly caused by maintenance outages and limitations due to work at Kristiansand substation.

Table 6.3.9 presents the numerical values behind Figure 6.3.9.

TABLE 6.3.9 MONTHLY DIVISION OF EMAX IN SKAGERRAK 1 IN 2013

Skagerrak 1 [NO2 -> DK1]	January	February	March	April	May	June	July	August	September	Cctober	November	December	% (of Emax)
Disturbance outage [MWh]	0	0	0	0	0	0	0	0	67	46	742	796	0.1
Maintenance outage [MWh]	0	0	0	0	0	0	0	0	88000	35500	0	0	5.6
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	3500	16175	825	0	0	17400	1200	55300	17250	7950	8474	9994	6.3
Export losses [MWh]	3143	3296	6273	6769	3997	1815	836	586	566	2404	2868	3891	1.7
Export [MWh]	57626	61362	112479	120222	73143	36560	18094	13106	13114	46569	53790	69568	30.6
Import [MWh]	64076	41390	18131	7850	45432	55284	91904	57443	35347	47912	59383	43461	25.7
Import losses [MWh]	3352	2026	868	348	2512	2798	5163	2147	1752	2352	3104	2216	1.3
Technical capacity not used [MWh]	55531	44994	48002	45359	61436	68634	69125	60762	24707	45718	52352	58631	28.8
Emax (250 MW)	187228	169242	186578	180548	186519	182490	186323	189343	180802	188452	180714	188557	100.0

6.3.10 SKAGERRAK 2

Figure 6.3.10 presents the results of Skagerrak 1 for 2013. Skagerrak 1 and 2 have been in operation since 1976 and are the oldest HVDC links in operation in the Nordic countries. In Norway on the southern coast (bidding zone NO2) it is connected to Kristiansand and in Denmark (bidding zone DK1) to Tjele, approximately 15 km east of the town of Viborg in the northern part of Jutland. The transmission capacity is 250 MW.

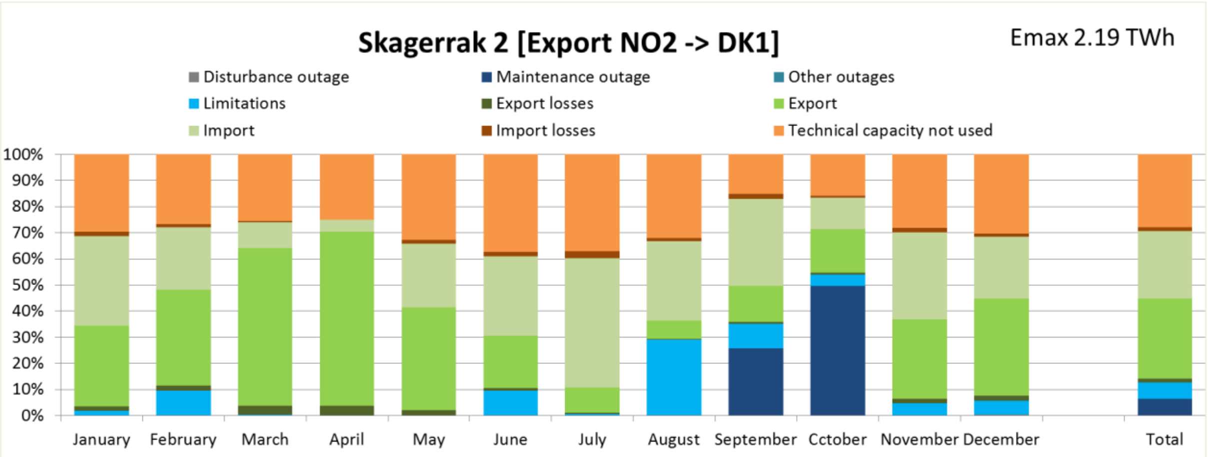

FIGURE 6.3.10 PERCENTAGE DISTRIBUTION OF THE CATEGORIES DEFINED IN CHAPTER 4 ACCORDING TO MONTH AND YEAR FOR SKAGERRAK 2 IN 2013

In 2013 Skagerrak 2 had an available technical capacity of 87%. The technical capacity not used was 28%. Totally 0.7 TWh (31%) was exported from Norway to the Denmark and 0.6 TWh (26%) was imported. This was a significant change compared with the export-dominated year of 2012.

In 2013, there were 3 disturbances, of which none caused long-lasting outages. The unavailable technical capacity *(E_U)* was mainly caused by maintenance outages and limitations due to work at the Kristiansand substation.

Table 6.3.10 presents the numerical values behind Figure 6.3.10.

TABLE 6.3.10 MONTHLY DIVISION OF EMAX IN SKAGERRAK 2 IN 2013

Skagerrak 2 [NO2 -> DK1]	January	February	March	April	May	June	July	August	September	Cctober	November	December	**% (of Emax)**
Disturbance outage [MWh]	0	0	0	0	0	0	0	0	454	0	0	550	0.0
Maintenance outage [MWh]	0	0	0	0	0	0	0	0	46000	93000	0	0	6.3
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	3500	16175	825	0	0	17375	1125	55175	17250	7950	8474	9994	6.2
Export losses [MWh]	3164	3335	6307	6810	4013	1828	842	591	1299	1708	2972	3891	1.7
Export [MWh]	57891	61734	112918	120740	73529	36796	18200	13197	24734	31218	55184	69976	30.6
Import [MWh]	64231	40574	18196	7865	45547	55426	92020	57415	60774	22582	60410	44627	25.8
Import losses [MWh]	3330	1972	863	345	2498	2779	5122	2129	3329	1081	3110	2248	1.3
Technical capacity not used [MWh]	55257	45175	47792	45145	61169	68361	69048	60865	27371	29826	50822	57307	28.0
Emax (250 MW)	187374	168966	186901	180904	186755	182565	186357	189372	181210	187364	180972	188594	100.0

6.3.11 SKAGERRAK 3

Figure 6.3.11 presents the results of Skagerrak 3 for 2013. Skagerrak 3 has been in operation since 1993. In Norway (bidding zone NO2) it is connected to Kristiansand and in Denmark (bidding zone DK1) to Tjele. The transmission capacity is 500 MW.

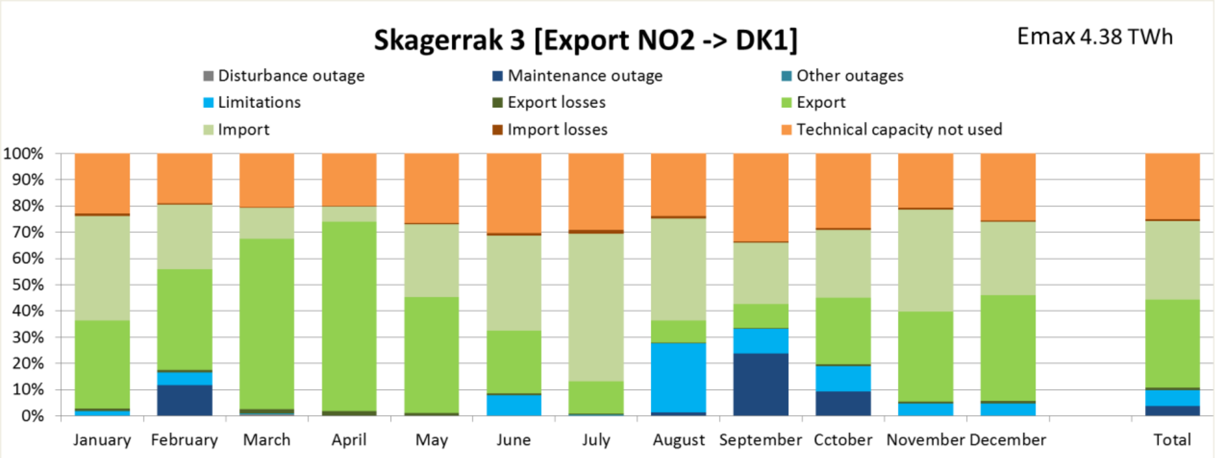

FIGURE 6.3.11 PERCENTAGE DISTRIBUTION OF THE CATEGORIES DEFINED IN CHAPTER 4 ACCORDING TO MONTH AND YEAR FOR SKAGERRAK 3 IN 2013

In 2013, Skagerrak 3 had an available technical capacity of 90%. The technical capacity not used was 25%. Totally 1.5 TWh (34%) was exported from Norway to the Denmark and 1.3 TWh (30%) was imported. This is a significant change compared with the export-dominated year of 2012.

There was only one disturbance outage in 2013 that lasted for 4 hours. The unavailable technical capacity (E_U) was mainly caused by maintenance outages and limitations due to work in the Kristiansand substation.

Table 6.3.11 presents the numerical values behind Figure 6.3.11.

TABLE 6.3.11 MONTHLY DIVISION OF EMAX IN SKAGERRAK 3 IN 2013

Skagerrak 3 [NO2 -> DK1]	January	February	March	April	May	June	July	August	September	Cctober	November	December	% (of Emax)
Disturbance outage [MWh]	0	0	1975	0	0	0	0	0	0	0	0	0	0.0
Maintenance outage [MWh]	0	39708	0	0	0	0	0	5775	88000	35500	0	0	3.8
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	7000	16600	1650	0	0	29250	1875	104250	34500	36250	16947	17540	6.0
Export losses [MWh]	3337	3364	6362	6950	4410	2318	1213	866	828	2388	3332	4156	0.9
Export [MWh]	126711	129693	241419	259377	164069	88039	46219	33690	33769	95016	123670	152715	33.6
Import [MWh]	149636	83223	44430	21254	103421	134343	209632	155741	85974	97480	140970	105620	29.9
Import losses [MWh]	3561	1914	1023	481	2514	3230	5317	3321	2111	2180	3335	2544	0.7
Technical capacity not used [MWh]	86498	64507	75774	72286	98195	111929	108559	95140	122856	106949	74813	96185	25.0
Emax (500 MW)	376742	339010	372633	360348	372608	369109	372816	398782	368038	375763	363067	378759	100.0

6.3.12 Storebaelt

Figure 6.3.12 presents the results of Storebaelt for 2013. Storebaelt has been in operation since 2010. It connects together the part of the Danish system that belongs to the Continental European synchronous system (the island of Fynen and Jutland) and the part belonging to the Nordic synchronous system (Zealand). The link is connected to Fraugde on Funen (bidding zone DK1) and to Herslev on Zealand (bidding zone DK2). The transmission capacity is 600 MW.

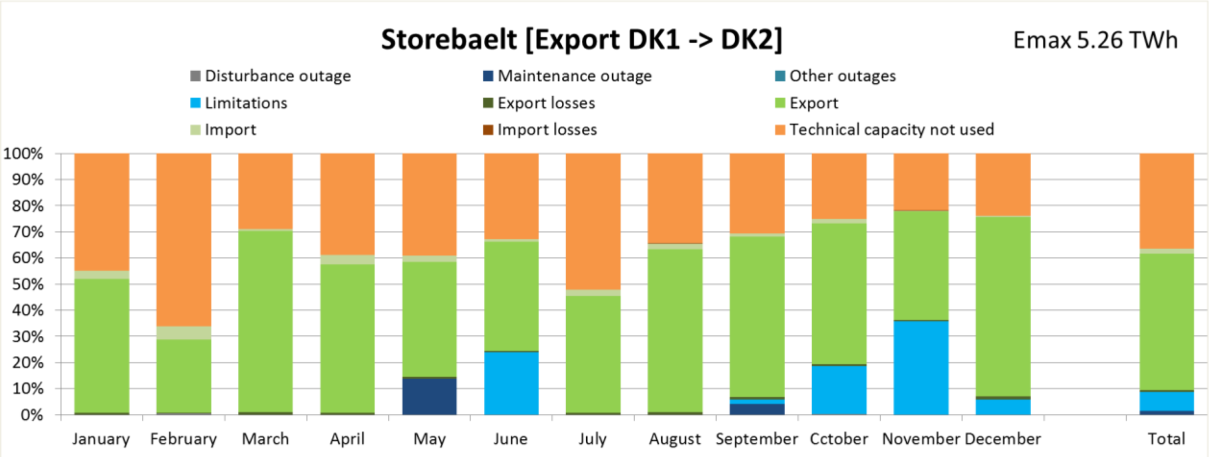

Figure 6.3.12 Percentage distribution of the categories defined in chapter 4 according to month and year for Storebelt in 2013

In 2013 Storebaelt had an available technical capacity of 91%. The technical capacity not used was 36%, which is a significant change compared with 2012. Totally 2.8 TWh (52% of the total technical capacity) was exported from Jutland to Zealand and 0.1 TWh (2%) was imported.

There were 2 disturbances in 2013, of which none caused long-lasting outages. The unavailable technical capacity (E_U) was mainly caused by limitations due to work in the Danish AC grid.

Table 6.3.12 presents the numerical values behind Figure 6.3.12.

Table 6.3.12 Monthly division of Emax in Storebaelt in 2013

Storebaelt [DK1 -> DK2]	January	February	March	April	May	June	July	August	September	Cctober	November	December	% (of Emax)
Disturbance outage [MWh]	0	1720	0	0	0	0	0	0	0	1200	0	0	0.1
Maintenance outage [MWh]	0	0	0	0	61690	0	0	0	18300	0	0	0	1.5
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	0	0	0	0	0	104400	0	0	7350	82633	155400	26700	7.1
Export losses [MWh]	3382	1731	4447	3633	3026	2780	3070	4212	4039	3880	2737	4560	0.8
Export [MWh]	229467	112682	310474	245949	197559	182205	201002	279482	266311	243147	180656	309260	52.2
Import [MWh]	13699	20395	2860	15371	10680	4292	9840	10535	5383	7714	990	2027	2.0
Import losses [MWh]	304	528	79	326	285	173	271	255	153	170	145	72	0.1
Technical capacity not used [MWh]	201040	267588	129840	168444	174966	142890	233827	153962	132971	112935	94889	107045	36.3
Emax (600 MW)	447892	404644	447699	433723	448206	436740	448010	448445	434507	451679	434818	449662	100.0

6.3.13 SwePol

Figure 6.3.13 presents the results of SwePol for 2013. SwePol Link connects the Swedish and Polish transmission grids. In south-eastern Sweden (bidding zone SE4) it is connected to Stärnö and in Poland (bidding zone PL) to Slupsk. The link has been in operation since 2000 and the transmission capacity is 600MW.

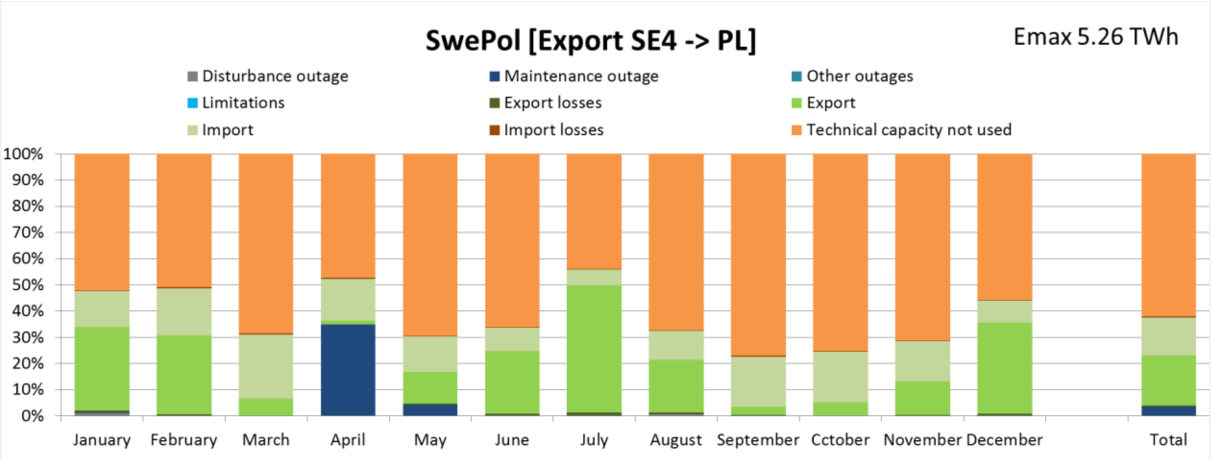

Figure 6.3.13 Percentage distribution of the categories defined in chapter 4 according to month and year for SwePol in 2013

In 2013, SwePol had an available technical capacity of 97%. The technical capacity not used was 62%. Totally 1.0 TWh (19% of the capacity) was exported from Finland to Estonia and 0.8 TWh (15% of the capacity) was imported.

There were 5 minor disturbances. There have been frequent limitations to the link due to limitations in the Polish AC grid.

Totally, the number of days for planned maintenance outages in April and May was 12.5.

Table 6.3.13 presents the numerical values behind Figure 6.3.13.

Table 6.3.13 Monthly division of Emax in SwePol in 2013

SwePol [SE4 -> PL]	January	February	March	April	May	June	July	August	September	Cctober	November	December	% (of Emax)
Disturbance outage [MWh]	4760	0	0	0	600	0	0	3260	880	0	0	0	0.2
Maintenance outage [MWh]	1200	0	0	151200	19200	700	0	0	0	0	0	0	3.3
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Export losses [MWh]	3670	3065	745	158	1326	2602	5738	2339	342	579	1222	3944	0.5
Export [MWh]	142191	121995	29314	5823	55593	103857	218062	90453	13701	22879	56015	156151	19.3
Import [MWh]	62565	72002	108849	69146	61067	38969	27349	49957	83389	86047	66404	37923	14.5
Import losses [MWh]	1276	1490	2180	1417	1252	792	583	1072	1746	1796	1392	801	0.3
Technical capacity not used [MWh]	233064	205996	305199	204524	314797	286513	197425	301695	332602	336018	307571	249518	62.0
Emax (600 MW)	448726	404548	446287	432269	453835	433433	449158	448776	432661	447319	432604	448337	100.0

6.3.14 Vyborg Link

Figure 6.3.14 presents the results of the Vyborg Link for 2013. The Vyborg Link is a back-to-back HVDC connection between Russia and Finland. The HVDC substation is situated in Vyborg, Russia. 400 kV lines from Vyborg are connected to substations Yllikkälä and Kymi in southern Finland. Commissioning years were 1981, 1982, 1984 and 2000. Each commissioning included a capacity of 350 MW. The total technical capacity today is 4 × 350 MW and the commercial transmission capacity is 1.3 GW. Fingrid allocates 100 MW for reserves. The direction of transmission has until now been possible only to Finland but during September 2013 one 350 MW unit was successfully tested to be able to export electricity to Russia.

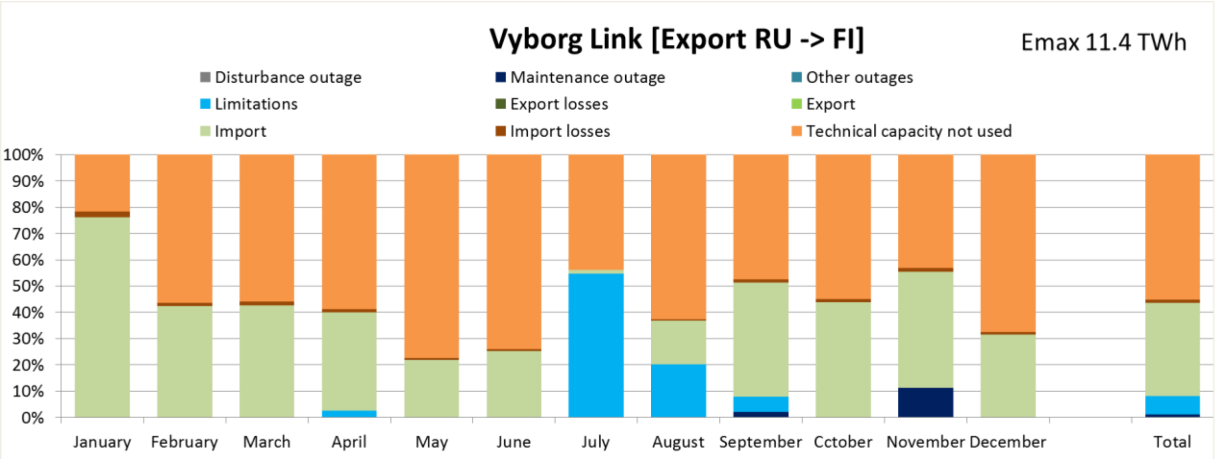

Figure 6.3.14 Percentage distribution of the categories defined in chapter 4 according to month and year for Vyborg Link in 2013

In 2013, the Vyborg Link had an available technical capacity of 92%. The technical capacity not used was 55%. The direction of the transmission was towards Finland. The total import was 4.1 TWh.

There were no disturbance outages during 2013. Substantial maintenance limitations caused by maintenance work in Finland (Anttila substation) took place between April 8 and 12. In September 16–27, there was a limitation due to maintenance in the Russian north-west power station.

The annual maintenance outage was between July 7 and August 8.

Table 6.3.14 presents the numerical values behind Figure 6.3.14.

Table 6.3.14 Monthly division of Emax in Vyborg Link in 2013

Vyborg link [RU -> FI]	January	February	March	April	May	June	July	August	September	Cctober	November	December	**% (of Emax)**
Disturbance outage [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Maintenance outage [MWh]	0	0	0	0	0	0	0	0	19500	0	105600	0	1.1
Other outages [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Limitations [MWh]	0	0	0	22977	0	0	530100	195300	55200	0	0	0	7.0
Export losses [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Export [MWh]	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Import [MWh]	748847	369630	412660	351786	211583	236230	12140	161080	406630	424370	414650	304410	35.5
Import losses [MWh]	22465	11089	12380	10554	6347	7087	364	4832	12199	12731	12440	9132	1.1
Technical capacity not used [MWh]	211685	492881	540860	550684	749270	692684	424596	606362	445614	531399	404796	653658	55.3
Emax (1300 MW)	982998	873600	965900	936000	967200	936000	967200	967574	939143	968500	937485	967200	100.0

Appendix A SCHEMATIC PRESENTATION OF HVDC LINKS

Figure A-1 and Figure A-2 present schematic presentations of an HVDC link with line commutated converters (LCC) and with voltage source converters (VSC). Figures A-1, A-2, A-3, and A4 also show definitions for the origin of an event. The origin of each event is used for categorizing a disturbance or a limitation for statistical purposes. The figures also show how terms 'local' and 'remote' are defined and the locations of the circuit breakers and measurement points for transferred energy on a link.

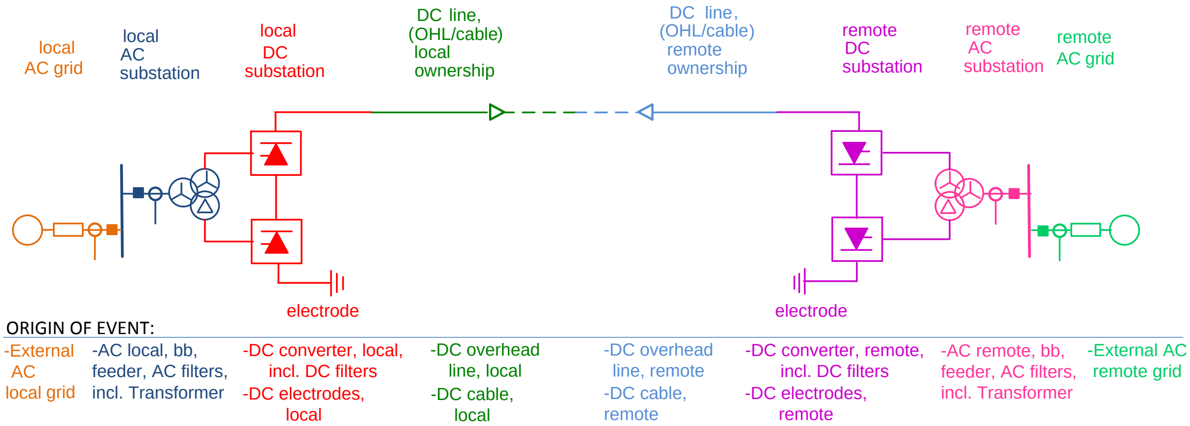

FIGURE A-1 A SCHEMATIC PRESENTATION OF A HVDC LINK WITH LINE COMMUTATED CONVERTERS (LCC)

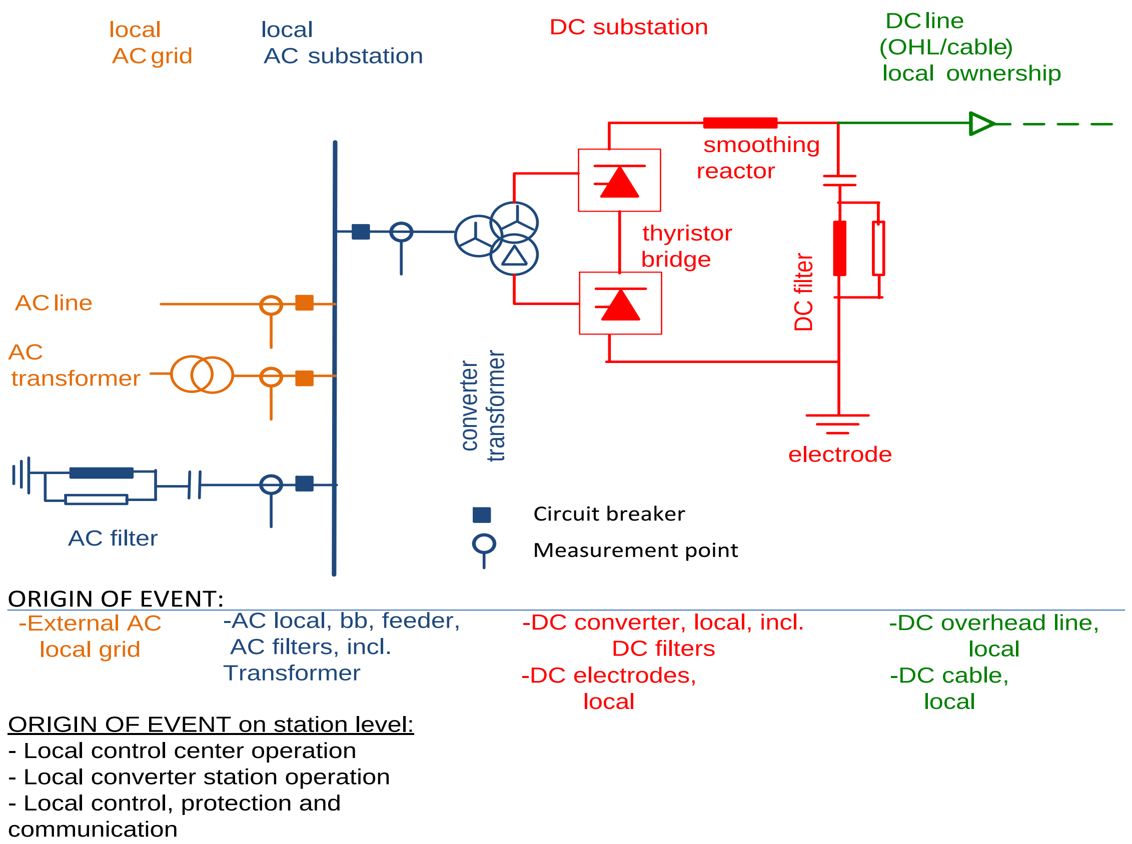

FIGURE A-2 A CONVERTER STATION OF A LINE COMMUTATED CONVERTER HVDC LINK WITH THE CONNECTION TO THE AC GRID

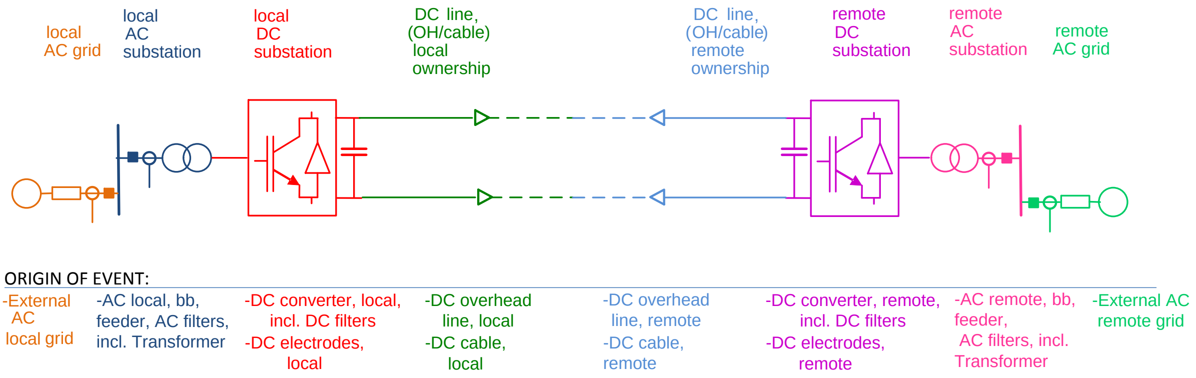

FIGURE A-3 A SCHEMATIC PRESENTATION OF A HVDC LINK WITH VOLTAGE SOURCE CONVERTERS (VSC)

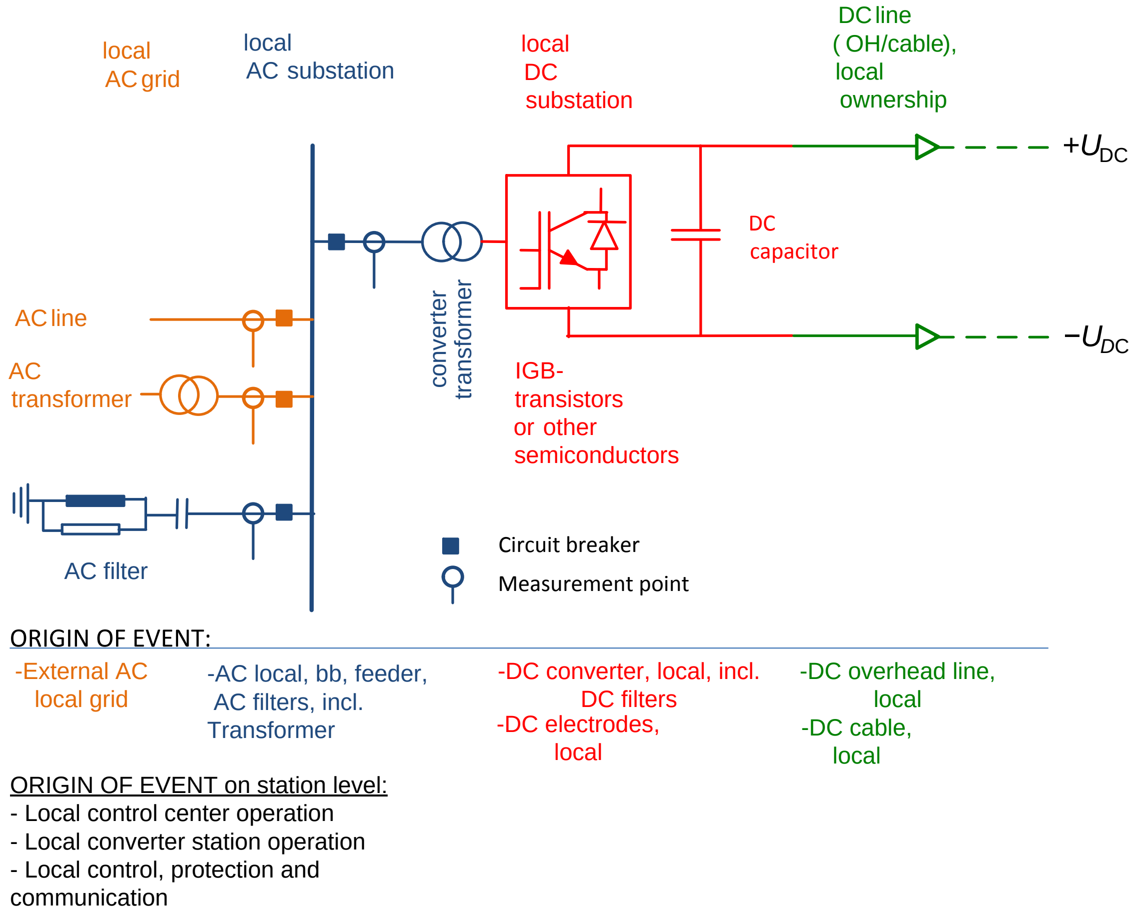

FIGURE A-4 A CONVERTER STATION OF A VOLTAGE SOURCE CONVERTER HVDC LINK WITH THE CONNECTION TO THE AC GRID

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Appendix C ANNUAL OVERVIEW OF ALL HVDC DATA WITH SORTED RESULTS OF EACH CATEGORY

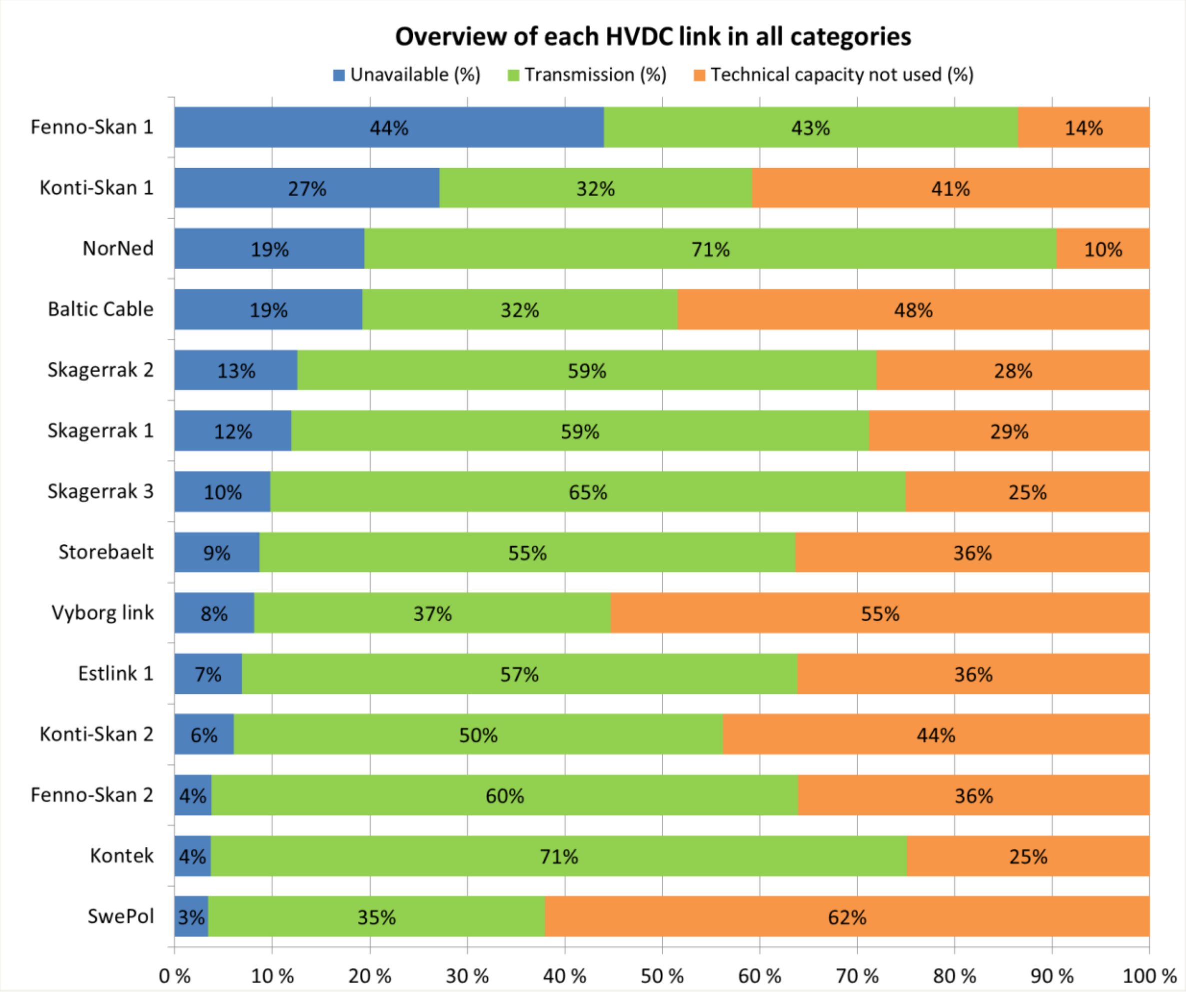

FIGURE C-1 ANNUAL OVERVIEW OF EACH HVDC LINK SORTED BY HIGHEST UNAVAILABLE TECHNICAL CAPACITY E_U IN YEAR 2013

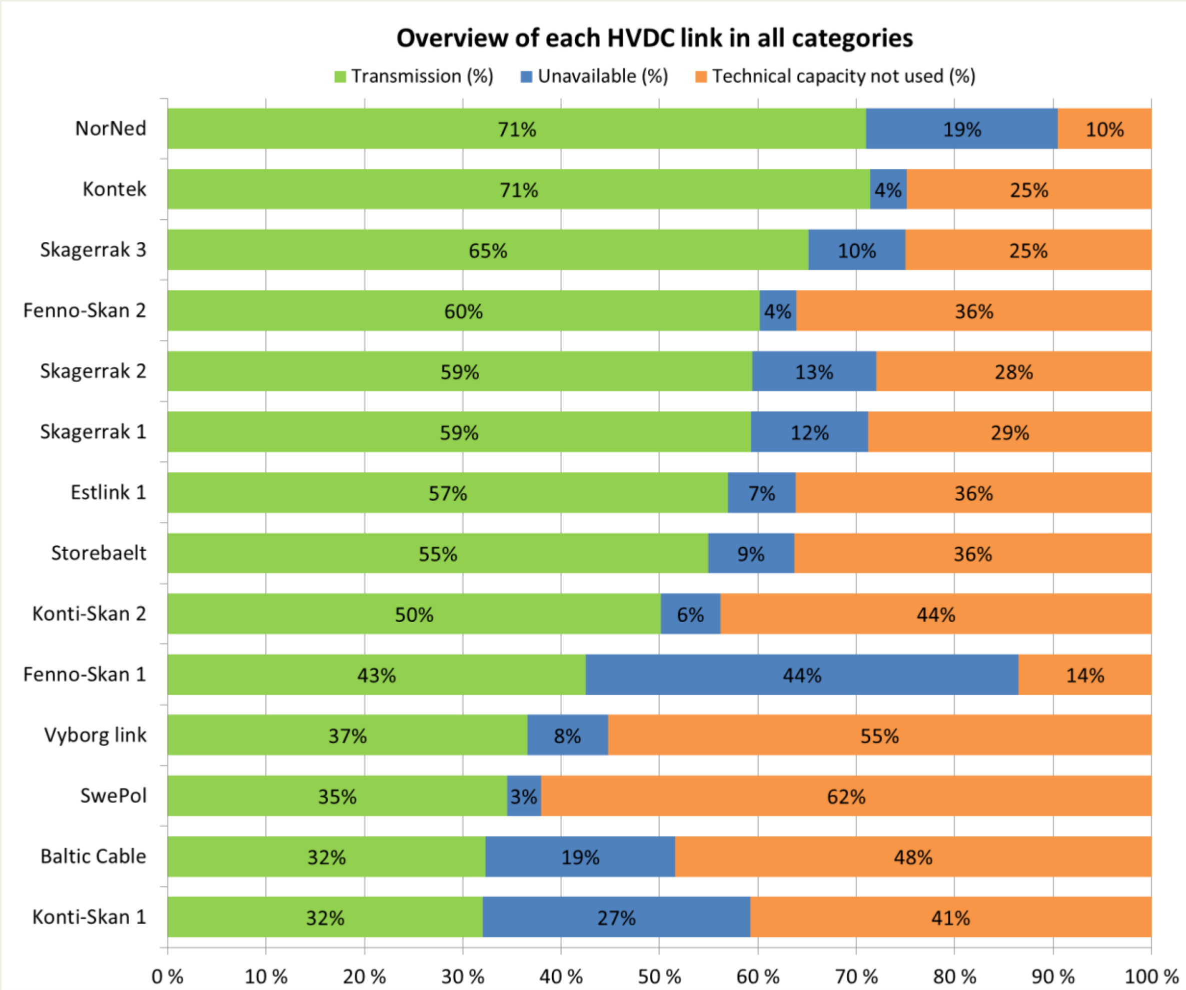

FIGURE C-2 ANNUAL OVERVIEW OF EACH HVDC LINK SORTED BY HIGHEST TRANSMISSION IN YEAR 2013

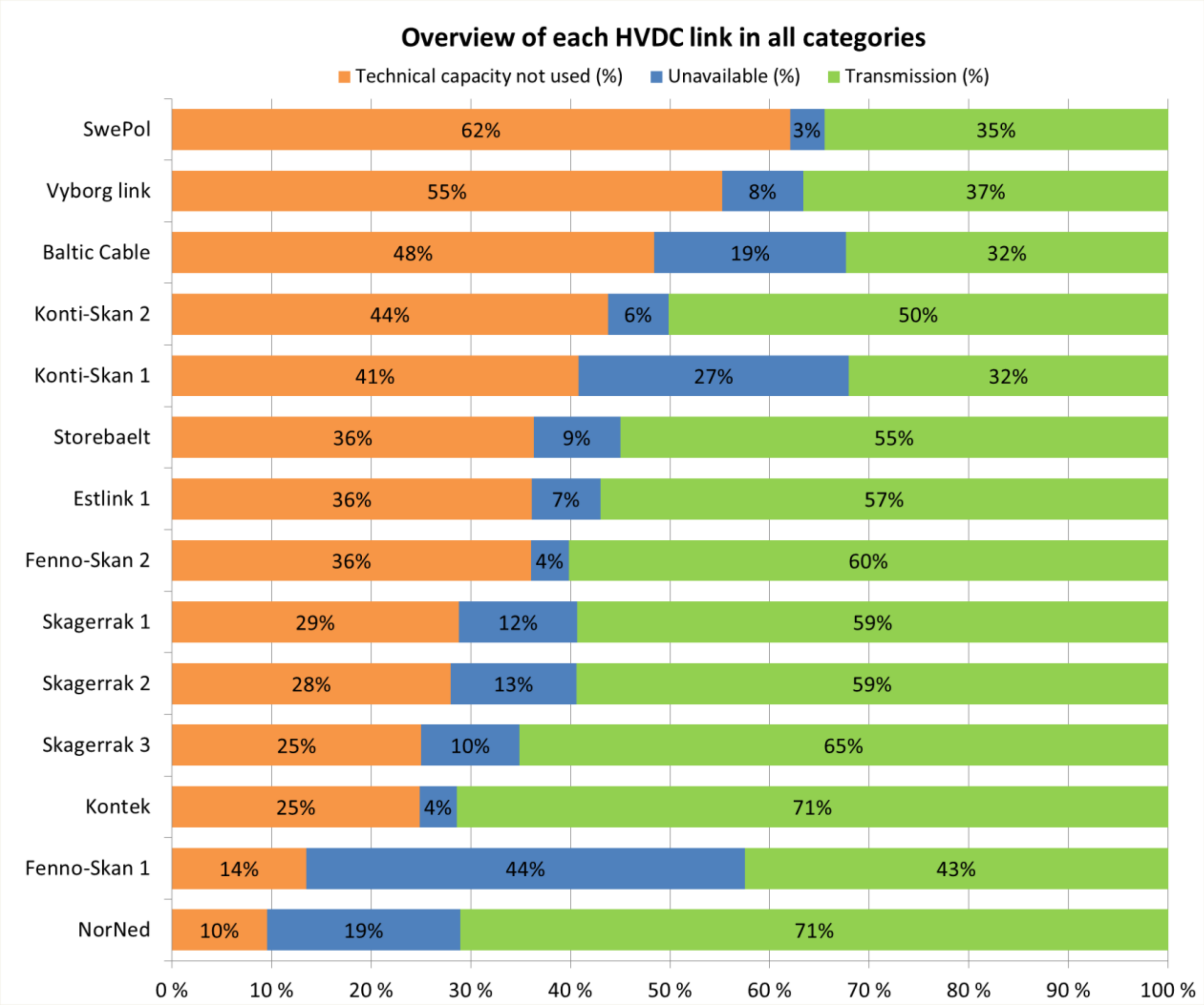

FIGURE C-3 ANNUAL OVERVIEW OF EACH HVDC LINK SORTED BY HIGHEST TECHNICAL CAPACITY NOT USED IN YEAR 2013