Statistik

Statistics

Nordel-statistikkens tal for 1979 er til dels præliminære. Eventuelle justeringer af tallene er sædvanligvis små og vil blive foretaget i næste årsberetning.

The statistical data for 1979 are preliminary. The necessary adjustments, which are usually small, will be made in the next annual report.

Installeret effekt

Den totale installerede effekt indenfor Nordel steg i 1979 med 2067 MW til 61713 MW, dvs. med 3,5%. Den installerede effekt i vandkraftstationer udgjorde ca. 58%. Kernekraftinstallationer udgjorde ved årets udgang 4790 MW i Sverige og Finland.

Indenfor Nordel-landene er fordelingen mellem vandkraft og varmekraft meget forskellig. I Danmark anvendes næsten udelukkende varmekraft, mens Norge mest bruger vandkraft. Vandkraften dominerer på Island og i Sverige, mens varmekraftinstallationer udgør ca. 76% af den totale installerede effekt i Finland.

Tabel 1

Installeret nettoeffekt 31. dec. 1979 og middelårs-produktion for vandkraft
Installed capacity 31. dec. 1979 and corresponding average-year production by hydro power

	Danmark	Finland	Island	Norge	Sverige	Nordel
Vandkraft MW *Hydro power*	8	2420	542	18395[1]	14167[1]	35507
Middelårs-produktion GWh *Average-year production*	20	11610	3320	88640	61210	164800
Varmekraft MW *Thermal power*	6760	7580	122	138	11606	26206
Deraf *of which*						
modtryk, fjernvarme konv. *back pressure, district heating conv.*	162	1360	–	–	2246	3768
modtryk, industriel *back pressure, industry*	105	1450	–	88	876	2519
kondens, proces *condense, process*	–	110	19	17	–	146
kondens, kerne *condense, nuclear*	–	1080	–	–	3710	4790
kondens, konventionel *condense, conventional*	6159[2]	2670	–	24	3006	11859
gasturbine, diesel *gasturbine, diesel*	334	910	103[3]	9	1768	3124
Total installeret effekt *Total installed capacity*						
1979 MW	6768	10000	664	18533[1]	25773[1]	61713
1978 MW	6459	9330	663	17716	25686	59829
Tilgang i 1979 MW *Additions in 1979 MW*	309	670	1	839	248	2067
Afgang i 1979 MW *Retirements in 1979 MW*	–	–	–	22	161	183

1) 25 MW norskejet effekt i Linnvasselv i Sverige er medregnet i den installerede effekt for såvel Norge som Sverige, dog kun én gang i totalsummen.
25 MW Norwegian-owned capacity at Linnvasselv in Sweden is included in both Norwegian and Swedish figures, but only once in the Nordel total.

2) Inkl. kondensturbiner med udtag for fjernvarme.
Incl. condensing turbines with some steam drawn for district heating.

3) Deraf geotermisk kraft 8 MW.
Of which geothermal power 8 MW.

Definitioner:

Ifølge Nordels definitioner har de anvendte udtryk følgende betydning:

Installeret maskineffekt i en kraftstation angives i MW og er summen af de enkelte aggregaters nominelle effekt, inkl. stations- og reserveenheder.

Overføringsevne for en kraftledning er den effekt i MW, som ledningen kan overføre under normale forhold, også under hensyn til eventuelle begrænsninger som skyldes tilknyttede anlægsdele.

Elproduktion angives i GWh og er den produktion, som de enkelte lande opgiver i deres officielle statistikker.

Modtryksproduktion er elektrisk energi, som produceres i en turbogenerator med damp, som efter turbinen anvendes til et andet formål end elproduktion, f.eks. fjernvarme, industriel procesdamp osv.

Kondenskraftproduktion er elektrisk energi, som produceres i en turbogenerator med damp, som efter turbinen kondenseres, således at dampens energi udelukkende benyttes til elproduktion.

Import og eksport af elektrisk energi angives i GWh og er de energimængder, som afregnes i køb og salg mellem de respektive lande. Nettoimport er differencen mellem import og eksport.

Bruttoforbruget af elektrisk energi angives i GWh og er summen af elproduktion og nettoimport.

Nettoforbruget af elektrisk energi angives i GWh og er summen af de energimængder, som er leveret til og målt hos forbrugerne samt de energimængder, som produceres i industrien til eget brug.

Tab er forskellen mellem bruttoforbrug og nettoforbrug.

Tilfældig kraft til elektrokedler er elektrisk energi, som anvendes til fremstilling af damp som erstatning for olie eller andet brændsel, og som leveres på særlige betingelser.

Magasinkapacitet for et reguleringsmagasin angives i GWh som den energimængde, som kan produceres i de nedenforliggende kraftværker ved engangs udtapning af fuldt magasin.

Magasinindhold på et givet tidspunkt angives i GWh som den energimængde, som kan produceres i de nedenforliggende kraftværker af vandindholdet over den laveste reguleringsgrænse.

Magasinfyldningsgrad på et givet tidspunkt angives i procent som forholdet mellem magasinindhold og magasinkapacitet.

Definitions:

Used expressions have the following meanings according to Nordel definitions.

Installed capacity: The installed generating capacity of a power station is given in MW and constitutes the arithmetic sum of the rated capacity of the units installed, including station service and stand-by units.

Transmission capacity is the rated capacity in MW of a line with due regard taken to the limits imposed by the transformers connected to it.

Electricity production is given in GWh and represents that output the individual countries officially report.

Back pressure production is the production of electric energy by a generator set driven by steam which, when discharged from the turbine, is applied for a purpose irrelevant to power production (such as district heating, process steam etc.).

Condense power production is defined as the output from a turbogenerator set operated by steam that is expanded in a cooling water condenser to enable the steam to be utilized exclusively for electric power generation.

Imports and exports: The exchange of power is given in GWh for the commercial blocks of power delivered or received by the individual countries. Net import is the difference between import and export.

Gross consumption of electric energy is given in GWh and is the sum of domestic production and net import.

Net consumption of electric energy is given in GWh and is the sum of the power delivered to and metered at the consumers plus the power produced by industry for its own consumption.

Losses are defined as the difference between gross consumption and net consumption.

Excess hydro power to electric boilers is defined as intermittent deliveries of temporary surplus power for raising steam in electric boilers on terms agreed on by the parties concerned.

Storage capacity of a reservoir is given in GWh and is equivalent to the power that is expected to be generated by all downstream power stations by full discharge of the impounded water.

Storage contents of a reservoir at a certain time is indicated in GWh as being the quantity of energy which can be extracted from the water contents above the lowest regulated water level at all power stations below the reservoir.

Rate of storage content at a given time is given as a percentage of the total reservoir capacity in terms of GWh.

Tabel 2

Nye anlæg i drift i 1979
New power plant capacity in 1979

Krafttype *Power category* / Kraftværk *Power plant*	Nye anlæg i drift i 1979 *New units taken into operation* — Antal enheder *Number of units*	Ny effekt *New capacity* MW	Stigning i middelårs-produktion *Increase in average year production* GWh[1]	Installeret nettoeffekt ialt *Total installed net capacity* 31. dec. 79 MW	Middelårs-produktion ialt *Total average year production* 31. dec. 79 GWh[1]
Danmark					
Vandkraft *Hydro power*	–	–	–	8	20
Konv. varmekraft *Conv. thermal power*	1	305	–	6760	–
Enstedværket	1	305	k/o	811[2]	–
Finland					
Vandkraft *Hydro power*	1	1	4	2420	11610
Konv. varmekraft *Conv. thermal power*	1	8	–	6500	–
Kernekraft *Nuclear power*	1	660	–	1080	–
Olkiluoto B1	1	660	–	660	–
Island					
Vandkraft *Hydro power*	–	–	–	542	3320
Konv. varmekraft *Conv. thermal power*	2	1	–	122	–
Norge					
Vandkraft *Hydro power*	14	805	2000	18395	88640
Strandfossen	1	25	147	25	147
Kjela	1	62	258	62	258
Aurland III	2	270	248	270	248
Høyanger[3]	–4[3]	54	44	105	377
Kolsvik	2	134	502	134	502
Lomi	2	126	350	126	350
Skibotn	1	72	274	72	274
Roskrepp	1	50	110	50	110
Sagfossen	1	11	47	11	47
Konv. varmekraft *Conv. thermal power*	1	12	–	138	–
Union	1	12	o	12	–
Sverige					
Vandkraft *Hydro power*	3	48	167	14167	61210
Konv. varmekraft *Conv. thermal power*	5	200[4]	–	–	–
Gasturbine, GT 200	1	78	o	78	–
Mønsterås	2	36	a	36	–
Kernekraft *Nuclear power*	–	–	–	3710	–

1) Kun for vandkraft. For den konventionelle varmekraft angives brændselstype. (o = olie, k = kul, g = gas, t = tørv, a = affald).
Only for hydro power. For the conv. thermal power: Type of fuel is stated: (o = oil, k = coal, g = gas, t = turf, a = garbage, waste).

2) Dansk andel af en fællesejet dansk-tysk 610 MW-enhed.
Danish share of a jointly-owned Danish-German 610 MW unit.

3) Udbygning af Høyanger V med 2 enheder, skrotning af Høyanger I med 6 enheder.
Høyanger V extended by 2 units, Høyanger I scrapped with 6 units.

4) Herfra går 161 MW på grund af skrotning.
With a reduction of 161 MW due to scrappings.

Tabel 3

Besluttede større kraftstationer*

Decided large power plants

Krafttype *Power category* / Kraftværk *Power plant*	Installeret nettoeffekt *Installed net capacity* 31. dec. 79	Middelårs-produktion *Average-year production* 31. dec. 79	Besluttede nye anlæg *Decided new plants*: Antal enheder *Number of new units*	Ny effekt *New capacity*	Stigning i middelårs-produktion *Increase in average-year production*	Beregnet idrift-sættelse *Estimated to be brought into service in*
	MW	GWh[1)]		MW	GWh[1)]	
Danmark						
Konv. varmekraft *Conv. thermal power*						
Asnæsværket	760	–	1	650	k/o	1980
Herningværket	–	–	1	95	k/o	1982
Randersværket	19	–	1	45	k	1983
Studstrupværket	415	–	2	700	k/o	1983/84
Amagerværket	256	–	1	480	k/o	1985
Finland						
Vandkraft *Hydro power*						
Porttipahta	–	–	1	38	90	1981
Konv. varmekraft *Conv. thermal power*						
Kuopio 2	36	–	1	60	t	1982
Naantali	120	–	1	96	k	1982
Salmisaari	92	–	1	150	k	1984
Joensuu	–	–	1	60	t	1986
Kernekraft *Nuclear power*						
Olkiluoto 2	660	–	1	660	–	1980
Loviisa 2	440	–	1	420	–	1980
Island						
Vandkraft *Hydro power*						
Hrauneyjafoss	–	–	2	140	850	1981/82
Kraftvarmeværk (geot.) *Geothermal plant*	–	–	1	6	–	1980
Norge						
Vandkraft *Hydro power*						
Rana G4	375	–	1	125	–	1980
Oksla	–	–	1	200	160	1980
Skjomen G3	200	1064	1	100	152	1980
Eidfjord	–	–	4	1120	2440	1980/81
Aurland	720	1541	5	152	892	1980/83
Ulla-Førre	–	–	10	2000[2)]	4350	1980/87
Osa (omb. + udv.)	7	34	2	85	270	1981
Kvinen	–	–	1	70	225	1981
Holen	–	–	2	210	510	1981
Steinsland	–	–	2	130	470	1981
Tafjord 5	180	–	2	70	265	1981/82
Skollenborg (omb. + udv.)	35	243	2	68	140	1982
Sildvik	–	–	1	56	200	1982
Orkla-Grana	–	–	5	270	1100	1982/87
Skarje	–	–	1	150	325	1985
Alta	–	–	1	150	625	1986

Tabel 3 (forts., cont.)
Besluttede større kraftstationer*
Decided large power plants

Krafttype *Power category* / Kraftværk *Power plant*	Installeret nettoeffekt *Installed net capacity* 31. dec. 79 MW	Middelårs-produktion *Average-year production* 31. dec. 79 GWh[1]	Besluttede nye anlæg *Decided new plants*: Antal enheder *Number of new units*	Ny effekt *New capacity* MW	Stigning i middelårs-produktion *Increase in average-year production* GWh[1]	Beregnet idrift-sættelse *Estimated to be brought into service in*
Konv. varmekraft *Conv. thermal power*						
Trondheim	–	–	1	25	o	1980
Orkla	–	–	1	21	g	1981
Øye	–	–	1	14	g	1981
Tofte	–	–	1	45	a	1982
Sverige						
Vandkraft *Hydro power*						
Porjus G12	295	1400	1	226	28	1980
Harsprånget G5	510	2162	1	464	208	1980
Ligga G3	160	797	1	169	–	1982
Messaure G3	300	1834	1	140	–	1983
Stenkullafors	–	–	1	56	230	1983
Konv. varmekraft *Conv. thermal power*						
Hälsingborg	–	–	1	55	o	1981
Korsta	–	–	1	59	a	1981
Kernekraft *Nuclear power*						
Forsmark B1	–	–	1	900	–	1981
Ringhals B3	1550	–	1	915	–	1981
Forsmark B2	–	–	1	900	–	1981
Ringhals B4	1550	–	1	915	–	1982
Forsmark B3	–	–	1	1050	–	1985
Oskarshamn B3	1020	–	1	1060	–	1986

*) I visse tilfælde forekommer skrotning i forbindelse med nyanlæg, således at installeret effekt efter udbygningen ikke i alle tilfælde er summen af installeret effekt pr. 31.12.1979 og effekten af besluttede nye anlæg.
In certain cases scrapping appears in connection with new plants so that after the extension installed capacity will not in all cases be the sum of installed capacity as 31. dec. 1979 and the capacity of decided new plants.

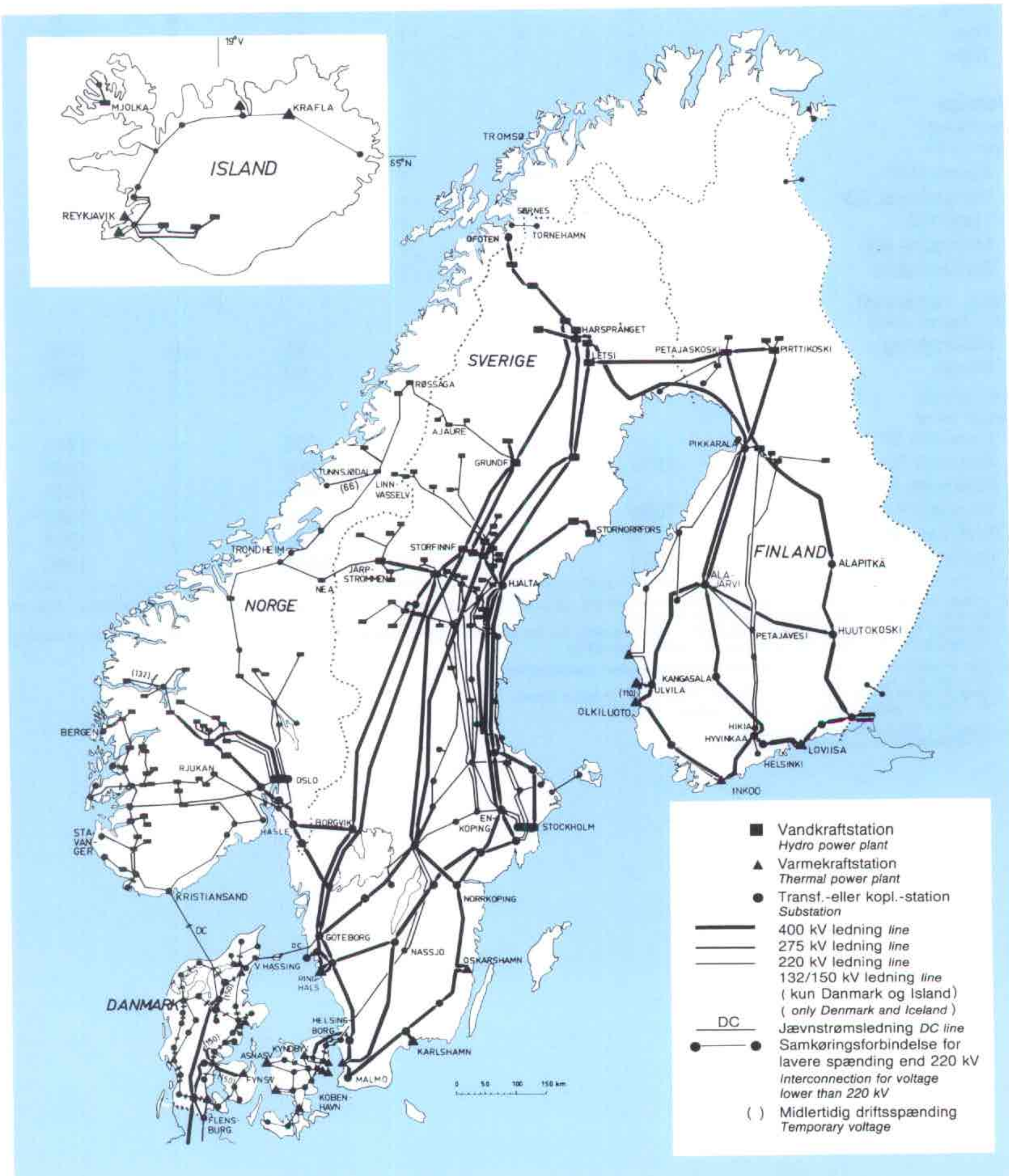
1) Kun for vandkraft. For den konventionelle varmekraft angives brændselstype.
(o = olie, k = kul, g = gas, t = tørv, a = affald).
Only for hydro power. For the conv. thermal power: Type of fuel is stated:
(o = oil, k = coal, g = gas, t = turf, a = garbage, waste).

2) Heraf 320 MW kombineret pumpe/turbine.
Of which 320 MW combined pump/turbine.

De nordiske højspændingsnet

Sverige har forbindelse til Danmark, Finland og Norge. De to sidstnævnte lande er ikke direkte forbundet, bortset fra enkelte lokale leverancer fra Norge til forbrugere i Finland. Den totale overføringsevne fra Sverige var ved udgangen af 1979 3855 MW og til Sverige 3095 MW. Mellem Danmark (Jylland) og Norge er der etableret en 250 kV-jævnstrømsforbindelse. Fra Sønderjylland i Danmark findes 400, 220 og 60 kV-forbindelser til Vesttyskland. Finland har lokale 110 kV og 25 kV-forbindelser og Norge en lokal 154 kV-forbindelse til Sovjetunionen.

Fig. 1
Det nordiske hovednet 1979
The Nordic Power System 1979



Tabel 4

Transmissionsledninger (km)
Transmission lines (km)

	400 kV		220, 300 kV		110, 132, 150 kV[4]	
	Taget i drift i 1979 *Brought into service in 1979*	I drift 31. dec. 79 *In service 31. dec. 79*	Taget i drift i 1979 *Brought into service in 1979*	I drift 31. dec. 79 *In service 31. dec. 79*	Taget i drift i 1979 *Brought into service in 1979*	I drift 31. dec. 79 *In service 31. dec. 79*
Danmark	266	765[1,2]	–	213[3]	8	3017
Finland	50	3027	–	2152	300	10400
Island	–	–	–	314	34	637
Norge	39	611	94	4538[3]	100	7724
Sverige	128	8606[1]	–	5505[3]	[5]	[5]

1) Inkluderer halvdelen af 400 kV-kabelforbindelsen (4 km) Sjælland-Sverige.
Including half of the 400 kV cable line (4 km) Sjælland-Sweden.

2) Heraf 13 km i drift med 220 kV, 238 km med 150 kV og 48 km med 132 kV.
Of which 13 km in service with 220 kV, 238 with 150 kV and 48 km with 132 kV

3) Heraf 80 km i Danmark og 96 km i Sverige (Kontiskan) samt 89 km i Danmark og 151 km i Norge (Skagerrak) med 250 kV jævnstrøm.
Of which 80 km in Denmark and 96 km in Sweden (Kontiskan) and 89 km in Denmark and 151 km in Norway (Skagerrak) with 250 kV DC.

4) Delvist skønnede værdier.
To some extent estimated values.

5) Værdier kendes endnu ikke.
Values at present unknown.

Tabel 5

Samkøringsforbindelser mellem Nordel-landene – 31. dec. 1979
Interconnections between the Nordel-countries – 31. dec. 1979

Land *Country*	Stationer *Terminal stations*	Nominel spænding kV *Rated voltage kV*	Overføringsevne MW *Transmission capacity MW*		Længde km *Lenght km*	Kabel km *Cable km*
			Fra Danmark *From Denmark*	Til Danmark *To Denmark*		
Danmark-Norge	Tjele-Kristiansand	±250=	500	500	240/pol	127/pol
			Fra Sverige *From Sweden*	Til Sverige *To Sweden*		
Danmark-Sverige	Teglstrupgård-Sofiero	132	350[1]	350[1]	25	10
	Hovegård-Hälsingborg	400	700[1]	700[1]	91	8
	Vester Hassing-Göteborg	250=	260	260	176	88
Finland-Sverige-	Ossauskoski-Kalix	220 }			93	
	Petäjäskoski-Letsi	400 }	1100	600	230	
	Pikkarala-Messaure	400 }			425	
	Hellesby (Åland)-Skattbol	70	35	35	77	56
Norge-Sverige-	Sørnes-Tornehamn	132 }	150[2]	150[2]	39	
	Ofoten-Ritsem	400 }			58	
	Røssåga-Ajaure	220	260[3]	100[3,4]	117	
	Linnvasselv[7]	66	50	50	–	
	Nea-Järpströmmen	300	500[3]	500[5]	100	
	Hasle-Borgvik	400 }	800[3,6]	700[3,6]	106	
	Hasle-Trollhättan	400 }			135	
Totalt indenfor Nordel			4355	3595		
Besluttet: *Decided:*			Fra Sverige *From Sweden*	Til Sverige *To Sweden*		
Danmark-Sverige	Hovegård-Hälsingborg (1985)	400	7)	7)	91	8

1) Selv med begge forbindelser i drift er den samlede overføringsevne 700 MW i hver retning.
At parallel operation of the interconnections the total transmisssion capacity amounts to maximum 700 MW in both directions.

2) Efter udbygninger i Norge forøges overføringsevnen.
After extensions in Norway the capacity will increase.

3) I tilfælde af paralleldrift over flere samkøringsforbindelser Norge-Sverige og visse andre driftssituationer kan dimensionerede fejltilfælde give en lavere overføringsevne.
Transmission capacity is in some cases reduced by dimensioning fault case.

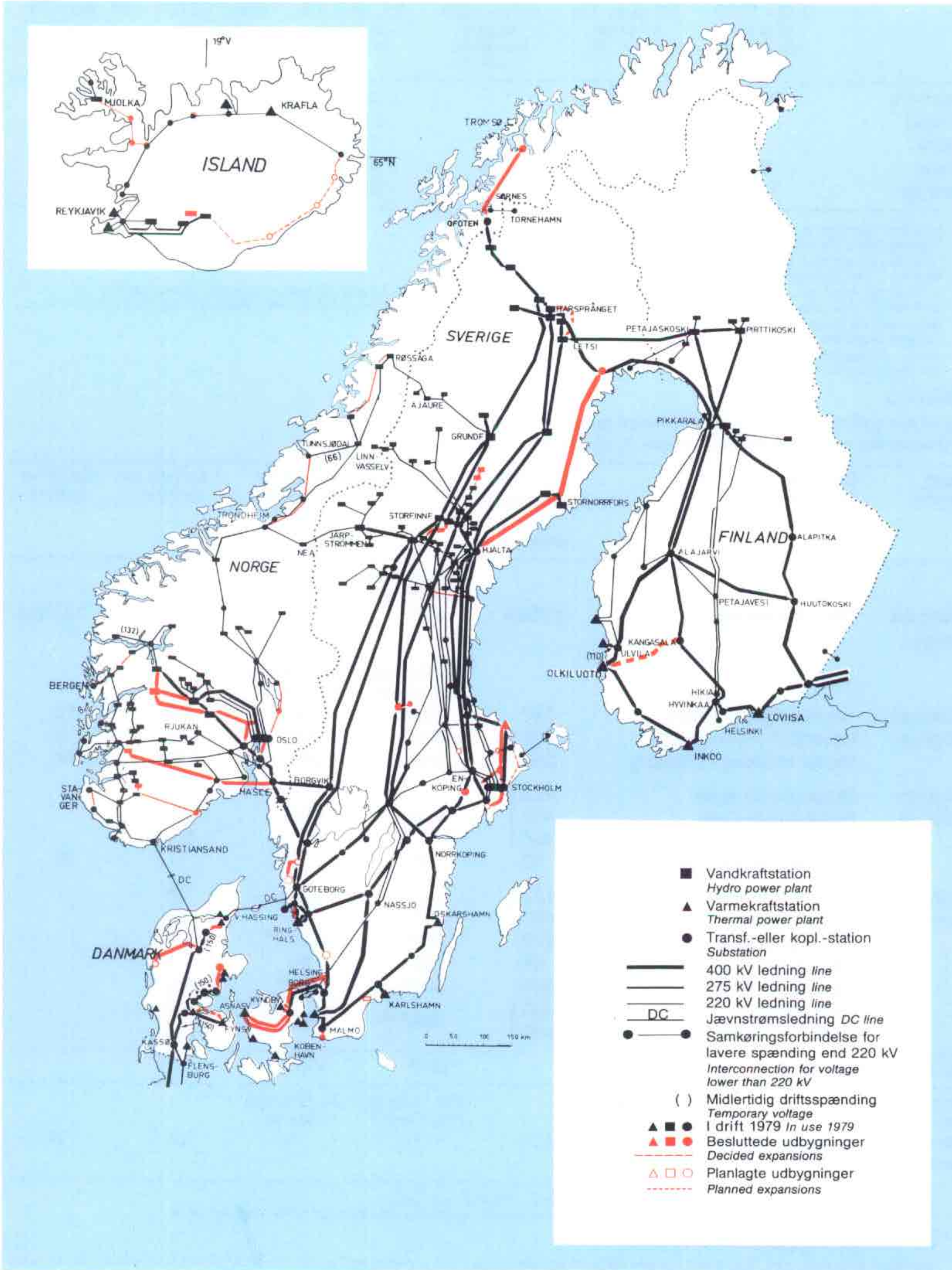
4) 100 MW gælder ved maximal produktion i Gejmån-Ajaure-Gardikfors. Ved minimal produktion i disse stationer og maximalt 250 MW produktionsoverskud i Helgeland er overføringsevnen 200 MW.
100 MW at maximum production in Gejmån-Ajaure-Gardikfors.
With minimum production in these stations and 250 MW surplus production in Helgeland the transmission capacity is 200 MW.

5) Samkøringsforbindelsen er en 220/66 kV transformator i den norsk-svenske kraftstation Linnvasselv.
The interconnection consists of a 220/66 kV transformer in the Norwegian-Swedish power station Linnvasselv.

6) Efter udbygninger i Norge forøges denne til 1200 MW fra Sverige og 1000 MW til Sverige.
After extensions in Norway this will increase to 1200 MW Sweden-Norway and 1000 MW Norway-Sweden.

7) Overføringsevnen efter udbygningen kendes endnu ikke.
Transmission capacity is at present unknown.

Fig. 2
Det nordiske hovednet med besluttede og planlagte udvidelser.
The Nordic Power System, with Future Expansions.



Tabel 6

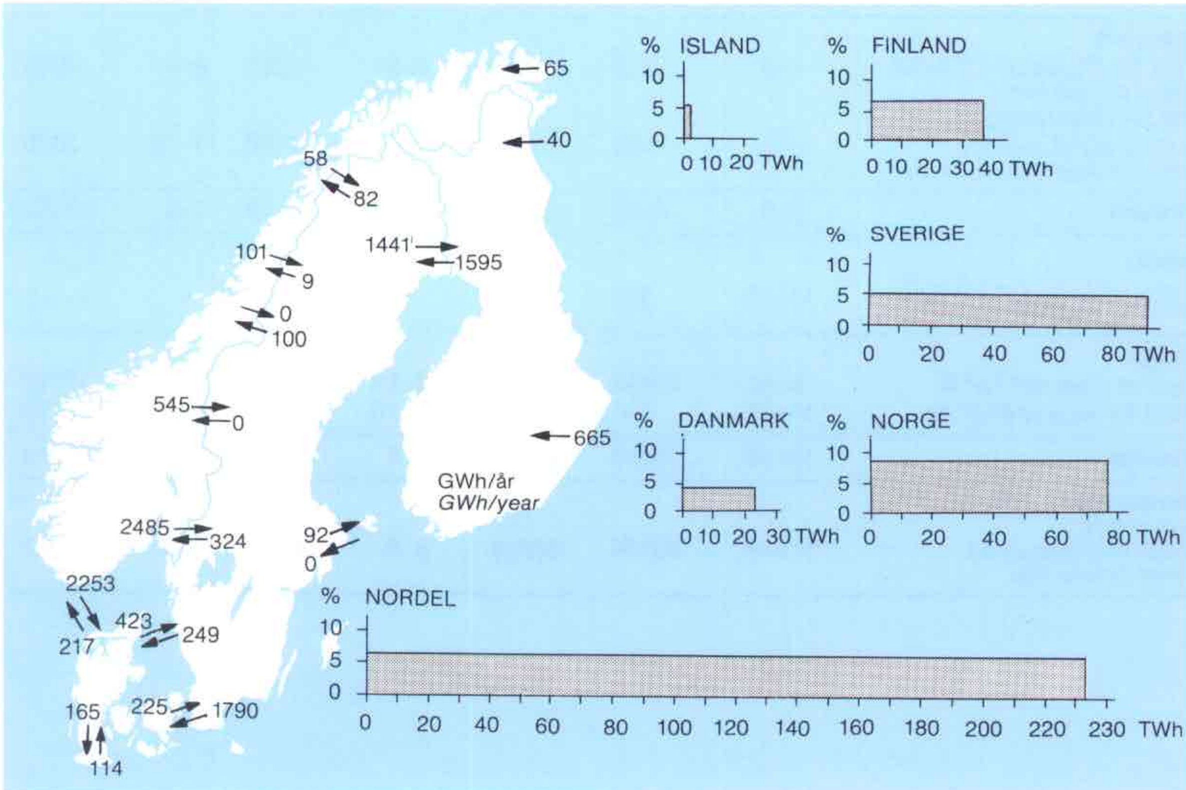
Maksimal belastning 3. onsdag i december 1979
Maximum load on the 3rd Wednesday in December 1979

	Maks. kraftstations-belastning *Max. power station output*		Installeret netto-effekt *Installed net capacity*	Maks. systembelastning *Max. system load*			
				1978		1979	
	Lokaltid *Local time*	MW	MW	Lokaltid *Local time*	MW	Lokaltid *Local time*	MW
Danmark							
Vest for Storebælt (ELSAM) *West of the Great Belt*	8–9	2210	3664	8–9	2365	8–9	2395
Øst for Storebælt ekskl. Bornholm (ELKRAFT) *East of the Great Belt excl. Bornholm*	8–9	1989	2880	17–18	1988	17–18	2050
Finland	8–9	6249	10000	8–9	6210	7–8	6185
Island							
Syd-, vest- og nord-Island *South, West and North Iceland*	11–12	392	626	–	–	–	–
Norge							
Syd for *(south of)* 67.5° N	9–10	13692	17482	9–10	11587	9–10	12790
Nord for *(north of)* 67.5° N	14–15	740	1051	14–15	747	17–18	793
Sverige	15–16	16553	25773	8–9	16182	8–9	17334
Nordel ekskl. Island *(excl. Iceland)*							
Mellemeuropæisk tid *Central-European time*	17–18	40794	60850	8–9	38937	8–9	40927

Omsætning af elektrisk energi

Tabel 7
Oversigt over omsætningen af elektrisk energi i Nordel 1979.
Review of the electric energy turnover in Nordel 1979

Af de små diagrammer til højre for kortet fremgår forbrugsstigningen i de enkelte lande og for Nordel totalt. Stigningen i % ses i forhold til forbruget det foregående år, og stigningen i TWh er proportional med arealet af de markerede flader.

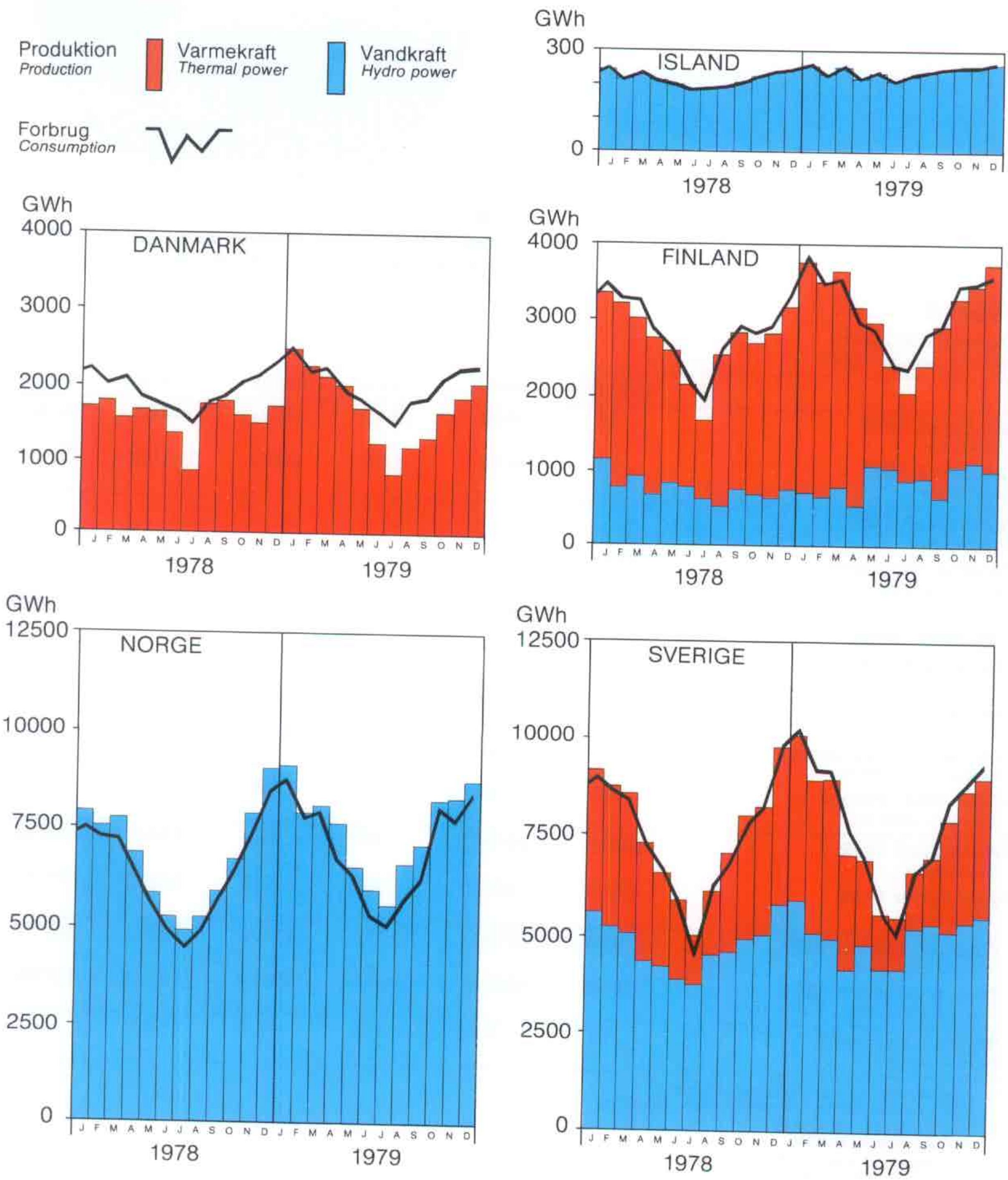


Tabel 7
Oversigt over el-energiomsætningen i Nordel 1979 (GWh)
Review of the electric energy turnover in Nordel in 1979

	Danmark	Finland	Island	Norge	Sverige	Nordel
Produktion *Production*	20834	37151	2915	88870	92434	242204
Heraf vandkraft *Of this hydro power*	20	10658	2819	88737	60188	162422
Import	4406	2238	–	797	5432	884
Total produktion og import *Total production and import*	25240	39389	2915	89667	97866	243088
Eksport	1030	1595	–	5442	4087	165
Bruttoforbrug *Gross consumption*	24210	37794	2915	84225	93779	242923
Tilfældig kraft til elektrokedler etc.1) *Excess hydro power for electric boilers etc.*	–	4	96	1800	–	1900
Bruttoforbrug ekskl. tilfældig kraft til elektrokedler etc. *Gross consumption excl. excess hydro power for electric boilers etc.*	24210	37790	2819	82425	93779	241023
Stigning fra 1978 % *Increase as against 1978 %*	4,4	7,5	5,4	8,2	5,0	6,4

1) Heraf pumpekraft 410 GWh.
Of which pumped storage power 410 GWh.

Fig. 3
Produktion og bruttoforbrug, ekskl. tilfældig kraft til elektrokedler.
Production and gross consumption excl. excess hydro power to electric boilers.



Elproduktion

Tabel 8 giver en oversigt over elproduktionen, opdelt på vandkraft og varmekraft i 1978 og 1979. Den totale produktion inden for Nordel var i 1979 242,3 TWh, altså 6,5% højere end i 1978. Vandkraftens andel af totalproduktionen var 67% mod 66% i 1978.
Fig. 4 viser, hvordan produktionen i 1979 fordelte sig på de forskellige kategorier.

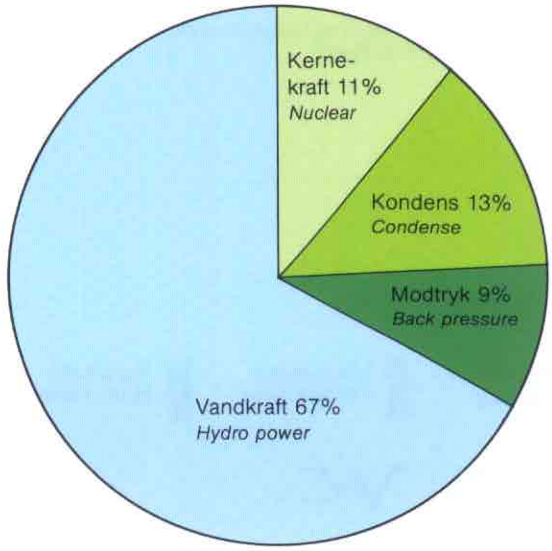


Fig. 4
Total elektricitetsproduktion inden for Nordel
Total electricity production within Nordel

Tabel 8

Elproduktion (GWh)
Electricity production (GWh)

	Danmark	Finland	Island	Norge	Sverige	Nordel
Vandkraft 1979 *Hydro power*	20	10658	2819	88737	60188	162422
Vandkraft 1978 *Hydro power*	23	9646	2605	80864	57049	150187
Varmekraft 1979 *Thermal power*						
Modtryk, fjernvarme *Back pressure, district heating*	2720	3749	–	–	5055	11524
Modtryk, industriel *Back pressure, industry*	260	6353	–	67	4188	10868
Kondens, proces *Condense, process*	–	473	–	–	–	473
Kondens, kerne *Condense, nuclear*	–	6388	–	–	20137	26525
Kondens, konventionel *Condense, conventional*	17712	9250	–	29	2716	29707
Gasturbine, diesel m.v. *Gasturbine, diesel etc.*	122	280 1)	96	37	150	685
Varmekraft 1979 *Thermal power*	20814	26493	96 2)	133	32246	79782
Varmekraft 1978 *Thermal power*	19505	24225	69 3)	133	33250	77182
Total produktion 1979 *Total production 1979*	20834	37151	2915	88870	92434	242204
Total produktion 1978 *Total production 1978*	19525	33871	2674	80997	90299	227366
Stigning i procent *Increase, per cent*	6,7	9,7	9,0	9,7	2,4	6,5

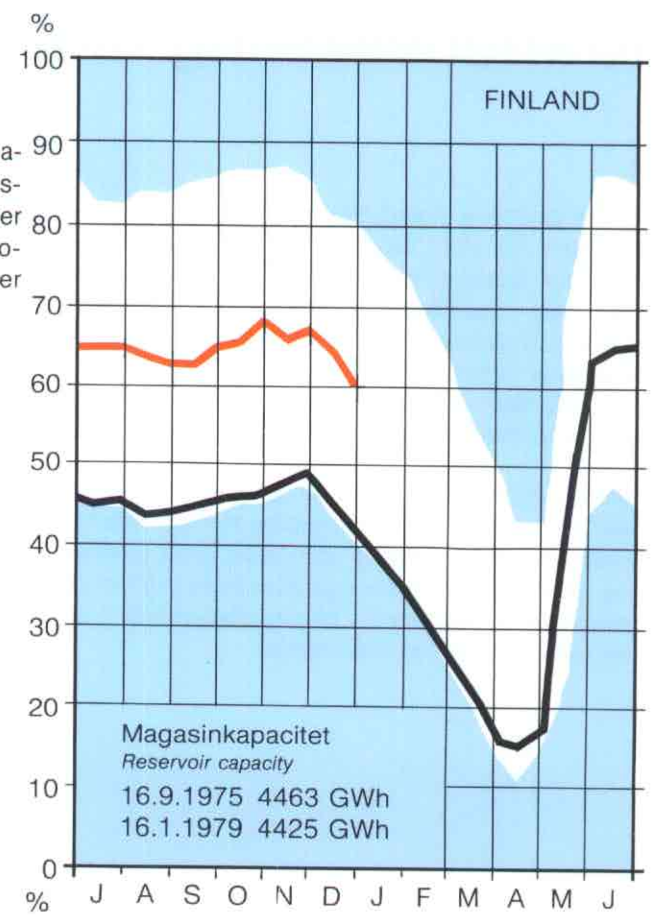
1) Heraf 277 GWh naturgas – grundlastproduktion.
Of this 277 GWh base – load production from natural gas.

2) Heraf geotermisk kraft 42 GWh.
Of this geothermal 42 GWh.

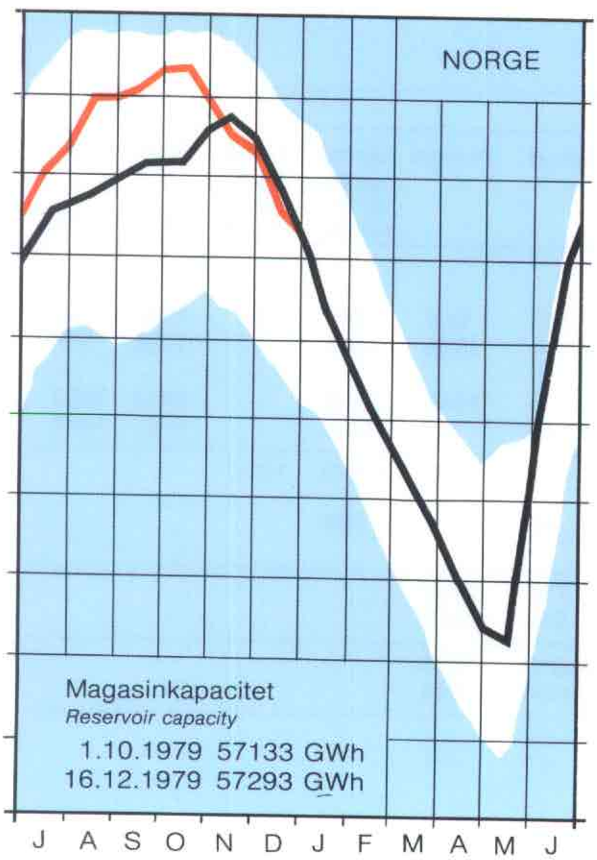
3) Heraf geotermisk kraft 18 GWh.
Of this geothermal 18 GWh.

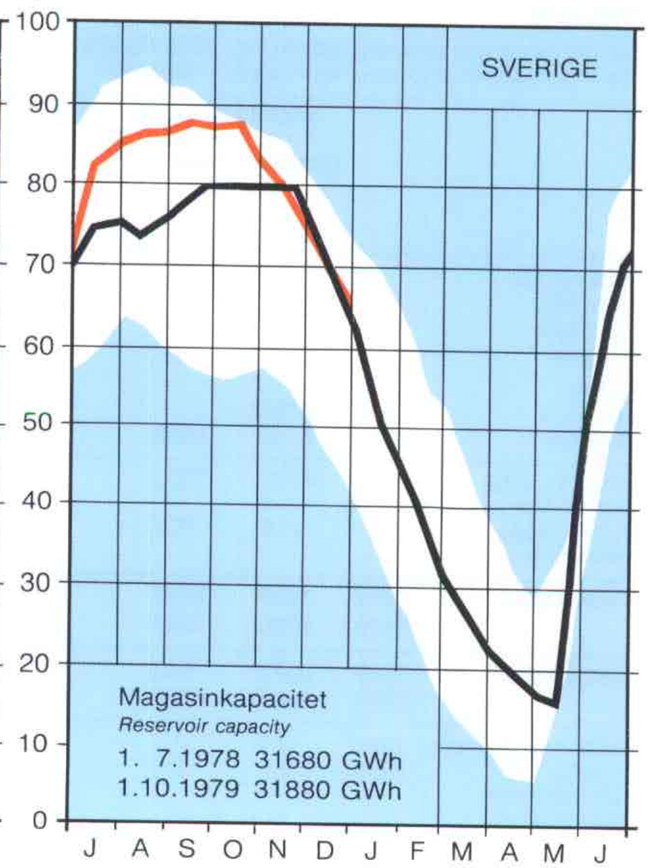
Fig. 5
Magasinindhold
Energy stored in the reservoirs

I fig. 5 vises magasinfyldningen – i % af fyldte magasiner – i Finland, Norge og Sverige i løbet af driftsårene 1978/79 og 1979/80. De blå-skraverede felter angiver begrænsningskurverne for magasinvariationerne: De højeste, resp. laveste ugeværdier som er registreret i tiårsperioden 1969-1979.



1978/79
1979/80
Ekstremværdier (1.7.1969-30.6.1979)
Extreme values





Kraftudveksling mellem landene

Nordel-landenes import og eksport er vist i tabel 9. Desuden er vist nettoimporten i % af bruttoforbruget. Sverige havde den største import på 5,4 TWh, men hovedparten af denne import videreeksporteres til Danmark eller tilbageleveres til Finland, således at nettoimporten kun blev 1,3 TWh. Største nettoimportør var Danmark med 3,4 TWh, og største nettoeksportør var Norge med 4,6 TWh.

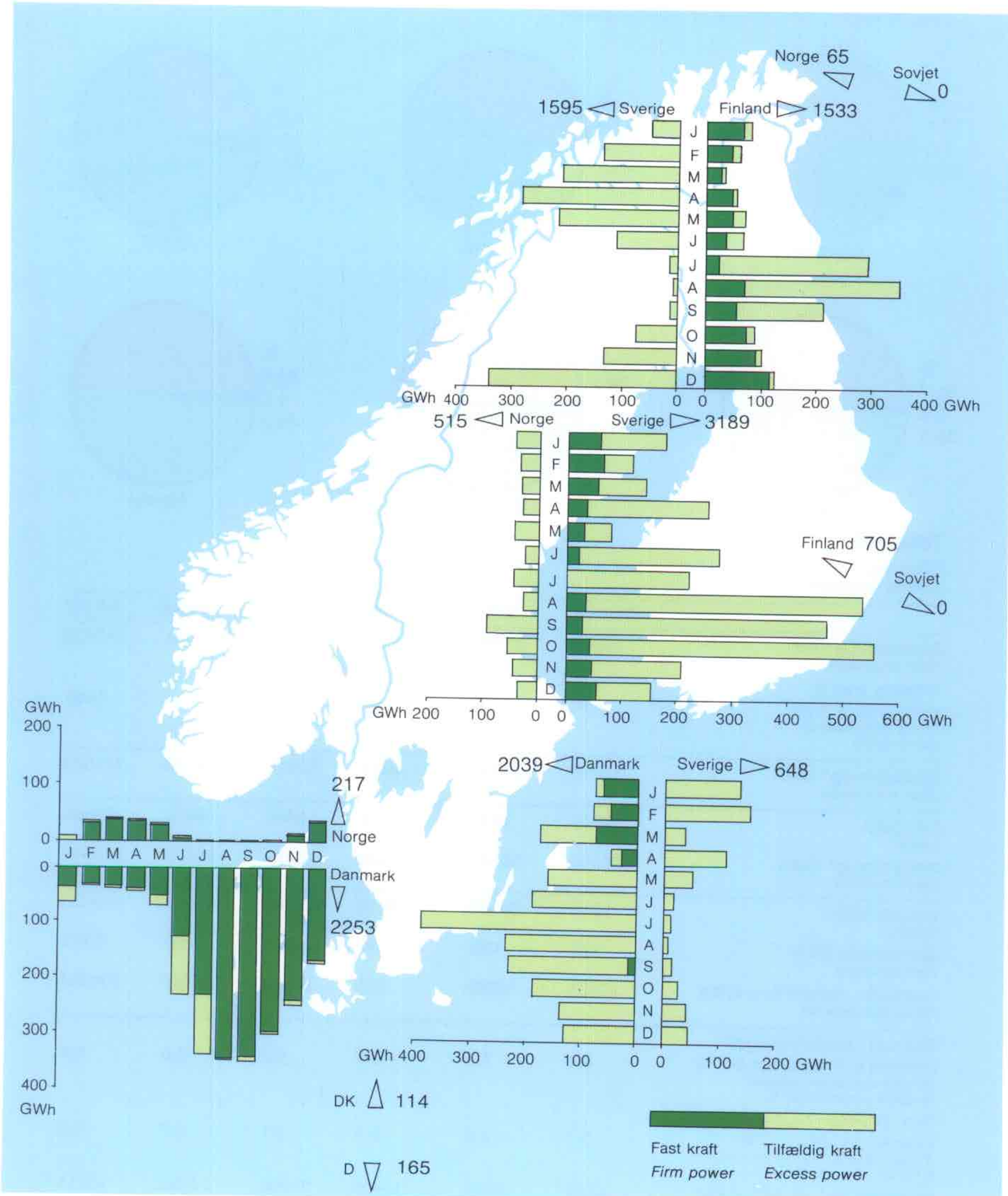
Værdierne i tabel 9 og fig. 6 omfatter de fysiske udvekslinger, dvs. hvis en udveksling mellem to lande modsvares af en samtidig og modsat rettet udveksling på en anden samkøringsforbindelse mellem de samme lande modregnes begge udvekslinger i de respektive import- og eksportsaldi.

Tabel 9

Nordel-landenes el-energiudveksling 1979 (GWh)
The Nordel-countries' exchange of electric energy in 1979 (GWh)

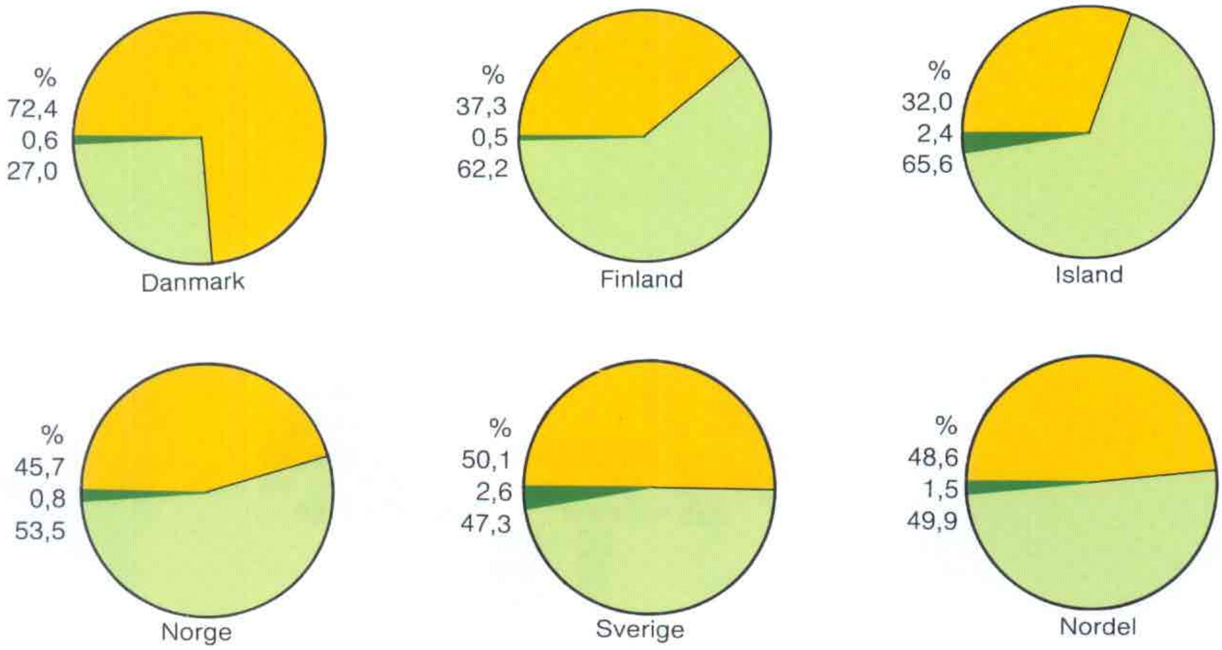
		Import til/*Import to*								
		Danmark	Finland	Island	Norge	Sverige	Nordel-lande *Nordel countries*	Andre lande *Other countries*	Total eksport 1979	Total eksport 1978
Eksport fra: *Export from:*										
Danmark		–	–	–	217	648	865	165	1030	706
Finland		–	–	–	–	1595	1595	–	1595	277
Island		–	–	–	–	–	–	–	–	–
Norge		2253	–	–	–	3189	5442	–	5442	3923
Sverige		2039	1533	–	515	–	4087	–	4087	3418
Nordel-lande *Nordel countries*		4292	1533	–	732	5432	11989	165		
Andre lande *Other countries*		114	705	–	65	–	884			
Total import	1979	4406	2238	–	797	5432				
	1978	4386	1554	–	515	2412				
Nettoimport	1979	3375	643	–	–4645	1345				
	1978	3680	1277	–	–3408	–1005				
Nettoimport/brutto-forbrug i % *Net import/gross consumption in per cent*	1979	13,9	1,7	–	–5,6	1,4				
	1978	15,9	3,6	–	–4,5	–1,1				

Fig. 6
Månedlig udveksling af elektrisk energi mellem Nordel-landene 1979
Monthly exchange of electricity within Nordel 1979



Elforbruget

Fig. 7
Elforbrug fordelt på konsumentgrupper
Electricity consumption distributed on consumer groups



Tabel 10
Elforbrug
Electricity consumption

	Danmark	Finland	Island	Norge	Sverige	Nordel
Bruttoforbrug GWh *Gross consumption*	24210	37794	2915	84225	93779	242923
Tilfældig kraft til elektrokedler GWh *Excess hydro power to electric boilers*	–	4	96	1800[1)]	–	1490
Bruttoforbrug* GWh *Gross consumption*	24210	37790	2819	82425	93779	241023
Tab GWh *Losses*	2210	2240	275	8840	8416	21981
Nettoforbrug* GWh *Net consumption*	22000	35550	2544	73585	85363	219042
Industri GWh *Industry*	5950	22100	1670	39360	40355	109435
Samfærdsel GWh *Communications*	125	190	61	605	2262	3243
Husholdn., handel m.v. GWh *Households, trade etc.*	15925	13260	813	33620	42746	106364
Stigning i bruttoforbruget* i forhold til foregående år i % *Increase in gross consumption as against previous year, %*	4,4	7,5	5,4	8,2	5,0	6,4
Gns. stigning i bruttoforbruget* indenfor de sidste 10 år i % *Average increase in gross consumption in the last 10 years, %*	5,1	6,9	12,1	4,1	4,3	4,3
Bruttoforbrug* pr. indb. i kWh *Gross consumption per inhabitant*	4724	7920	12429	20205	11293	10711

*) Ekskl. tilfældig kraft til elektrokedler.
Excl. excess hydro power to electric boilers.

1) Heraf pumpekraft 410 GWh.
Of which pumped storage power 410 GWh.

Fig. 8
12-måneders kurve for bruttoforbruget* 1970-1979
12-months curve for gross consumption 1970-1979*

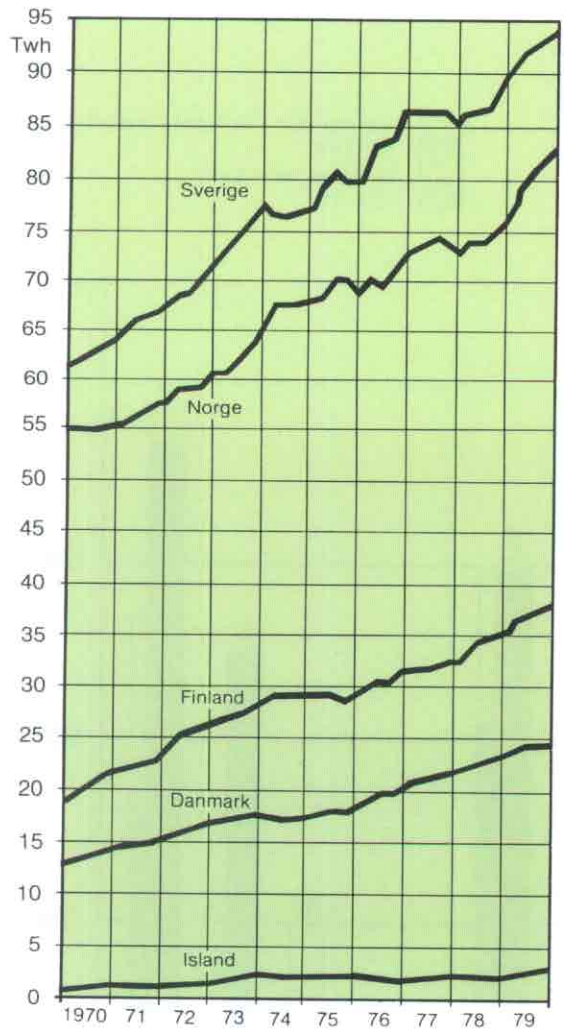
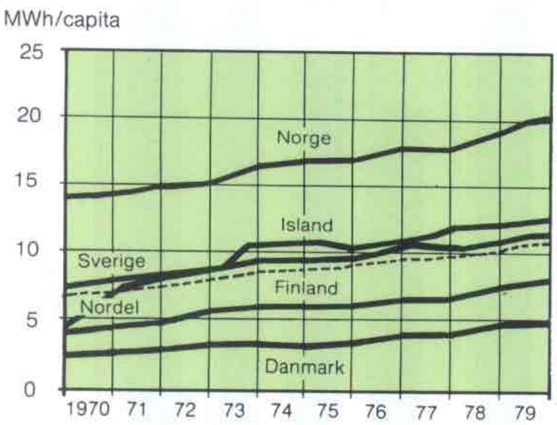


Fig. 9
Bruttoforbrug* pr. indbygger
*Per capita consumption**



* Ekskl. tilfældig kraft til elektrokedler.
Excl. excess hydro to electric boilers'.

Prognoser

Nedenstående tabeller bygger på elforsyningens egne vurderinger af elforbrugets sandsynlige udvikling, for 1979 og 1979/80 dog på konstaterede værdier. Prognoserne danner grundlag for planlægningen af den videre udbygning af elforsyningen. Hvis den faktiske udvikling viser et lavere forbrug, end der regnes med i prognosen, kan denne uden vanskelighed tilpasses år for år.

Tabel 11

Prognoser for elenergiforbruget (TWh/år)
Forecasts for the electric energy consumption (TWh/year)

	1979	1985	1990
Danmark	24,2	34	42
Finland	37,8	49	57
Norge[1)]	82,4	92	105
Sverige	93,8	121	138
Nordel totalt*	238,2	296	342

1) Prognoserne er baseret på NVE's prognoser for almindelig forsyning plus regeringens program for kraftintensiv industri.
NVE's forecasts for ordinary supplies and the government's programme for power intensive industry.

* *Ekskl. Island*
Excl. Iceland

Tabel 12

Effektprognoser (MW)
Power forecasts (MW)

	1979/80	1985/86	1990/91
Danmark	4900	6900	8650
Finland	6700	8800	10200
Norge	13590	15500	17700
Sverige	17479	22800	26000
Nordel totalt*	42669	54000	62550

* Ekskl. Island
Excl. Iceland

Tabel 13

Prognoser for installeret effekt i MW i de enkelte lande (pr. 31. dec.)
Forecasts for installed capacity in MW in each country (valid per 31. dec.)

	1979	1985	1990
Danmark	6768	8950	9100
Finland	10000	11100	11650
Norge	18533	24600	28350
Sverige	25773	34400	35600
Nordel totalt*	61074	79050	84700

* Ekskl. Island
Excl. Iceland

Fig. 10

Fordeling af elenergitilgang på energityper.
Til vandkraft er alene medregnet fast krafttilgang.
Yderligere tilgang af vandkraft vil medføre et mindsket forbrug af fossilt brændsel.

Distribution on energy of electricity (production and import)

Fordeling af brændselsforbrug udenfor elsektoren.

Fuel consumption, other than for electricity production.

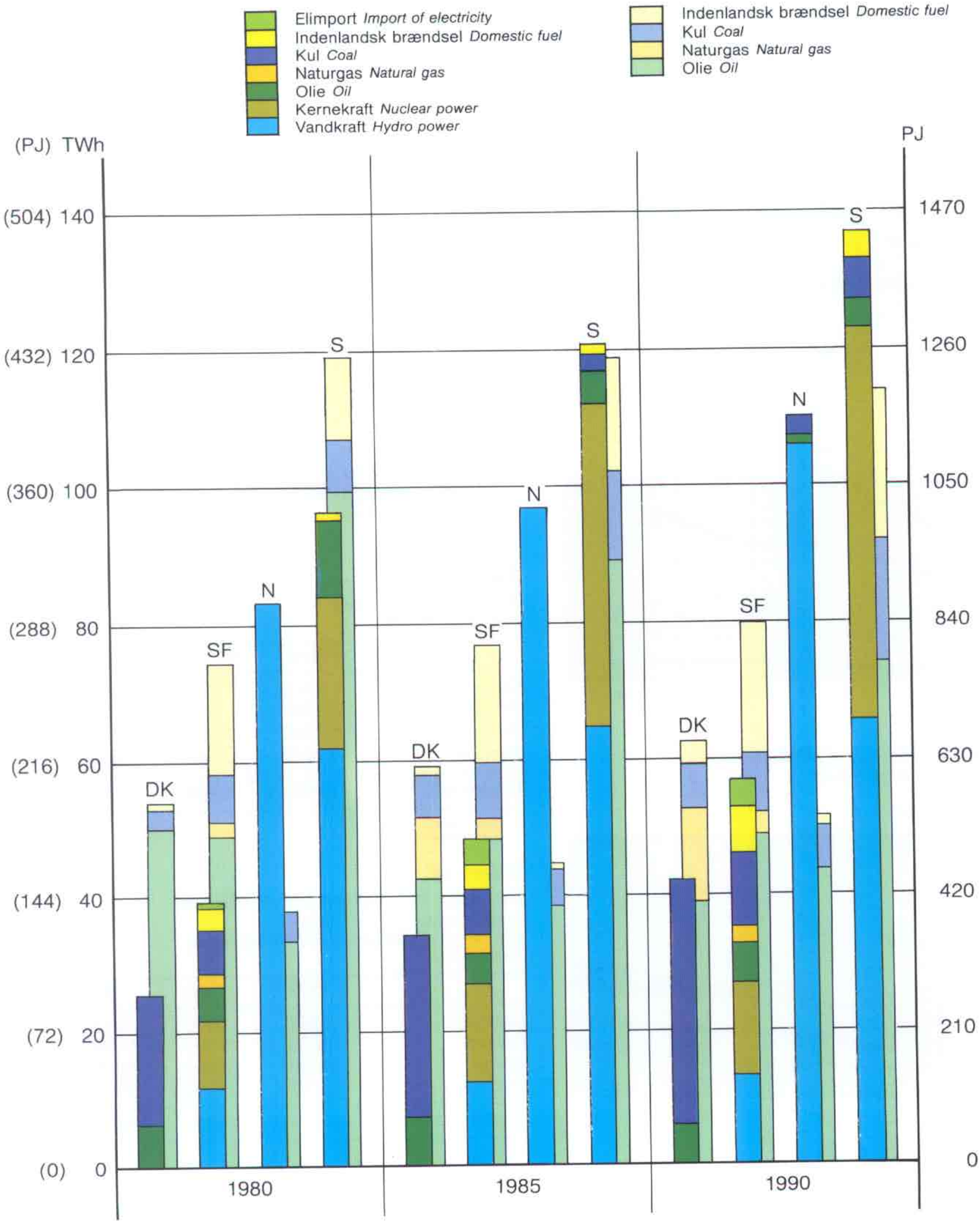


Fig. 10 viser fordelingen af forventet elenergitilgang (produktion + import) i de 4 lande Danmark, Finland, Norge og Sverige på de forskellige kategorier af vandkraft, kernekraft og anden varmekraft baseret på forskellige brændselstyper. Der vises prognoser for årene 1980, 1985 og 1990. (For vandkraften er der regnet med middelårs-produktion for Finland og Sverige, mens der for Norge er regnet med produktionsevne for fastkraft).

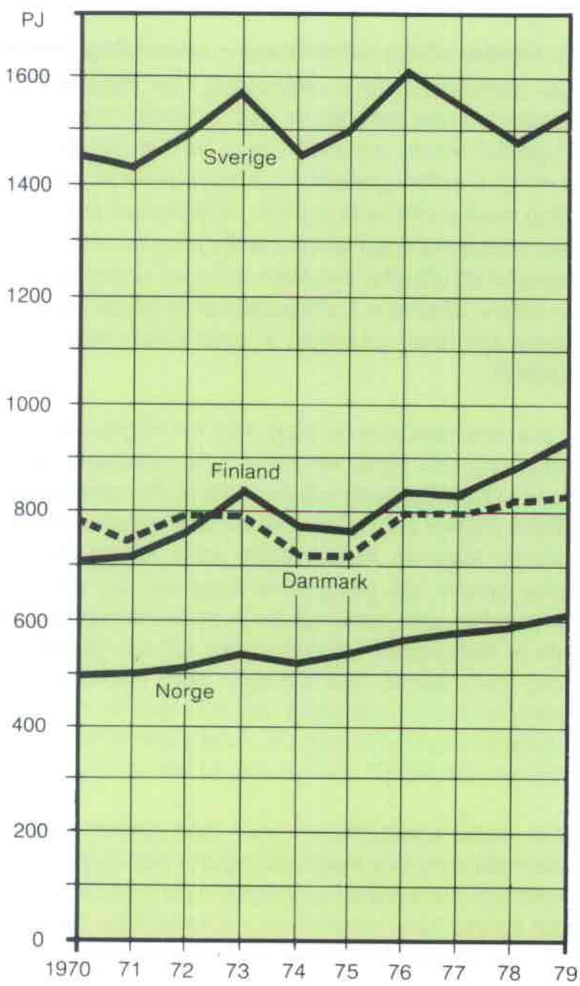
Elenergifordelingen er vist på baggrund af landenes energiforbrug uden for elsektoren. For hvert af årene er der for hvert land indtegnet to søjler. Den venstre, forreste, søjle viser fordelingen af elenergien. Den højre, bageste, søjle viser det øvrige energiforbrug.

For skalaerne i figuren gælder følgende:

- Venstre skala i TWh gælder for elenergitilgangen.
- Højre skala i Mtoe (mill. t olieækvivalent) gælder for det øvrige energiforbrug og er således valgt, at den også viser, hvilke brændselsmængder, der i moderne varmekraftværker medgår til produktion af de elektricitetsmængder, der indgår i venstre søjle (0,25 Mtoe pr. TWh).

Figuren giver grundlaget for en sammenligning mellem elsektoren og de øvrige energisektorer. Specielt viser figuren meget tydeligt vandkraftens dominerende rolle i norsk energiforsyning.

Fig. 11
Totalt energiforbrug
Total energy consumption



Totalt energiforbrug

De dominerende energikilder i verden er kul, olie og naturgas. Indtil udvindingen af olie og gas i Nordsøen kom i gang, kunne ingen af disse energikilder regnes blandt de indenlandske energikilder i de nordiske lande. Vandkraftens andel i verdens energiforsyning er kun ca. 5%, men med undtagelse af Danmark har alle de nordiske lande gode vandkraftressourcer, og de har i stor udstrækning kunnet basere deres elforsyning på vandkraft.. Dette gælder først og fremmest i Norge, hvor praktisk talt al elektricitet hidtil er produceret ved vandkraft, og hvor der endnu i nogle år er mulighed for udbygning af vandkraften.

Foruden vandkraften har de nordiske lande i en vis udstrækning indenlandsk brændsel, træ, tørv (fortrinsvis Finland), kul på Svalbard (Norge) og varme kilder (Island). Den helt overvejende del af brændslet har imidlertid måttet importeres, først og fremmest i form af olie og kul.

Fra 1974 har udnyttelsen af olie- og gasfundene i den norske del ef Nordsøen udviklet sig til en årsproduktion i 1979 på 17,9 mill. t olie og 19,5 mia Nm^3 gas, svarende til i alt ca. 1500 PJ.

Fig. 11 viser udviklingen af det totale energiforbrug i Danmark, Finland, Norge og Sverige i 10-års-perioden 1970-79, angivet i PJ. Vandkraft og kernekraft er her omregnet efter det teoretiske energiindhold, dvs. 1 TWh = 3,6 PJ.

Överföringsnätet – ryggraden i det nordiska kraftsamarbetet

av Olov Edberg, Statens Vattenfallsverk, Staben

1. Allmänna krav på nätet

En väsentlig del av fördelarna med samdrift mellan skilda kraftsystem ligger i att systemen har olika karaktär i ett eller flera avseenden, t ex olika sammansättning av produktions-apparaten, olika belastningskaraktär eller olika regleringsmöjligheter för vattenkraften. En annan generell fördel är att stora produktionsenheter med lägre specifik kostnad än små bättre kan utnyttjas i ett integrerat kraftsystem än om systemen drivs var för sig.

De nämnda förutsättningarna för ett ekonomiskt kraftsamarbete föreligger i hög grad för de nordiska länderna utom Island, vars nät av geografiska skäl ej kan hopkopplas med de övriga. Medan Norge så gott som helt täcker sitt elbehov med vattenkraft, är den danska elförsörjningen till 100 % baserad på värmekraft. Sverige och Finland intar en mellanställning. Vattenkraftandelen uppgår för Sverige till ca 65% och för Finland till ca 30%, men värmekraften tar successivt en stigande andel av produktionen. Dessa förhållanden ställer på det sammankopplade kraftnätet kravet att under torrår dansk värmekraft skall kunna transporteres till Sverige och Norge för att täcka bristen på vattenkraft i dessa länder, medan under vattenrika år krafttransporterna kan komma att gå i motsatt riktning. Stora belopp av överskottskraft i framför allt Norge skall då transporteras till såväl Danmark som till Sverige och Finland, varigenom produktionen av dyr värmekraft i dessa länder kan reduceras.

Ny produktion byggs nu i form av värmekraft i stigande grad i de nordiska länderna. Man vill då av kostnadsskäl bygga så stora aggregat som möjligt, varvid det kan inträffa att ett nytt aggregat till en början får en viss överkapacitet för det nationella systemet, vilken kan exporteras till angränsande länder. Nästa gång kanske samma sak inträffar i ett annat land. Denna s k saxning vid utbyggnad av stora vämekraftaggregat ställer alltså krav på att nätet mer eller mindre temporärt skall kunna överföra kraftbelopp av växlande storlek och riktning länderna emellan.

Planerna för produktionsutbyggnaderna baseras på prognoser över den förväntade belastningsutvecklingen. Medan produktionsbyggnad är en i tiden relativt stel verksamhet på grund av de långa genomloppstiderna för stora aggregat, kan däremot belastningsutvecklingen med kort varsel komma att avvika från prognosen, t ex genom konjunktursvängningar eller andra orsaker, varigenom obalans uppstår mellan belastning och tillgänglig produktion. Ett etablerat kraftsamarbete kan då ge möjlighet att utjämna sådana obalanser, vilket ställer ytterligare krav på nätets överföringsförmåga.

Till allt detta kommer de tillfälliga och mer eller mindre kortvariga över- och underskott på kraft som uppstår i ett stort system med i tiden varierande belastning och som kan ge stora vinster om de kan utjämnas mellan kraftsystemets olika delar. Även sådana transporter skall överföringsnätet kunna klara av.

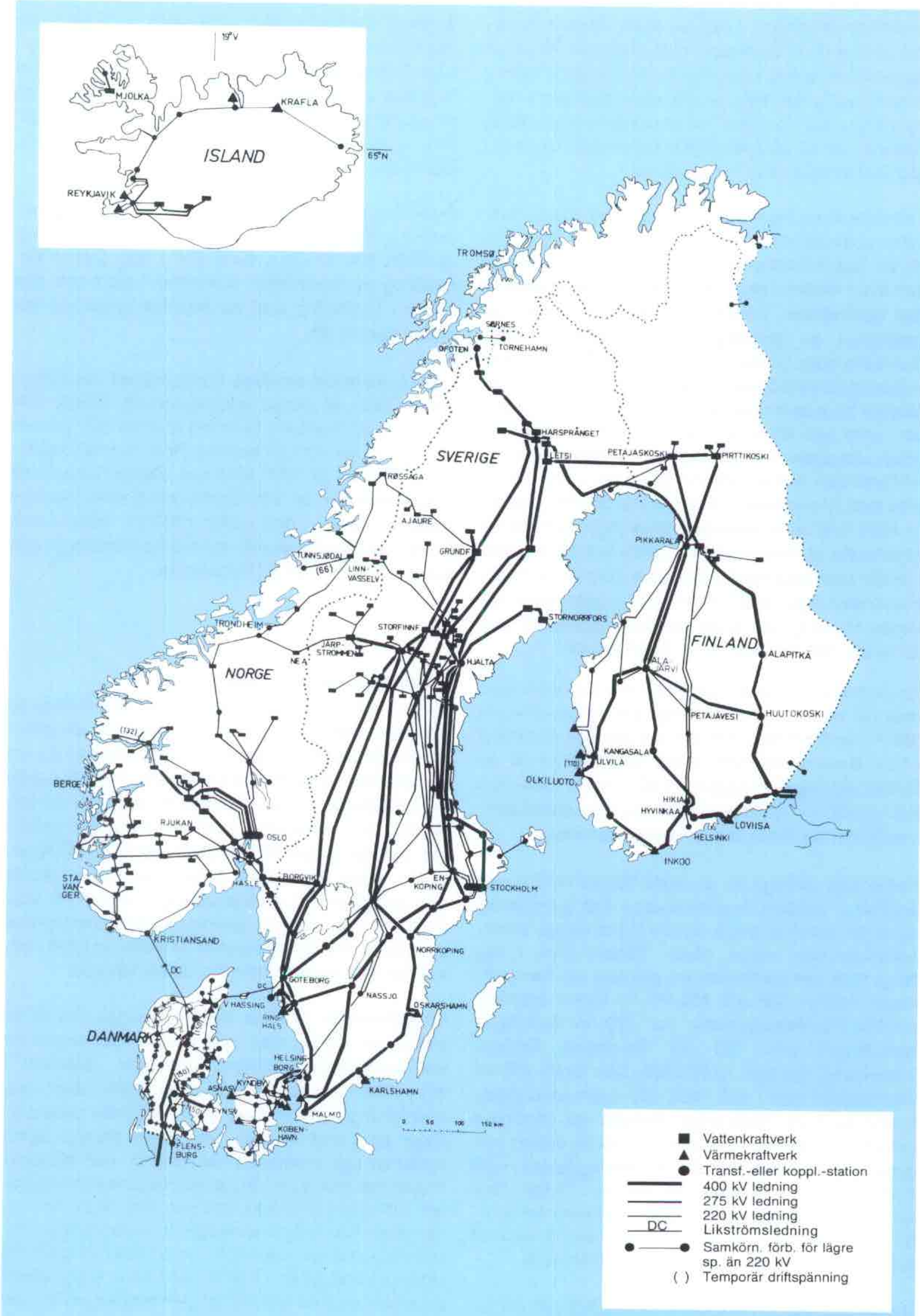
2. Nordel-nätets utformning – utveckling hittills

De nationella nätens utformning i de olika Nordelländerna i dag framgår av bild 1. Under lång tid utbyggdes dessa nät enbart med hänsyn till det egna landets överföringsbehov och utan tanke på samkörning med andra kraftsystem. Allteftersom det nordiska kraftsamarbetet växte i omfattning har detta även kommit att påverka dimensioneringen av de nationella näten, eftersom krafttransporterna på de separata systemen även påverkas av samdriften med andra kraftnät.

I alla fyra länderna är idag 400 kV högsta systemspänning och bildar stommen i de nationella systemen. Underliggande nät har i allmänhet spänningen 220 à 300 kV och 110 à 150 kV. Det svenska kraftsystemet intar en central plats inom Nordel-blocket, dels genom sitt geografiska läge och sin stora utsträckning, dels därför att det är det kraftmässigt största av delsystemen. Det svenska 400 kV nätet täcker idag hela landet. Det tjänstgör som överföringssystem för den norrländska vattenkraften till Syd- och Mellansverige och inom de södra delarna för överföring av värmekraft och för distribution av belastning.

Det finska kraftsystemet har i stort samma karaktär som det svenska med vattenkraft i norr och värmekraft och huvuddelen av belastningen i söder, medan det norska nätet visar en mer splittrad bild. Det beror bl a på att den helt dominerande kraftkällan, vatten-

Bild 1


ISLAND
MJOLKA
KRAFLA
REYKJAVIK
65°N
TROMSØ
TORNEHAMN
HARSPRÅNGET
LETSI
PETAJASKOSKI
PIRTTIKOSKI
SVERIGE
RØSSÅGA
AJAURE
GRUNDF
TUNNSJØDAL
(66)
LINN-VASSELV
PIKKARALA
STORNORRFORS
TRONDHEIM
STORFINNF
JÄRP-STRÖMMEN
NEA
HJALTA
NORGE
FINLAND
ALAPITKÄ
ALAJÄRVI
PETAJAVESI
HUUTOKOSKI
(132)
KANGASALA
ULVILA
OLKILUOTO
BERGEN
HIKIÄ
HYVINKAA
LOVIISA
HELSINKI
INKOO
RJUKAN
OSLO
STA-VAN-GER
HASLE
BORGVIK
EN-KÖPING
STOCKHOLM
KRISTIANSAND
NORRKÖPING
DC
GÖTEBORG
V HASSING
NÄSSJÖ
OSKARSHAMN
RING-HALS
DANMARK
HELSING-BORG
KYNDBY
ASNÆS
KARLSHAMN
MALMÖ
KØBEN-HAVN
FLENS-BURG
Vattenkraftverk
Värmekraftverk
Transf.-eller koppl.-station
400 kV ledning
275 kV ledning
220 kV ledning
DC
Likströmsledning
Samkörn. förb. för lägre sp. än 220 kV
( ) Temporär driftspänning

kraften, finns spridd över hela landet, dels på att de topografiska förhållanderna gör det svårt att bygga förbindelseledningar. I dag har dock större delen av det norska nätet sammanknutits med 300 kV till en samkörande enhet, men 400 kV finns endast i södra delarna av landet. Det danska nätet slutligen är genom Stora Bält uppdelat i två separata system, ett på Själland och ett på Jylland plus Fyn. I båda näten är i dag 400 kV spänning introducerad.

Förbindelseledningar mellan de olika nordiska kraftnäten är av gammalt datum. Redan 1915 byggdes en 25 kV kabelförbindelse mellan Skåne och Själland, och även mellan Norge och Sverige etablerades tidigt förbindelser. Dessa tidiga ledningar hade inte karaktären av egentliga samkörningsförbindelser utan baserades på lokala tvåpartsöverenskommelser mellan olika kraftföretag i respektive länder. Så småningom började emellertid förbindelserna tillväxa både i antal och kapacitet i takt med att de nationella näten utbyggdes till mer sammanhängande system. Förbindelsen Skåne-Själland utökades under 1950-talet med fyra stycken 130 kV kablar och fick i början av 1970-talet sin nuvarande omfattning, då en 400 kV kabel lades ut. Redan tidigare, 1965, fick det svenska och det jylländska nätet förbindelse, då den s k Kontiskanlänken togs i drift mellan Göteborgsområdet och Vester Hassing. Det stora avståndet gjorde att man här valde 250 kV likström för överföringen.

De svenska och finska systemen är i dag hopknutna med tre ledningar, som samtliga går mellan de norra delarna av det finska nätet och det svenska stamnätet i Lule älvsområdet. Den första förbindelsen var en 220 kV ledning som byggdes 1959. Under 1970-talet har två 400 kV ledningar tillkommit, vilka direkt sammanbinder de finska och svenska stamnäten.

Norge och Sverige är de båda Nordel-länder vars kraftnät är starkast sammanknutna. Det geografiska läget gör också att det är relativt lätt att bygga förbindelseledningar mellan näten. Sådana finns i dag längs hela den gemensamma gränsen och för spänningar mellan 132 och 400 kV. De första egentliga samkörningsförbindelserna var 220 kV ledningen Nea-Järpen och 132 kV ledningen Sørnes-Tornehamn. De togs i drift 1960. Den första 400 kV förbindelsen kom i drift 1963 och sammankopplade Sydnorge med Västsverige. Nyligen har ytterligare en 400 kV ledning tillkommit i samma region och dessutom ävenledes en 400 kV ledning längst i norr mellan Ritsem i Sverige och Ofoten i Norge. Den sammanbinder det svenska stamnätet med det nordnorska nätet, vilket ännu så länge bildar ett separat system skilt från det övriga norska huvudnätet.

De geografiska förhållandena har medfört att det inter-nordiska kraftnätet har kommit att bilda ett i stort sett radiellt system med Sverige i mitten och därifrån utstrålande samkörningsförbindelser till de övriga tre länderna. Denna tendens bröts dock 1976 då en direkt förbindelse togs i drift mellan Sydnorge och Jylland. Det var en likströmsförbindelse med i dag två parallella undervattenskablar. Med en kabelsträcka på ca 130 km och sitt stora förläggniggsdjup betecknade projektet en milstolpe för kraftöverföringsteknologi under vatten.

Överföringsförmågan från Sverige till de tre grannländerna har under 1970-talet ökat från sammanlagt ca 2000 MW till drygt 4000 MW i dag. Denna fördubbling av kapaciteten motsvarar i stort sett den tillväxt i belastning som de enskilda systemen haft under samma tid.

Det samkörande nordiska kraftsystemet har förbindelser även till övriga europeiska nät. Mellan Jylland och Västtyskland finns två stycken 220 kV ledningar och en 400 kV ledning med en total överföringskapacitet på 1000 MW, och mellan Finland och Sovjet kommer en likströmskoppling med lika stor kapacitet att tas i drift under 1980/81. Finland och Sovjet har även lokala nät, och mellan Nordnorge och Sovjet finns en 154 kV förbindelse.

3. Dimensionering – ekonomi

Syftet med det nordiska elsamarbetet är att skapa ett integrerat kraftsystem som kan tillgodose elkraftbehovet i de berörda länderna till lägre kostnad än om de nationella systemen drivs separat. Detta förutsätter kraftutbyten mellan länderna av skiftande storlek, riktning och varaktighet som inledningsvis beskrivits, och det är överföringsnätets uppgift att möjliggöra alla dessa transporter. Nätet skall kunna fullgöra sina uppgifter inte endast vid lugn ostörd drift utan även vid olika typer av störningar. Att dimensionera ett optimalt överföringssystem är därför en både central och svår uppgift inom Nordelsamarbetet.

Ett kraftsystem drabbas oundvikligen då och då av störningar i driften med varierande konsekvenser för kraftförsörjningen. Sådana störningar uppträder i form af plötsliga bortfall av stora produktionsenheter, kortslutningar på ledningar eller i stationer, bortkopplingar på grund av åska, etc. Felets art och läge i systemet och funktionen hos kontroll- och manöverorgan har stor inverkan på störningens konsekvenser. De flesta fel märks inte hos abonnenterna medan några kan leda till omfattande nedbrytning av nätet och bortfall av matningen inom stora områden. Att skapa ett kraftsystem som är hundraprocentigt säkert är varken ekonomiskt rimligt eller tekniskt möjligt. En hög leveranssäkerhet eftersträvas emellertid, och driftsäkerheten är därför en faktor som måste tas med i den ekonomiska avvägningen vid nätets dimensionering. I princip kan detta ske på två sätt, antingen så att driftsäkerheten ingår som en rent ekonomisk faktor där man fastlagt kostnaderna för längre och kortare leveransavbrott genom en ekonomisk avbrottsvärdering eller så att kravet på driftsäkerhet bestäms genom fasta nätkriterier, dvs ett antal feltyper som nätet skall klara utan sammanbrott. Med den senare metoden är det lättare att garantera en hög driftsäkerhet och en jämnstark dimensionering av nätets alla led. Det är också den som tillämpas vid planeringen av det nordiska nätet.

De dimensioneringskriterier som ligger till grund för planeringen av det samkörande nordiska storkraftnätet antogs av Nordel 1972. De innebär i korthet att vissa angivna typer av fel i nätet ej får leda till instabil drift eller otillåtna bestående förändringar i spänning eller frekvens. De får inte heller leda till frånkoppling av belastning. Kraftsystemet skall uppfylla dessa krav vid varierande produktions- och överföringsförhållanden och med hänsyn till att vissa anläggningsdelar kan vara avställda för revision. Feltyper som nätet under dessa premisser skall klara är plötslig bortkoppling av största produktionsenhet, bortkoppling av godtycklig överföringsledning eller systemtransformator, korrekt bortbrytning och omedelbar återinkoppling av någon ledning som drabbas av ett snabbt övergående fel, t ex orsakat av åsknedslag, och definitiv bortkoppling av ledning eller samlingsskena behäftad med kvarstående kortslutningsfel.

De överväganden som lett fram till ovannämnda dimensioneringsregler baseras bl a på statistik över felfrekvenserna hos olika nätkomponenter. De dimensionerande felen är mycket sällsynta och valet av dem medför en hög driftsäkerhet på det samkörande nordiska nätet. Det rekommenderas emellertid att man vid nätplaneringen studerar även svårare och ännu mer sällsynta fel och planerar åtgärder för att begränsa verkningarna av dem. Sådana fel, som det för närvarande alltså inte anses rimligt att kräva att nätet skall klara, är t ex bortfall av all produktion i ett större kraftverk, bortkoppling av båda ledningarna på en dubbelledningsstolpe eller alla ledningar i en kraftledningsgata och utebliven brytarfunktion i samband med bortkoppling av en felbehäftad ledning.

För att det nordiska kraftsystemet framdeles skall kunna uppfylla de uppställda dimensioneringsreglerna fordras att det kontinuerligt förstärks. Utöver nätförstärkningar, såväl inom de nationella näten som utbyggnad av samkörningsförbindelserna, erfordras också tillgång till en s k störningsreserv, dvs maskineffekt utöver den som erfordras för att med tillräcklig leveranssäkerhet täcka den aktuella belastningen.

Störningsreserven består dels av till nätet infasat maskineri som momentant kan ingripa med produktion, dels av generatorer som är avställda men kan tas i drift med längre eller kortare varsel. Sådan reserveeffekt behövs vid störningar i produktionsapparaten, t ex för att ersätta en plötslig bortkoppling av någon stor produktionsenhet, men kan även ingripa vid rena nätfel för att förstärka ett försvagat nät genom att minska spänningssänkningar och tendenser til instabil drift. På så vis kan störningsreserven i viss mån ersätta nätutbyggnader, och den påverkar därigenom nätets dimensionering. Planering av en för hela Nordelsystemet gemensam störningsreserv, dess storlek och fördelning inom systemet, ingår också i den gemensamma utbyggnadsplaneringen.

Liksom vid all industriell verksamhet är ekonomin en primärt styrande faktor även vid utformningen av det internordiska kraftsystemet. Att ekonomiska vinster finns att hämta i det nordiska kraftsamarbetet är fullt klart. De härrör dels från ett totalt sett minskat behov av installerad effekt, dels från en rationellare utnyttjning av den gemensamma produktionsapparaten genom tillfälliga kraftutbyten. Att i förväg beräkna storleken av dessa vinster kan däremot vara nog så svårt. Principiellt är svårigheterna inte annorlunda än vid planeringen av vilket kraftsystem som helst, men de förstoras genom det integrerade systemets komplexa uppbyggnad och stora geografiska utsträckning samt osäkerheten om vilka energiutbyten framtida kraftsituationer kan komma att ge upphov till.

Huvudvinsten med det nordiska kraftsamarbetet har hittills varit att man kunnat köra produktionen där den för tillfället varit billigast, att man kunnat hjälpa varann i besvärliga haverisituationer och att produktionsutbyggnader kunnat förskjutas i tiden. Introduktionen av värmekraft i det norska systemet har exempelvis kunnat uppskjutas. Bild 2 (s. 44) illustrerar elenergiutbytet mellan Nordelländerna under den senaste 10-årsperioden.

4. Framtidsutsikter

Alltsedan det nordiska elsamarbetet tog fast form i och med att samarbetsorganisationen Nordel bildades 1963 har utvecklingen präglats av att de nationella kraftsystemen knutits allt fastare samman genom utbyggnad av nya samkörningsförbindelser. En fortsatt utveckling efter dessa linjer kan förutses. Full utnyttjning av de möjliga samkörningsvinsterna kräver nämligen att överföringsförmågan mellan blocken står i en viss relation till de växande nationalla nätens storlek. Den successiva övergången från vattenkraft till värmekraft när det gäller nybyggd produktion innebär en växande storlek på de produktionsenheter som ansluts till nätet. Detta ställer driftsmässiga krav på ett starkt och väl sammankopplat överföringsnät. Den osäkra energisituationen, inte minst beträffande kärnkraftens framtid, är en annan faktor som bör befrämja ett intimt nordiskt samarbete på elsidan. I Nordels regi har också startats en scenariostudie som med tonvikt på elsektorn och perspektiv in på 2000-talet skall studera möjligheterna för Norden som enhet att bli mer eller mindre självförsörjande med energiråvaror.

Av planerade utbyggnader av samkörningsförbindelserna under 1980-talet är närmast en andra 400 kV kabel mellan Skåne och Själland aktuell. Också en utbyggnad av Skagerak-förbindelsen eller Kontiskan eller eventuellt båda har visat sig ha ett produktionsekonomiskt värde, och förhandlingar skall upptas mellan berörda kraftföretag i Danmark, Norge och Sverige.

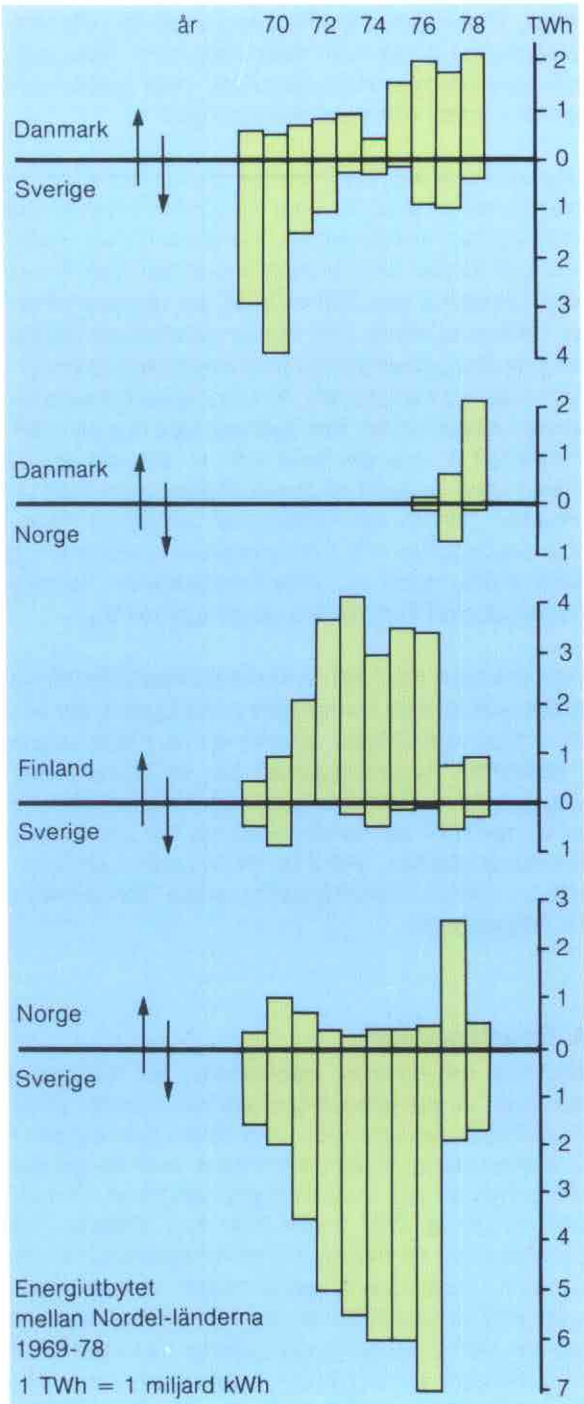
Reservmatningen av Nordnorge är ett annat problem som kräver en lösning. Området utgör som tidigare nämnts i dag dag ett separat system. En hopkoppling med det övriga norska nätet med 400 kV spänning planeras. En metod bland andra att dessförinnan förbättra matningen av området är anslutning till det finska nätet.

I ett längre perspektiv skymtar en hopkoppling av de båda danska näten på Själland resp Jylland som en ur nätsynpunkt önskvärd åtgärd och kanske också en likströmsförbindelse mellan södra Finland och Sverige. Det skulle ge ett väl hopmaskat nordiskt kraftnät med stor flexibilitet för kraftutbyten.

Den högsta systemspänningen inom det samkörande nordiska nätet är i dag 400 kV. Det har den varit sedan 1952, då den första 400 kV ledningen togs i drift i Sverige. För mer än tio år sedan startades undersökningar om motiven att införa en högre ysstemspänning i Sverige. Man fann att motiv förelåg att successivt bygga upp ett system med högre spänning i Sverige med början omkring 1980. Av olika skäl har den högre spänningsnivån ännu ej introducerats. I de övriga nordiska länderna ligger behovet av en högre systemspänning längre fram i tiden.

De regler för nätdimensionering som tidigare beskrivits har varit i bruk sedan 1972. Som bör ha framgått av det föregående har under denna tid karaktären hos det samkörande systemet i flera avseenden förändrats, och ytterligare omstrukturering kan väntas i framtiden. Undersökningar har därför startats med syfte att se efter om dessa regler passar morgondagens kraftnät, eller om de bör modifieras i ett eller annat avseende.

Bild 2



Energiutbytet mellan Nordel-länderna 1969-78
1 TWh = 1 miljard kWh

Nordels Activities in 1979

The ordinary annual meeting of Nordel was held at Tavastehus, Finland, on August 30th, 1979. No other plenary meetings were held in 1979.

At the annual meeting the actual power situation within the five Nordic countries was reviewed. Besides, there were reports from a number of the committees and ad hoc working groups being responsible for and co-ordinating the work within Nordel, and from Nordels representatives and contact groups within various international organizations.

One of the most important tasks of the Planning Committee is an evaluation of the need for interconnections between Nordel countries. Studies by the committee have shown that another 400 kV connection between South Sweden and Denmark (Sjælland) is needed, and that extension of the Skagerrak and/or the Kontiskan connections between Denmark (Jutland) and Norway and Sweden respectively, will probably be economical.

On this background Nordel passed the following two recommendations:

- "Nordel recommends that the negotiations going on (between the parties involved) are terminated with a view to reaching a decision on establishment of another 400 kV connection between Hälsingborg in Sweden and Hovegård in Denmark".
- "Nordel recommends that the parties involved in Denmark, Norway and Sweden enter into negotiations on extension of the Kontiskan and/or the Skagerrak connections".

The negotiations regarding the 400 kV connection Hälsingborg-Hovegård have been concluded, and the line is planned for commissioning in 1985.Negotiations on extension of the Kontiskan connection are to be initiated.

Due to the energy situation of late years, thermal power, and especially coal-fired thermal power, is playing a still more important role within the Nordic countries. Still the co-operation within Nordel in the nuclear field is characterized by different situations in the Nordel countries, which to some extent has limited the work of the Nuclear Power Committee.

At the annual meeting of Nordel it was, therefore, decided to establish a Thermal Power Committee, whose working field will include all kinds of thermal power, i.e. oil and coal based conventional thermal power as well as nuclear power. The new committee is succeeding the previous Nuclear Power Committee.

1979 was characterized by good run-off conditions in both Finland, Norway and Sweden, which resulted in an increase in hydro power production by 8%. The increased hydro power surplus gave rise to a considerable exchange within the Nordic countries. Most of the Norwegian hydro surplus was exported to Denmark, i.e. 3.4 TWh, corresponding to 14% of that country's electricity consumption. The commissioning of the nuclear power plant Olkiluoto in Finland resulted in an increase in total nuclear power production by about 3%, this in spite of the generator break-down at Barsebäck. Thus the greater part of the increase in the level of consumption could be covered by non-fossil energy sources.

Total electricity consumption in the Nordic countries increased by 6.4% as against 5.4% in 1978. The increase was lowest in Denmark with 4.4% and highest in Norway with 8.2%.

The Committee for Operating Problems

As previously, the committee has been engaged in the routine treatment of current questions of joint operation as well as the power situation within the Nordic countries, and matters relating to reliability of operation and to disturbances within the Nordic power system.

For appraisal of the power situation during the next 2 to 3 years, power and energy balances have been established with respect to this period of time.

The committee has discussed the black-out which occurred in the northern part of Sweden on January 13th, 1979. The black-out affected the whole interconnected system of Nordel and resulted in extensive load rejection in Sweden and on Sjælland.

During the year a new method for frequency and production control has been taken into use. According to this method the deviation from the set point for the various areas is automatically and continually calculated, and this deviation is then used by the dispatching centres as the basis for changes of production set points.

Again the committee has discussed how to divide the operating reserves on the individual countries.

The committee has thoroughly discussed the questions of how to co-ordinate the automatic load rejection that occurs in connection with disturbances, which result in an unusually low frequency.

On exchange of excess power between the countries an agreed highest addition to the seller's marginal production costs has since long existed. During the year the size of this so-called price ceiling has been discussed within the committee. So far an amount of 50 Skr./MWh instead of 35 Skr./MWh has been agreed upon.

The decision to introduce summertime as from 1980 has been discussed within the committee, and contact groups have been set-up within Nordel for co-ordination of power accounting and questions of current interest.

In connection with Nordels decision to extend the work of the Nuclear Power Committee to include questions of thermal power production in general certain tasks have been transferred from the Committee for Operating Problems to the Thermal Power Committee.

The Planning Committee

During the year the work by the Planning Committee has largely been concentrated on questions partly relating to a reinforcement of the interconnections between the Nordic countries and partly to the committee's scenario 2000.

Further studies in progress have been an evaluation of the need for a reinforcement of the interconnections Sweden-Jutland (Kontiskan) and Norway-Jutland (Skagerrak) respectively. The studies have shown that extensions could be advantageous in both cases, and that negotiations on the subject should be started.

In 1973 Nordel recommended that the interconnection capacity between Sjælland and Sweden should be 700 MW in both directions. However, under certain operating conditions the capacity to Sweden is becoming lower. In order to be able to maintain the capacity recommended after 1985, a reinforcement of the 400 kV connections Sjælland-Sweden will be needed. Negotiations on this matter have been conducted between ELKRAFT at Sjælland and Vattenfall and Sydkraft in Sweden.

As mentioned above Nordel passed two recommendations on these subjects at the annual meeting in August.

A decision on establishment of another 400 kV connection between Hälsingborg in Sweden and Hovegård in Denmark was reached after the annual meeting.

The possibilities of transfer of power from Finland to Sweden or Denmark have also been under review. This, however, calls for an extension of the transmission capacity. Various reinforcement alternatives are being studied and the Planning Committee intends to submit a report on the market potentials and the transmission capacity reinforcements necessary at the annual meeting of Nordel in 1980.

Possibilities of transfer of power from Finland to Norway via the Swedish transmission lines are also being studied. However, during periods of high system load, the possibility of such a transfer is very limited.

The necessity for a reinforcement of the reserve power capacity to the eastern parts of North Norway has been discussed within the committee. The alternatives under review are extensions of the 132 kV network, increased thermal power production or interconnection with the network in northern Finland.

Furthermore, the committee is evaluating the need for transmission capacity on the interconnections about 1985. The purpose of this study is to submit reports to Nordel with proposals for Nordel recommendations in 1981.

At the annual meeting in 1979 the Planning Committee presented its scenario 2000. According to proposals by the committee Nordel decided that the studies in progress should be continued. During the year much valuable work has been done on this study and the final purpose has been to

- illustrate the consequences of different energy strategies for the Nordic countries in co-operation
- on this background make decisions on the possibilities for and the value of a closer Nordic energy co-operation
- inform, and if possible, to influence decisionmakers with relations to the energy field, first and foremost within the electricity field.

Two alternative scenarios are under review. Partly an optimum-economic scenario and partly a scenario on how the Nordic countries can be self-sufficient in energy raw materials. Work has shown that a further strengthened energy policy involves only marginal economic advantages. The greatest advantage is on electricity, where a comprehensive co-operation is already going on within Nordel. Therefore, the efforts have been concentrated on the self-sufficiency alternative, and various development trends are being studied. A report on this subject is being prepared and is to be presented to Nordel at the annual meeting in 1981.

Besides, the committee is preparing a report on basic principles and relationships within the energy field and on the energy flow in a society. The report deals with a single energy flow diagram and is especially intended for specialists with a particular interest in energy questions. The report should be available at the annual meeting in 1980.

Nordel has asked the committee to pursue the development in the Nordic countries on the subject "renewable energy". During 1979 a mapping of the existing, the decided and the planned schemes within Nordel in the field of solar energy and heat pumps has been initiated. The result of this work will be presented at the annual meeting in 1980. Later on the work might be expanded to include studies of suitable co-operation projects.

The Nuclear Power Committee

The committee had two meetings in 1979, one at Ringhals and one in Copenhagen.

At the meetings the following questions have been discussed: The nuclear fuel supply situation within Nordel, nuclear research within Nordel, the situation on the project on nuclear waste in Sweden, Finland's nuclear waste handling, Nordic Co-ordination Project on Nuclear Energy (NKA), supported by the Nordic Council of Ministers, status reports from utilities, the consequences of the Harrisburg accident, the work by the working group on nuclear power costs, information to the public before the Swedish referendum, and the technical standing at Ringhals.

The working group on nuclear fuel (permanent) submitted its annual report which only contained minor changes compared with last year's report.

The report by the ad hoc working group for nuclear power costs is to be presented at the beginning of 1980. The 1979 report by the nuclear research co-ordinating group (not permanent) contained useful information on the activities within Nordel.

In 1978 it was suggested by the Nuclear Power Committee that the work by the committee should include the entire field of thermal power production. In 1979 Nordel decided, on a new Swedish initiative, that the committee should be reconstructed into a Thermal Power Committee.

At the final meeting of the Nuclear Power Committee the future work of the Thermal Power Committee was discussed in detail both on the basis of experiences made by the Nuclear Power Committee and on experiences made by the chairmen and secretaries of the Committee for Operating Problems and the Planning Committee. Detailed statements of programme proposals have been documented in protocols from meetings between the parties involved.

The reconstruction, which applies to all the Nordic countries, was unanimously approved. However, the more specific co-operation on nuclear power should be continued, partly through contacts between nuclear power utilities, but also within the framework of the Thermal Power Committee on a more general basis.

Denmark

Electricity Consumption

In 1979 electricity consumption in Denmark increased by 4.4% from 23.2 TWh to 24.2 TWh as compared to 6.9% in 1978. During the year great fluctuations have been ascertained in the development in electricity consumption. When compared to the corresponding month of the previous year a decline has occurred in some months. During the year the current 12 months' development changed from +8.3% to an annual result of a 4.4% increase. This is the lowest annual increase since 1974.

By the end of 1979 a contact committee to investigate future developments was set up between the Ministry of Energy and the Danish Association of Electricity Supply Undertakings (DEF) with participation of representatives from among others ELKRAFT and ELSAM. The committee is to discuss and develop principles and model foundation for future developments, and, as far as agreement can be reached, to work out future electricity forecasts.

In connection with the overall increases in energy taxes as at July 1st, 1979, the tax on electricity was raised from 2 to 8 øre/kWh. At the same time provisions for exemption from taxation were modified, so that in the future all trades can have their electricity taxes repaid.

Energy Policy

In the spring Danish Folketing (Parliament) passed two important bills relating to the energy field in connection with the energy policy account of the Ministry of Trade: Law on Heat Supply and Law on Introduction of Natural Gas.

In the future most Danish buildings are to be heated by either natural gas or district heating from combined production of electricity and district heating.

However, for geographical reasons, this only applies to buildings that are situated in urban areas near existing or planned thermal power plants, district heating plants or the planned network for natural gas. Outside these areas the need for heating has to be covered by e.g. oil firing, electric heating, etc.

According to Law on Heat Supply a nation-wide planning of heat supply is to be made. In this connection the distribution of responsibility of the government, the counties and the municipalities in the stage of planning has been determined.

The Ministry of Energy is responsible for the nationwide planning of heat supply. In a heating plan directive the Minister of Energy can lay down the presumptions which locally and regionally are to form the basis of the planning. The practical mapping of existing and possible future possibilities for heat supply is to be carried out by counties, municipalities and power supply undertakings, including electricity supply undertakings, in co-operation.

The purpose of the law is a heat supply planning for new residential areas. However, a redistribution of the energy supply to include certain existing areas might also be a possibility. Natural gas from Germany to southern Jutland is expected to be supplied in 1982 and from the North Sea to the rest of the country during 1984.

Following the general election in October a new Social Democratic government was formed. Realizing the importance of energy questions a separate Ministry of Energy was established on this occasion. At the same time the government announced that it intended to adhere to the original time schedule for a referendum on introduction of nuclear power in Denmark to be held during 1981. However, it was pointed out that the result of the investigation by the electricity supply undertakings on the feasibilities of disposal of high-level radioactive waste in Danish salt domes was awaited. In the light of the nuclear power incident at Harrisburg it was also decided to make a reappraisal of the safety problems when using nuclear power. After the government's decision at the beginning of 1980 to postpone the time for a referendum on the use of nuclear power in Denmark indefinitely, it is now very uncertain when this can take place.

By the end of December the electricity supply undertakings submitted to the Minister of Energy and to the Danish Energy Agency the result of the investigation, started in November 1978, on the role of electric heating in the future energy supply.

The report deals with the possibilities of supplying those residential areas with electric heating that because of their situation cannot be supplied with natural gas or district heating from combined production of electricity and district heating. The report thus describes the various systems of electric heating – direct-, accumulating- or interruptible electric heating, as well as electrically powered heat pumps. According to the report investment in supply of electric heating in sparsely populated areas will be remunerative from a national as well as from a private economic point of view.

The previous generally deprecatory attitude by the authorities to electric heating now seems to be changing. Recently the Minister of Energy has confirmed that by saying that electric heating, possibly supplemented by alternative energy sources, will be an extremely sensible heating method in areas that cannot be supplied with natural gas or combined power and district heating.

Fuel

The moderate decline in oil production, caused by the change of system in Iran at the beginning of 1979, resulted in a general feeling of disquietude on the oil markets. Fear of oil shortage made the consuming countries buy additional oil for stock building which lead to an increase in spot prices for fuel oil. Later on OPEC increased their prices considerably with the result that by the end of the year the price for fuel oil on long term contracts was more that doubled compared with the price at the beginning of the year.

However, prices for oil products increased considerably more than the official OPEC-prices. The increases were greatest for light products, but also heavy fuel oil (max. 3.5% sulphur content) increased considerably from about 80$/t in January to about 195$/t in November. However, the great stock building during the year caused a temporary stop for price increases by the end of the year.

In 1979 the coal market has been influenced by the increasing freight market for bulk carriers. Though the strain is greatest on overseas coal from Australia, Canada and South Africa, this may effect Polish coal prices, too. As most coal is supplied on long-term contracts, 1979 coal supplies have been relatively unaffected by the increase.

In 1979 the barge system, which supplies the Fynsværket with coal from the port of transit at Ensted, was taken into use. By the end of the hard winter of 1978/1979 about 1 million tons were forwarded in nine months. In 1979 the harbour at Stigsnæs was opened. This harbour is used for call of ships up to 75-120.000 tons, which as the second harbour are to call at the Asnæsværket, as 25% of the cargoes have to be discharged at Stigsnæs.

Because of the heavy increases in oil prices and the more modest increases in coal prices, oil is now 2.5-3 times as expensive as coal. It has, therefore, been good economy to increase the share of coal firing in 1979. From 58% in 1978 this has increased to 65% in 1979.

In 1978 I/S DANASKE was established. The company, which is owned by ELKRAFT, ELSAM and Aalborg Portland A/S, is to be responsible for sale and distribution of fly ash to the cement and concrete industries. In 1979 the work with utilization of fly ash got a breakthrough. The fly ash was used in the cement and concrete industries and for road construction. Work on development of further applications of fly ash is being continued, and it is expected, that in the near future use can be made of about 30-40% of the total fly ash production. The remaining fly ash must be deposited in accordance with guidelines recently worked out by the Ministry of Environmental Protection.

Capacity Extensions

During the last two years conversion of three 250-300 MW units, Asnæs 4, Stigsnæs 2 and Vestkraft B2, to coal firing, has been completed. Fynsværket B3 and Skærbækværket B2, both of 250 MW, will become operational in 1980 after conversions, and conversion of Stigsnæs 1, of 130 MW, will be completed in 1981.

By the end of 1979, the jointly-owned Danish-German 600 MW unit at the Enstedværket was commissioned, and Asnæs 5, of 600 MW, is expected to be in operation by the end of 1980.

Conversion of the Amagerværket from 70%-100% coal firing has been decided, and decisions have also been made on new units at the Amagerværket (480 MW) and the Studstrupværket (350 MW). Both of these units will be designed for combined production of district heating and electricity, and the unit at Studstrup will be identical to Studstrup 3, which was decided on in 1978.

Finland

Economic Development

The positive economic trend, which started in 1978, was gaining strength during 1979. The volume of industrial production increased by 8.5% and the gross national product increased by 6.5% as compared to 1978. Industrial competitive power increased because of the moderate income policy carried on. Revaluation of the Finnish currency in the autumn had the opposite effect by 1.8%. Investments increased by 3.5% from the low level of the previous year.

The trade balance was deteriorated because the increase in demand caused higher export prices. This was caused by a considerable rise in export prices of oil. Thus the trade balance showed a deficit of 0.6 billion FIM. In 1978 the surplus was 2.9 billion FIM.

In spite of the improved economic situation unemployment rates were still high, amounting to the average of 141,000 persons, i.e. 6.2% of the labour force.

Energy Consumption

Energy consumption increased by 6% to 25.5 Mtoe. Consumption of electricity increased by 7.5% to 37.8 TWh.

The share of domestic sources of total energy consumption such as hydro power, peat, wood and lye was about 28%. During the year only a few small peat-fueled heating units were taken into operation in the district heating area. The rate of increase in the use of peat thus stabilized from the previous year. The increased forest industry production has raised the use of lye and wood lumber for energy production.

A considerable change from 1978 occurred in the production of nuclear power. The nuclear power plant in Loviisa 440 MW produced energy amounting to 2.9 TWh (net). The maximum continuous reactor power permitted by authorities was still limited to 92%. Test operation of the first 660 MW unit in Olkiluoto was, because of generator difficulties postponed until the beginning of October, when the commercial operation could be started. The production of the plant was 3.5 TWh. Production of nuclear energy accounted for 17% of electricity production.

Capacity Growth and Construction

There was only little increase during the year. The second units of Loviisa and Olkiluoto nuclear power plants will be taken into operation in the spring of

1980. A 150 MW coal-fueled power plant in Helsinki, a 60 MW peat-fueled power plant in Kuopio and a 38 MW hydro power plant in Kemijoki are also being constructed. Imatran Voima and municipalities in Turku area have decided to supply district heating from 1982 from the power plant of Naantali. Two units are to be reconstructed for heat production. The town of Joensuu and Imatran Voima have decided that Imatran Voima is to build a 60 MW peat-fueled power plant in Joensuu in 1986. Imatran Voima is to supply the town with district heating.

In Imatran Voima a planning project on a 1000 MW nuclear power plant in co-operation with Soviet Atomenergoexport is under review. The project is to be started in the spring of 1980 and is to be completed in 1982. Imatran Voima is also studying a peat-fueled and a coal-fueled condensing power plant. These are alternatives for a possible decision to build a large-scale power plant. No decisions are to be made before 1982.

Questions on Electric Heating

A nation-wide project on the heating methods in areas with small houses was started by Imatran Voima during 1978. The purpose of the project is to develop and to test electric heating, which saves energy and investment costs, and which can be exploited together with domestic fuels and coal energy.

According to plan 1000 small houses, which have been built or will be built during 1978 to 1980 are to be tested. Energy consumption and costs will be examined until the end of 1983. At present about 400 small houses are included in the project. Besides Imatran Voima, co-ordinator of the project, almost 30 electricity supply undertakings and 40 distributors are taking part in the project.

Electricity Law

The new electricity law was approved by Parliament in February 1979. The law will become effective at the beginning of 1980 and is replacing the previous one, which is 50 years old. The new law is primarily based on proposals submitted by the commission which worked during the years 1972 to 1975, on many statements on these proposals and on the decisions of the Energy-Political Commission of that time.

The law regulates, deviating from the previous law, production and distribution of electricity rather strictly. It also contains stipulations on electric security, mainly contained in the previous law. The main renewal is an organization of the energy supply. According to the law energy supply is to be planned on a nation-wide and regional level of which there are exact stipulations in the law. Besides, there is a nation-wide planning of energy supply and on the other hand own plans of an enterprise. Possibilities of the state to regulate legislative planning, permission and control system have increased considerably as compared to the previous system. Stipulations on electric security have not changed much from the old stipulations, which have been found good. The practical application of the law and a successful implementation of the co-operation, being mentioned among the motivations of the law are affected by legislation and rules, which at present are to be drawn up.

Energy-Political Programme

The energy-political programme proposed by the Energy-Political Commission has been approved by the government. The programme is the first comprehensive principal programme covering the entire energy field and being the starting point for development of energy supply and for measures within the energy field.

The starting point for the programme was the problems caused by the great dependence on imports, especially on oil. Thus the main energy-political task is to secure energy sources. The most important objective is to save energy and to increase the domestic share of energy production.

In the production of electricity the combined electricity and heat production has been set together with hydro power – with low building costs but little volume – when the aim is an increase of capacity. The next decision on a large-scale power plant will be made in 1982 at the earliest. An implied condition of the programme is that decision on studies concerning peat and condensing power and on a 1000 MW nuclear power plant is made beforehand.

Iceland

In 1979 electricity production amounted to 2915 GWh, of which 96.7% was hydro power production, 1.4% geothermal production and 1.9% was produced by diesel units. The corresponding figures for 1978 were 97.4%, 0.7% and 1.9% respectively.

Gross consumption increased by 5.4% from 2674 GWh in 1978 to 2819 GWh in 1979. By the end of the year, installed capacity was 664 MW, of which hydro power accounted for 542 MW, fossil-fueled units (diesel, condense and gas turbine) for 114 MW and geothermal units for 8 MW.

In southern Iceland, near the Sigalda hydro power plant, construction of a new hydro power plant, Hrauneyjafoss, was started. Two new units are expected to be in operation by 1981 and 1982 respectively. A third 70 MW unit may be added at a later time.

The efforts of the government, started in 1978, to reorganize the power industry were continued. In February, a committee appointed by the Ministry of Industry, proposed that the Landsvirkjun, operating in south-west Iceland, and being the largest power producer of the country, should be merged with the second largest producer, the Laxarvirkjun in north Iceland. The expanded Landsvirkjun should take over all 132 kV main transmission lines constructed – and paid for by the state – during late years between south-west and north Iceland and from there to east Iceland, and in the current year to north-west Iceland. The new company should also build and operate all new power stations of 5 MW or more.

Negotiations were initiated between representatives of the state, the municipalities of Reykjavik and Akureyri, part owners of the Landsvirkjun and the Laxarvirkjun respectively and a draft for articles of association for the new company was agreed upon. The draft was, however, rejected by the city council of Reykjavik and, as a consequence of this the plans for a nation-wide Landsvirkjun have been suspended, at least for the time being.

According to the statutes for the Landsvirkjun, the Laxarvirkjun is entitled to merge with the Landsvirkjun on certain conditions. The Laxarvirkjun has now initiated negotiations with the Landsvirkjun with a view to a merger. The result of a merger will be an intermediate stage between the present situation and the merger proposed by the above mentioned committee, but later on developments could lead to the foundation of a nation-wide production company.

In 1978 the Ministry of Industry submitted a revised energy bill, which calls upon the government to prepare a long-term energy plan and to submit this plan to the Altinget (Parliament). The proposed bill is still under consideration by the government.

Following the sharp rises in oil prices on the spot market in the spring of 1979 two oil supply committees were appointed by the government. One of these committees, the so-called oil purchasing committee has studied the possibilities of purchasing oil from Great Britain and Norway. Saudi Arabia, too, has been considered. At present the major part of the oil imports to Iceland is supplied by the Soviet Union.

Norway

Economic Growth

According to preliminary estimates gross national product (GNP) increased by 3.7% (by volume) during 1979 as compared to 3.0% in 1978. If oil activities on the Norwegian continental shelf and shipping are excluded, the "mainland GNP" increased by about 2.2% in 1979, as against 0.9% in 1978. Average annual GNP growth rate in the years since World War II amounted to about 4.6%.

Industrial production increased by 2.3%, however still being below the level of 1974. The production increase was dominated by growth of oil and gas output and the exporting industries.

Production and Consumption of Energy

Electric energy production in Norway increased by 9.7% to a record total of 88.9 TWh. The Norwegian power system is practically speaking 100% based on hydro power and the total, useful run-off was about 3% above normal in 1979. During the year the firm power capacity of the power system, including import agreements, increased by 1.9 TWh to 81 TWh.

Gross consumption of firm power increased by 8.2% to 82.4 TWh during 1979. During the past 10 years the average annual growth of this consumption has been 4.1%. For several years gross consumption increased more rapidly than the increase in production capacity. Production margins within the system have, therefore, been narrowing. Net general consumption of electric energy (excluding power intensive industries) increased by 7.2% to 45 TWh. Corrected for abnormal temperatures the increase was 6% to about 43.7 TWh. Peak load, referred to the power stations, during the year was 13,541 MW.

Total net energy consumption (delivered to consumers) is estimated at about 616 PJ, an increase of 5.8% from the previous year.

For the last 5 years the trend shows an annual increase of 3.3%. In 1979 net energy consumption was met by 43.7% electric energy, 50.3% oil products and 6% solid fuels and gas.

The increase in energy consumption was dominated by the power intensive industries (aluminium, steel, ferro alloys and chemical raw materials) and by other exporting industries such as pulp and paper. Preliminary estimates indicate that the domestic sector recorded significant increase in electric energy consumption because of the sharp increase in oil prices during the year.

Favourable run-off conditions in the hydro power system produced a sizable amount of surplus power, which was sold for electric boilers (1.4 TWh) and exported (4.6 TWh).

Maximum capacity of Norwegian power stations increased by 817 MW to 18,533 MW, i.e. an increase of 4.6%.

Crude oil production on the Norwegian continental shelf increased from 17 million tons in 1978 to 17.9 million tons in 1979. Natural gas production sold was 19.5 billion Nm^3 in 1979 as against 13.5 billion Nm^3 in 1978. The Statfjord field, so far the biggest oil and gas field in the North Sea, started production in November 1979.

Energy Policy

The government's white paper on energy conservation (St. meld. No. 42 (1978/79)) was discussed by the Storting (Parliament) in April 1979. According to the white paper the main instrument for achieving effective energy conservation is the price of energy carriers. The government also adopts a new principle for pricing of electric energy. The white paper proposes that the price of electricity should gradually be increased to cover the cost of additional new power in the system, i.e. the long term marginal cost.

The Storting has discussed a white paper on oil activities north of the 62nd parallel (St. meld. No 57 (1978/79)). According to this white paper exploratory drilling for oil and gas will start off the coast of middle and north Norway during the summer of 1980.

Sweden

General Economic Development

The improvement in the general state of business which began in 1978 was continuing during 1979. According to estimates industrial production increased by about 6% and total growth in economy was about 4%. Investments, which had previously been declining for several years in succession, showed a clear upswing, too. This did not apply to building construction, however, which was hampered by shortage of construction workers.

Negative features in development during 1979 were the substantial deterioration in the balance of current payments and the sharp rise in the consumer price index which occurred during the second half of the year, mainly because of the increase in oil prices. The increased costs for imports of oil have been estimated at 11,000 million kronor, corresponding to 2.5% of the GNP. This has to a great extent worsened the prospects for further recovery of the Swedish economy. The growth of private consumption was moderated already during the second half of 1979 because of the higher rate of inflation and the application of more severe credit-policies.

Electricity Consumption

During 1979 total consumption of electricity in Sweden, including transmission losses, amounted to 93.8 TWh. Compared with 1978 the increase was 4.5 TWh or 5.0%. Right until the end of November the twelvemonths' increase was 7%, but December turned out to be a much warmer month compared with the record cold which characterized the end of 1978. Between 1977 and 1978 consumption of electricity rose by 3.7 TWh (1.3 TWh in December only) corresponding to 4.3%.

According to guidelines for energy policy during the period 1973 to 1985, which Parliament decided on in 1975, consumption of electricity was expected to increase by 6% annually. During the period 1973 to 1979 growth was 3.3% per year and is thus still considerably below the average figure. A new forecast indicates that the average annual growth from 1979 to 1990 will be 3.6%.

The increase in consumption of electricity by industry, which began at the end of 1978, was continuing during 1979. During the year total industrial consumption rose by 4% to 40.4 TWh. Relatively, the increase was particularly large for the mining industry, the pulp and paper industries, ferro-alloy plants and certain parts of the engineering industries.

During the year consumption of electricity in households, agriculture and the service sectors rose by 5.9% to 42.7 TWh. The rate of increase is unchanged as compared with 1978.

Electricity Production

Hydro power production was 60.2 TWh or 3.1 TWh higher than in 1978 and answered for 65% of total domestic production, which was 92.4 TWh. The increase was mainly due to greater run-off during 1979. At the end of the year the storage reservoirs were 65.6% full as compared with 63.3% at the previous turn of the year.

Nuclear power production declined from 22.7 to 20.1 TWh (−11%) thus accounting for 21.8% of total production as compared with 25.2% in 1978. One of the reasons for the reduction is that one of the blocks at Barsebäck was shut down for 5 months after a generator break-down in mid-April.

Back pressure production was practically unchanged as compared with 1978 (9.2 TWh), while production by oil-fired condensing units increased from 1.1 to 2.7 TWh. The remaining increase in consumption was covered by a heavy increase in imports.

During 1979 installed hydro power capacity only increased insignificantly. Only a few minor stations were added. In the thermal power sector, the largest addition was a new gas turbine at Stallbacka (80 MW).

National Grid

The second 400 kV interconnection between Sweden and southern Norway, Trollhättan-Halden, and the 400 kV Ritsem-Ofoten interconnection link between northern Sweden and northern Norway, were taken into operation in April 1979 and December 1979, respectively.

Several lines and substations in the Swedish grid were reinforced during the year in order to improve short-circuit conditions and loading capacity.

A decision was made to build a 400 kV line between Boden and Hjälta, planned for operation in 1984.

Energy Policy

A government bill on guidelines for the energy policy was submitted to Parliament in the spring of 1979. The bill contained proposals for among other things construction of a total of 12 nuclear power reactors and strong measures to reduce oil dependence. However, before reading of the bill by Parliament, the reactor break-down at Harrisburg occurred, for which reason the Parliamentary parties agreed on an advisory national referendum to be held on the role of nuclear power in future power supplies. Therefore, Parliament postponed treatment of those parts of the bill which directly or indirectly applied to the utilization of nuclear power. By the end of the year proposal for a national referendum on the question of nuclear power to be held on March 23rd, 1980, was submitted. Voters were to decide on three alternatives ("lines"). Lines 1 and 2 both referred to a maximum of 12 nuclear reactors. Besides, line 2 recommended that nuclear power plants and other future major power plants should be publicly owned. Line 3 rejected further expansion of nuclear power and wanted to phase out the existing 6 reactors within not more than 10 years. Uranium mining in Sweden was to be prohibited.

In order to retain freedom of action before the national referendum, in the spring of 1979 Parliament passed an act prohibiting the supply of fuel to nuclear reactors, not yet in operation, for a certain period.

After the agreement on a national referendum the government appointed a committee on reactor safety, and a committee to deal with the consequences of a phasing-out of nuclear power. Both committees of enquiry submitted their reports in November 1979.

In its findings, the Committee on Nuclear Reactor Safety pointed out that the reactor break-down at Harrisburg does not give rise to any substantial revaluation of the risks attached to nuclear power. However, much more rigorous requirements should be stipulated for safety in nuclear power plants than before. The committee suggested a comprehensive programme for action to increase safety. During the year the power industry also took its own initiatives towards intensified activities in this field.

The Committee on the Effect of Abandonment of Nuclear Power studied the consequences of a phasing-out of nuclear power by 1990. The purpose was to illustrate the consequences of two different levels of electricity use and to compare the results with a reference alternative based on 12 nuclear power blocks. According to the committee's report, in case nuclear power is phased out, it will not be possible to provide for the same level of electricity use as in the reference alternative. The rate of increase in the use of electricity must, therefore, in case of a phasing-out, be kept down, e.g. by a rise in prices. The reduced use of electricity, together with the costs of replacing nuclear power plants by other production plants, and higher fuel costs for electricity production, would according to the committee mean a cost to community amounting to about 75,000 million kronor. This would still further worsen the prospects of coming to grips with the already troublesome economic situation in Sweden.

The referendum on nuclear power showed a majority of 58% for lines 1 and 2 together as against 38.6% for line 3.

This means that the 4 new nuclear reactors already constructed and another 2 reactors under construction can be put into operation. Efforts on development of alternative sources of energy will also be increased. A new government bill on guidelines for the energy policy with considerations of the result of the referendum is now being prepared (in the spring of 1980).

Electricity Prices

The high-voltage tariffs introduced on January 1st, 1978, will also be in force during 1980. During 1979 and 1980 certain reductions of the index and fuel price increments were carried out. Certain increases of the low-voltage tariffs have been carried out during the year. As from January 1st, 1980, the energy tax was increased by 1 öre per kWh.

Studies on the future structure of the low-voltage tariffs are in progress. Possibilities are being investigated, e.g. of adapting the tariffs to variations in the cost of electricity seasonally, weekly and over the 24-hour day. Development in the field of microcomputers has provided opportunities for electronic meters to be designed for this purpose.

Statistics

Some of the 1979 Nordel statistical data are preliminary. However, the deviations are only minor, and corrected figures will be included in next year's Nordel report.

Installed Capacity

In 1979 the total capacity in the Nordel countries increased by 2067 MW to 61713 MW, or by 3.5%. Of the total capacity 58% consisted of hydro power plants. The values given in this report are net capacity values.

In the Nordel the relation between hydro and thermal power capacity differs considerably. In Denmark, the generating plants are almost entirely thermal, whereas in Norway they are hydro. Hydro power predominates in Sweden and in Iceland, while in Finland thermal capacity is predominating.

The Grid System in the Nordel Countries

Sweden is connected with Denmark, Finland and Norway. The latter two countries are not interconnected except for a few lines between Finland and Norway for local consumption in Finland. The total transmission capacity from Sweden was 3855 MW and to Sweden 3095 MW. The ±250 kV DC cable connection between Denmark (Jutland) and Norway was commissioned in 1976 and 1977. From southern Jutland in Denmark there are 400, 220 and 60 kV interconnection links to western Germany. Finland has local 110 and 25 kV interconnections with the Soviet Union, and Norway has a 154 kV link with the same country.

Electric Energy Turnover

Figure 3 shows the monthly production and gross consumption of power, excluding excess hydro power to electric boilers, in 1978 and 1979. Further details of the monthly exchanges of firm and excess power are given in Figure 6 in the section discussing the power exchange between the countries.

On the map relating to table 7 are given the blocks of power delivered over the transmission links between the Nordel and non-Nordel countries. The 400 kV and 220 kV links joining Finland with Sweden as well as the 70 kV cable-connection between Sweden and Finland's Aaland Isles are regarded, for accounting purposes, as one line.

The small diagrams to the right of the map give the increase in consumption for the individual countries and for Nordel as a whole. From the diagrams can be read the percentage increase for each country and Nordel (y-axis), as well as the actual power increases in TWh, since the dark areas are proportional to the increases.

The grand total for Nordel rose from 226.5 TWh to 241.0 TWh or by 6.4%. Corresponding increase in 1978 was 5.4%. Table 6 gives the maximum station and system loads on the third Wednesday in December. For Sweden and Finland the data apply to the countries as a whole while other countries are broken down into pooling areas.

Production of Electrical Energy

In table 8 is given the power production in 1978 and 1979 divided into hydro and thermal generation. The total Nordel output increased by 6.5% from 1978 to 1979. The share of hydro power of the total production was 67% as against 74% during the 5-year period 1971-75. The output of nuclear power was 26.5 TWh, which is 11% of the total production.

The sector diagramme in Figure 4 shows the breakdowns of the total power output within Nordel in hydro power, condense and back pressure power.

Figure 5 gives the impounded water in per cent of total storage capacity in Finland, Norway and Sweden for the operating years 1978/79 and 1979/80. The extremes give the weekly maxima and minima recorded for the ten year periods 1st July 1969 to 30th June 1979.

Exchange of Electrical Energy Between the Countries

Imports and exports of the Nordel countries are shown in table 9 together with net imports in relation to gross consumption. The exchange of electrical energy between the Nordel countries was 12.0 TWh. Figure 6 shows monthly imports and exports.

Electricity Consumption

Figures 7-9 and table 10 show the development in electricity consumption in different Nordel countries and Nordel as a whole. Total consumption increased in 1979 by 6.4% from previous year to 241.0 TWh. Of the net power consumption within Nordel, excluding excess hydro power to electric boilers, industry accounted for 49.9%, communications for 1.5% and the rest, 48.6% to households, trade etc.

Total Energy Consumption

The predominant primary sources of energy in the world are at present coal, oil and natural gas, but on the whole they have until recently been lacking as domestic energy sources in the Nordic countries. The share of hydro power in the energy supply of the world is only about 5%, but Finland, and especially Iceland, Norway and Sweden have had the advantage of good hydro power resources and have been able to obtain the main part of their supply of electric energy from hydro power, while Denmark depends entirely on thermal power. In addition to hydro power, the Nordic countries, especially Finland, use domestic fuel (Iceland hot springs) to some extent in their energy supply, but the major part of the fuel (oil, coal and natural gas) has to be imported. From 1974, exploitation of the oil and gas resources in the Norwegian part of the North Sea has developed up to a quantity of approx. 40 Mtoe in 1979.

It is, of course, of great interest to compare the role of electricity with that of other energy sources. Estimates are shown in Fig. 10 for the years 1980, 1985 and 1990. For each year there are two columns for each country. The left column shows electric energy available in each of the countries and its distribution of categories, hydro and thermal. The back-ground column represents consumption of fuel for other purposes than electricity production. The left-hand scale in TWh is for electricity. The right-hand scale in Mtoe (millions of tons oil equivalent) is for fuel, and is adjusted to give also the quantities of fuel required to produce the quantities of thermal electricity in the left columns (0.25 Mtoe per TWh).

Figure 10 shows that the degree of oil dependence differs very much for the Nordic countries. The most conspicuous point being perhaps the major importance of hydro electricity to Norwegian energy supply. It also shows the assumed contribution of coal and nuclear electricity in 1985 and 1990.

Figure 11 shows the development of the total energy consumption (energy supplied) in PJ (petajoule). Hydro and nuclear energy are included with the theoretical content, that is 1 TWh = 3.6 PJ.

Nordel in Brief

Nordel, founded in 1963, is an association for people who are active in the field of power supply in Denmark, Finland, Iceland, Norway and Sweden. It is an advisory and recommendatory organization aimed at promoting international, mainly Nordic, cooperation in the field of production, distribution and consumption of electrical energy.

Nordel has the following permanent tasks:

- to continually follow developments in production and consumption of electrical energy in the Nordic countries by, for example, publishing suitable statistics
- to collocate consumption forecasts and extension plans drawn up in the respective countries
- to publish an annual report which, in addition to information about work completed during the year in question in Nordel, and statistical information about power supply in the Nordic countries, can also contain special articles of interest in the field of Nordic power cooperation.

A considerable amount of Nordel's work takes place in standing and special committees. Standing committees have been appointed to deal with recurrent questions while special committees deal with questions of a more transient nature. In some cases contact groups have also been appointed.